REPORT
TO
THE CITY OF GUELPH

PRELIMINARY REMEDIAL ACTION PLAN
FORMER IMICO PROPERTY
200 BEVERLEY STREET
GUELPH, ONTARIO

Prepared by:

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6 March 2008

City of Guelph
Legal Department
City Hall
59 Carden Street
Guelph, Ontario
N1H 3A1

Attention: Mr. Jim Stokes, B.Sc., SR/WA
Manager, Realty Services

Re: **Preliminary Remedial Action Plan**
Former IMICO Property
200 Beverley Street
Guelph, Ontario

Dear Sirs:

Decommissioning Consulting Services Limited (DCS) is pleased to provide the following preliminary remedial action plan report for the former IMICO facility located at 200 Beverley Street in the City of Guelph. The report presents and discusses approaches to be taken to remediate and or manage subsurface contamination present on the subject site.

We trust that the information presented in this report is of assistance to the City of Guelph in initiating the redevelopment of this former industrial property. Please do not hesitate to contact us should you have any questions or if we may be of further assistance.

Yours very truly,

DECOMMISSIONING CONSULTING SERVICES LIMITED

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EXECUTIVE SUMMARY

Decommissioning Consulting Services Limited (DCS) has been retained by the City of Guelph to prepare a Preliminary Remedial Action Plan for the redevelopment of the brownfield property located at 200 Beverley Street in the City of Guelph. This property was formerly occupied by the International Malleable Iron Company (IMICO).

The soils and ground water on the 200 Beverley Street property have been impacted by long term industrial use and exceeds the applicable O.Reg 153/04 standards for both MOE Table 1 background standards and MOE Table 2 standards for coarse grained soils in a potable ground water scenario. Due to the environmental concerns associated with the site the property is also subject to a MOE Directors Order. Given the shallow overburden conditions present the property is considered a potentially sensitive site. Therefore, MOE Table 1 background standards are the applicable generic standards for the site. As a result, it will be necessary to remediate and/or manage the soil and ground water environmental impacts on the property to allow for redevelopment of the site.

Based on the results of the DCS Phase II ESA it has been determined that the ground water in the eastern portion of the property is more highly impacted than within the west portion of the site. Groundwater impacts within the eastern portion of the site appear to at least in part originate off site. These off site contaminant issues significantly complicate future ground water remediation activities at the site. Therefore, it is recommended that consideration be given to legally severing or otherwise separating the property on or near a line extending from the east side of Kingsmill Avenue northward to the north property line. The property to the west of this line could be more readily redeveloped for a variety of land uses. More long term ground water remediation activities will likely be required for the eastern portion of the site potentially restricting some of the potential land use options for this area.

Given the above issues less extensive soil remediation activities may be appropriate for the eastern portion of the site, depending on the proposed land use for this area and the overall approach to be taken to soil and ground water remediation and management in this area. In some cases, prior to severing of the lands, it may be advantageous to transfer some of the impacted soil from the west portion to the east portion of the site.

Four main scenarios have been considered with regard to soil remediation. These include:

1. Using the currently applicable MOE Table 1 background Standards
2. Completing a LSRA to allow for the use of MOE Table 2 Standards applicable for a potable ground water use area
3. Completing a LSRA for the use of MOE Table 2 Standards plus using the elevated zinc background values
4. Completing a full scope Risk Assessment for the proposed site specific land use

Currently the applicable generic cleanup requirements for the site are MOE Table 1 standards. Site remediation using these standards would result in the order of 79,200 m^3 of impacted soil being removed from the property at substantial cost.

Completion of a Limited Scope Risk assessment (LSRA) would potentially allow for the use of MOE Table 2 potable standards to govern site remediation requirements. The site could then be remediated with approximately 50,000 to 54,000 m^3 of soil requiring removal.

The third option is the completion of a LSRA to meet MOE Table 2 potable standards for all parameters with the exception of zinc for which a higher value would be used due to the existing evidence of elevated background zinc concentrations in the Guelph area. Given that zinc is the primary contaminant of concern on the property the soil remediation quantity would reduce to about 23,000 m^3.

The final option is completing a full scale risk assessment as permitted by the MOE with no special local restrictions or limitations. Some soil remediation activities may be required on the site, however, the quantity of soil involved is not possible to accurately predict without completing the risk analyses. It is anticipated that many soil impacts can be managed on site by placement of asphalt and concrete hard surfacing, clean soil barriers, controls on surface water infiltration and similar risk management measures. The RA will likely be required to ensure that groundwater discharging from the site meets MOE potable ground water quality standards.

Ground water impacts relative to the current or proposed MOE Table 1 background standards are present throughout most of the western portion of the site and may locally extend off site. Ground water remediation to MOE Table 1 background levels would very difficult. A more practical approach would be to complete a LSRA justifying the use of MOE Table 2 potable ground water standards. Currently the contaminant impacts exceeding MOE Table 2 are primarily within the limits of the property, however, some PAH impacts are present near the west property boundary. In order to prevent the impacted ground water from reaching the property lines recovery well(s) could be installed. Water recovered would be directed to a treatment system and typically discharged to the municipal sewer.

Even with the completion of a full scope risk assessment potentially not requiring MOE Table 2 standards to be met within the western portion of the site, it is anticipated that some pump and treat activities will be required to be installed, if only for use on a standby bases, to ensure that ground water leaving the site meets MOE Table 2 potable ground water standards.

In the eastern portion of the property the source and extent of the ground water impacts has not yet been fully determined. Information obtained to date, as well as MOE correspondence, suggests that ground water impacts within the east portion of the site originate, at least in part, off site. Some ground water impacts are also present downgradient of the 200 Beverley Street site. Additional investigation work should be completed to define the source area and the full extent of the off site plume.

Given the ground water contaminant concentrations, the presence of the impacts within fractured bedrock and the associated off site impacts, completion of a ground water remediation program limited to within the eastern portion of the 200 Beverley Street site is not practical as there is a high potential for the site to become recontamination by ground water from upgradient areas.

Ex situ methods would likely be the most effective ground water clean up approach within the eastern portion of the site. These methods could include a series of recovery wells leading to a treatment system which would consist of filtration, precipitation and granulated activated carbon polishing.

Further ground water quality review should also be carried out to determine if ground water migrating across the eastern portion of the site is subject to in any appreciable increase in contaminant concentrations. For some contaminants upgradient contaminant concentrations are similar to those downgradient suggesting that the eastern portion of the 200 Beverley Street site is not necessarily contributing to the groundwater impacts. The "reasonable use" scenario should be considered in any future ground water treatment and/or risk assessment approval request.

In conclusion, it is suggested that ground water quality issues within the eastern portion of the site be dealt with separately from the western portion of the property. Both groundwater treatment and/or risk assessment approaches may be required to manage the ground water impacts.

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1.0 INTRODUCTION

Decommissioning Consulting Services Limited (DCS) has been retained by the City of Guelph to prepare a Preliminary Remedial Action Plan for the brownfield property located at 200 Beverley Street in the City of Guelph. This property was formerly occupied by the International Malleable Iron Company (IMICO).

The work was completed as part of an evaluation of the property in preparation for redevelopment. This evaluation included completion of Phase I and Phase II Environmental Site Assessments (ESAs) that further defined the extent of contamination on the site. These studies built on the knowledge gained through previous investigations completed by others since 1989. The DCS reports as well as the previous documents should be reviewed to gain a more complete understanding of the subsurface environmental conditions present at the site.

1.1 PREVIOUS ENVIRONMENTAL INVESTIGATIONS - PHASE I ESA

Numerous environmental studies have been completed in the past by others and these have been summarized in the following report prepared by DCS for City of Guelph:

- *Phase I Environmental Site Assessment, IMICO Property, 200 Beverley Street, Guelph, Ontario*, dated 20 December 2007.

The following paragraphs summarize the findings and recommendations of the Phase I ESA.

1.1.1 Historic Land Use

The International Malleable Iron Company purchased the site as 200 Beverley Street in 1912 for development as a foundry. No evidence of previous commercial or industrial land use has been found. The foundry operated as an iron-jobbing facility for the production of various metallic forms using malleable and ductile iron.

A complete description of the historic land use is provided in the Phase I ESA report.

1.1.2 Historic Nearby Land Use

Nearby historic land use activities that could have had a detrimental effect on the site included:

- a facility operated by Canadian Oil Company at the northwest corner of Elizabeth Street and Victoria Street. This facility operated from at least 1938 to 1957.

- a facility operated by Guelph Stove Works located at 490 York Road, immediately to the east of the IMICO property. This facility included machine shops, enamelling facilities, presses and assembly areas. This facility operated from at least 1930 to later than 1964. Further information was not available at the time of the preparation of this report.

- a plant operated by Holody Electro-Plating located at 66 Victoria Road South. This facility operated from at least 1957 to the present.

- a coal/coke dealer was located at 141 Victoria Road South in 1957. Additional information is not available.

- a number of wood working facilities operated along Elizabeth Street and Victoria Roads between 1926 and the present.

1.1.3 Current Land Uses

There was no evidence of current activities on the site could affect the quality of the soil or ground water. The site is currently fenced and no tenants occupy the property.

1.1.4 Adjacent Land Use

Current nearby land use generally consist of light industrial activities with some residential use located to the south and north east of the site. A number of facilities, located within 0.5 kilometres, have the potential to impact on the site. These include gasoline stations, a polymer manufacturer and an electro-plating operation; however, there is no direct evidence that any adverse effects have been generated by the current property occupants.

There have been three Certificates of Approval (C of A) issued on nearby lands that could impact the soil and/or ground water. These include two ground water treatment systems and one soil treatment demonstration plant.

One C of A is for a facility located approximately 0.2 km to the south west of the site on Alice Street. According to available information a toluene discharge has occurred in the past and a number of recovery wells and treatment system are in place. In addition, a number of observation wells are in the area including one located on the east side of Stevenson Street at the intersection with Alice Street.

The second C of A for ground water treatment is for a site located on Morris Street approximately 0.5 km to the south west. This system is for a site that was owned at the time by Esso Canada. This C of A was issued in 1991 and it is not known if Esso continues to operate the site nor if the treatment system is still in operation.

The C of A for the soil treatment demonstration plant is registered to a site located across from the property at the south east corner of Stevenson and Beverley Streets. This C of A was issued in 1992 and it is not known if the system is still being operated.

A national PCB site is reported to be located on the adjacent property at 490 York Road. This site consists of six transformers that contain PCBs. The concentration of PCB in these transformers nor the conditions of the transformers is not known.

There are numerous sites registered as waste generators under O. Reg. 347. A total of 86 (including six for the IMICO property itself) are located within 0.5 km of the site with an additional 301 being located between 0.5 and 2 kilometres from the property. The types of waste generated within 0.5 km include organic and inorganic chemicals, emulsified oils, petroleum distillates, aromatic and aliphatic solvents and acidic wastes.

A compete description of adjacent land use has been provided in the Phase I ESA report.

1.1.5 Recommendations of the DCS Phase I ESA

In order to address the potential environmental concerns identified, the Phase I ESA recommended that a Phase II ESA subsurface investigation program be undertaken. The Phase II ESA program was required to address the following:

- At the eastern end of the property there is residual contamination present in both the soil and ground water that consists of metals, VOCs and petroleum hydrocarbons. Given that the previous soil sampling took place a number of years ago and the volatile nature of VOCs and petroleum hydrocarbons, natural degradation may have resulted in lower concentrations of these contaminants at the site. Therefore, soil sampling and chemical analyses was proposed to ascertain the current concentration of these contaminants. As metals, PAH and PCB do not readily degrade their concentrations were assumed to be similar to that originally identified.

- In the centre of the property, in the vicinity of the capacitor room, there have been PCBs detected in low concentrations in the ground water. In addition, PCBs were detected in low quantities in the bedrock after the completion of the remediation of the capacitor room. Additional boreholes and monitoring wells were proposed to be installed in this area to further define the soil conditions.

- At the western end of the site property elevated levels of metals and occasional VOCs were found. Additional boreholes were proposed to be drilled and soil samples submitted to further define the extent of impact.

- The impacts downgradient of the site, along Kingsmill Avenue, were not known. In addition, it is not known if there are impacts in the vicinity of the houses located to the south of the property along Beverley Street. Monitoring wells were proposed to be installed in order to obtain ground water samples for analysis.

1.2 PREVIOUS ENVIRONMENTAL INVESTIGATIONS – DCS PHASE II ESA

The results of the Phase II ESA work completed by DCS are presented in the following report:

- *Report to the City of Guelph, Phase II Environmental Site Assessment, Former IMICO Property, 200 Beverley Street, Guelph, Ontario*, dated 21 December 2007.

The following paragraphs summarize the key findings of the Phase II ESA completed for the site.

The proposed MOE standards of the *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act* (O.Reg. 153/04) were used to compare the results of the chemical analyses of representative soil and ground water samples obtained from the site. The proposed standards, rather than the current standards, were used as it was anticipated that a significant period of time would elapse between when the site investigation work was being carried out and when environmental approval for the proposed redevelopment was obtained.

Under O.Reg. 153/04 the property is considered to be a shallow soil condition site in that the overburden is less than 2 m in thickness and therefore MOE Table 1 is considered to be applicable.

If the proposed MOE Table 1 background standards are utilized the main subsurface impacts will be from metals, in both the soil and ground water, across the entire site. Numerous metals were found but the primary impacts are from lead and zinc. Impacts from PHCs, VOCs, PAHs and PCBs are mainly present in three areas with isolated impacts found elsewhere. These areas are at the east end of the site, within the centre of the site in the vicinity of the former power house and capacitor room and in the vicinity of the former maintenance garage.

If the proposed MOE Table 2 standards for potable ground water land use areas are applied to the site widespread soil metal contamination is identified across the site. Proposed MOE Table 2 exceedances for metals in the ground water are found in the east end of the site. The remaining parameters are primarily restricted to the east end of the property, in the centre of the property in the vicinity of the former capacitor room and power house and in the vicinity of the former maintenance garage. Additional exceedances were found elsewhere across the property in isolated locations.

Given the nature of the soil and ground water impacts at the site an extensive soil remediation program would be required to clean up the property to proposed or current generic standards suitable for residential/parkland/institutional use. Alternative, consideration could be given to utilizing a risk assessment approach to manage the impacted soils on site. This could be most readily accomplished if industrial/commercial/community use of the property is continued in the future.

2.0 PRELIMINARY REMEDIAL ACTION PLAN - SOIL

Four options for the Preliminary Remedial Action Plan (RAP) for the soil are being considered at this time. The following sections provide details and a rationale for each option. The options considered at this time are:

1. Generic Cleanup to MOE Table 1 Background Standard
2. Limited Scope Risk Assessment to Current MOE Table 2 Standards
3. Limited Scope Risk Assessment to Current MOE Table 2 Standards With Elevated Zinc
4. Full Scope Risk Assessment

In generating the options described below and determining the area and therefore volume of impacted soils, a number of assumptions have been made. These are as follows:

1. Metal, PAH and PCB data obtained over a number of years was utilized while the VOC and PHC data obtained during the 2007 sampling program was used to determine the contaminant distribution.

2. The areal limit of soil impacts has been assumed to extend to the first 'clean' borehole that does not have any parameters exceeding the applicable standard. This assumption is in line with MOE requirements but may result in an overestimation of the limits and volume of impact.

3. Review of borehole log information indicates that the total overburden thickness above bedrock is typically 2 m or less. If one sample in the soil profile is found to exceed the applicable standard it has been assumed that the entire relatively thin soil sequence is impacted. During the Phase II ESA it was found that in some instances a sample in the upper portion if the soil sequence exceeded the applicable standard while a sample lower in the sequence met the standard. At a different location the opposite was true. As a result, it has been concluded that it is not feasible to attempt to sort the soils in the sequence based on the previously collected data.

4. The average depth of the soil cover is 1.65 m across the entire site. The actual depth to bedrock varies slightly between borehole locations.

5. The area of the entire site is approximately 52,250 m^2 (5.2 ha).

6. The total volume of soil on the property using the above values is estimated to be 86,000 m^3.

Consideration should be given to surveying and potentially legally severing the property along a line that extends northward along the east side of Kingsmill Avenue through the site to the northern property line. The soil and ground water in the eastern portion site have been heavily impacted by metals, VOCs, PAHs and PHCs. The lands to the west of this proposed line are not as heavily impacted. Severing the property at some point during the overall process will allow for a more rapid remediation, and therefore redevelopment, of the western portion of the site. This tentative severance line has been shown on the attached site remediation drawings. The line location is primarily governed by the estimated extent of ground water impacts. The severance line could be readily moved to the west should this be advantageous from a landuse ownership perspective.

If the property is severed along this line the following dimensions and soil volumes will apply:

PROPERTY	AREA (m^2)	TOTAL SOIL VOLUME (m^3)	AVERAGE DEPTH (m)
Total Property	52,250	86,026	1.646
Eastern	7,920	14,628	1.85
Western	44,321	71,357	1.61

The areas and volumes for the entire property and each of the severed portions, will be carried through this document. A summary of all soil remediation areas and volumes is provided in Table 2.1.

2.1 GENERIC CLEANUP TO MOE TABLE 1 BACKGROUND STANDARDS

A revised draft set of soil, ground water and sediment standards was released by the MOE for public comment on 23 March 2007. These standards, while not adopted at this time, may become part of the regulation within the next 2 years and potentially before redevelopment of the site has been completed. After the new standards have been accepted it will be necessary to meet these standards prior to the issuing of a Record of Site Condition (RSC) if a generic cleanup approach is chosen.

TABLE 2.1
FORMER IMICO PROPERTY
ESTIMATED EXTENT OF SOIL IMPACTS

Option Number	Scenario	Entire Property			Eastern Property			Western Property		
		Area (m^2)	Volume (m^3)	% of Site	Area (m^2)	Volume (m^3)	% of Site	Area (m^2)	Volume (m^3)	% of Site
1	Current Table 1	48,164	79,243	92%	7079	13,096	89%	41,085	66,147	93%
	Proposed Table 1	46,092	75,888	88%	7000	12,950	88%	39,092	62,938	88%
2	LSRA - Residential (Current Table 2)	32,494	53,966	62%	6877	12,722	87%	25,617	41,243	58%
	LSRA - Industrial (Current Table 2)	30,014	49,956	57%	6804	12,587	86%	23,210	37,368	52%
3	LSRA - Elevated Zinc	22,993	38,588	44%	6539	12,097	82%	16,454	26,491	37%

	Entire Property	Eastern Property	Western Property
Average depth to bedrock =	1.6500 m	1.85 m	1.61 m
Total area of property =	52,250 m^2	7,929 m^2	44,321 m^2
Total Volume of Soil	86025.46	14668.65	71356.81 m^3

For the Phase II ESA report DCS opted to select the proposed standards as it was believed at the time that they would be in place when the property was developed. However, since that time objections to the proposed standards have been raised by various groups and, as a result, additional testing is being completed to determine background values in soils and ground water across the province. Issues have been raised as to the ability of laboratories to achieve some of the required detection limits. This may result in alterations to the proposed standards and delayed implementation. As a result, both the proposed and currently applicable generic standards have been carried through this preliminary remedial action plan report.

If the generic standards are accepted then the MOE Table 1 background standards must be followed as the IMICO property is considered a sensitive site due to the shallow soil conditions (i.e. less than 2 m).

A discussion of the extent of the soil impact associated with the proposed and current background standards is presented in the following subsections.

2.1.1 Current MOE Table 1 Background Standards

The extent of impact under the currently applicable O.Reg. 153/04 MOE Table 1 background standards is shown on Drawing 49520-RAP-2.1. As may be seen the impacted soils cover almost the entire site. Small areas of non impacted soil are found along the west and north side of the property. There is an area of non impacted soil in the north east corner of the property. This area was remediated during the demolition and initial remediation of the site completed by Proctor and Redfern/Earthtech in 1998 and 1999. A small area was also remediated in the centre of the property in the area of the former capacitor room. This is a small area which will not be feasible to isolate during any additional remediation program, therefore, it has not been identified on this plan as a clean soil area.

The estimated area of impacted soil is approximately 48,164 m^2 across the entire site. Based on an average depth of 1.646 m the total volume of soil to be removed from the site is 79,243 m^3. Clean up to these standards would result in removal of approximately 92% of the soil on the property.

If the property where to be severed the impacted area of the eastern portion of the property is approximately 7,079 m^2. Given an average overburden depth of 1.85 m a total volume of

13,096 m^3 of impacted soil would be excavated. This would result in approximately 89% of the soil being removed from this area.

If the western portion of the property was cleaned up to the current MOE Table 1 background standards an area of approximately 41,085 m^2 would be excavated. With an average depth to bedrock of 1.61 m the total volume of soil that would have to be excavated is approximately 66,147 m^3. This is approximately 93% of the soil in this portion of the property.

2.1.2 Proposed MOE Table 1 Background Standards

The extent of impact exceeding the proposed MOE Table 1 background standard soils at the site are shown Drawing 49520-RAP-2.2. As may be seen the impacts are similar under the proposed MOE Table 1 standards to those under the current MOE Table 1 standards. As may be seen the non impacted soils are primarily present along the north property line and within small areas along the west property line and within the central portion of the site.

Based on the limits shown the total area of soil impact is approximately 46,092 m^2 with an estimated volume of soil 75,888 m^3 resulting in removal of approximately 88% of the soil within the property.

On the eastern portion of the property the area of impact is 7,000 m^2 with the volume of impacted soil being 12,950 m^3. This would result in 88% of the soil being excavated from this portion of the site.

In the western portion of the property the area of impacted is approximately 39,092 m^2. Given an average depth to bedrock of 1.61 m there is approximately 62,938 m^3 of impacted soil to be removed from the property.

2.1.3 Summary

Using the MOE Table 1 generic background standards will result in removal of essentially all of the soil on the site and, if necessary, replacement with clean fill. The background standards are the applicable standards for the site given the shallow overburden conditions and the results of synthetic leachate testing on a variety of samples, as discussed in the DCS Phase II ESA report.

2.2 LIMITED SCOPE RISK ASSESSMENT TO CURRENT MOE TABLE 2 STANDARDS

To reduce the impacted soil volume and soil remediation costs for the 200 Beverley Street site one alternative is to complete a Limited Scope Risk Assessment (LSRA). The LSRA would be used to justify the use of the current MOE Table 2 site condition standards which are applicable for potable ground water use areas such as the City of Guelph. If approved by the MOE and if a RSC is submitted, this would in effect establish the current MOE standards as the applicable standards for the site rather than the somewhat more onerous proposed MOE Table 2 standards. Completion of a LSRA may be most appropriate for the western portion of the site as fewer ground water impacts are present in this area.

A LSRA is a risk assessment (RA) completed in accordance with Section 7 of Schedule C in O. Reg. 153/04; however, it does not attempt to find new allowable standards for all parameters that exceed the applicable generic MOE Table 1 standard rather it will attempt to find allowable values that use some or all of the generic standards. This approach can result in an RA of less complexity and a shorter time requirement for the review.

A LSRA can be undertaken if:

1. the risk assessment is not a "new science risk assessment";
2. the risk assessment is not a "wider area of abatement risk assessment"
3. no risk management measure is proposed or required to meet the target level of risk specified in "report sections" 4 and 5 of Table 1 of Schedule C of Ontario Regulation 153/04 under the heading "Risk Characterization"; and,
4. if one of the following conditions is met:
   - One or more applicable site condition standards are exceeded but only in the ground water under the risk assessed property and the source of the contaminant is or was located off the risk assessed property.
   - The applicable full depth generic potable site condition standards are met for all environmental media, but Section 41 (i.e. environmentally sensitive areas) of Ontario Regulation 153/04 applies to the property.
   - The risk assessment uses the same models and assumptions used by the Ministry to develop the full depth generic site condition standards and the models and assumptions are appropriate, having regard to the characteristics of the risk assessed property.

Situations may exist where, in the opinion of the qualified person assessing a property, there are significant physical and environmental conditions or receptors present that may not be protected by the full depth generic site condition standards. As these situations may be environmentally sensitive areas as identified in Subsection 41(1)(e) of Ontario Regulation 153/04, a LSRA may be warranted.

A new science risk assessment is applied when one of the following criteria is applicable:

- a contaminant of concern is identified during a Phase II ESA for which there is no applicable site condition standard;
- the risk assessment uses a computer (risk assessment) model that is not publicly available or unfamiliar to the Ministry of the Environment; or,
- the risk assessment uses a probabilistic model for exposure assessments.

At the 200 Beverley Street property none of the above criteria would apply as there are standards for all parameters under MOE Table 2 and, therefore, the risk assessment models would not be required.

The site is also not considered to be part of a wider area of abatement as the contaminants are considered to have originated on site at this point in time. If it is determined at a later date the impacts at the east end of the property are the result of off-site activities and it becomes part of a wider area of abatement then this portion of the property can be severed and the LSRA applied to the western portion of the property.

If all soil exceeding MOE Table 2 standards can be removed from the western portion of the site and a ground water pump and treat system installed to remediate localized ground water impacts to meet potable water quality standards then a LSRA could be successfully completed within this area of the site.

In this case no risk management plan will be required for the site and the third criteria from above is met. The pump and treat system for the ground water may be considered a remedial measure and not a risk management measure as it is being used to remove a contaminant so that the media meets the applicable standard. Risk management measure frequently are required to prevent the contaminant being transferred to another media such as being volatilized and being discharged into the atmosphere.

The fourth criteria will be met as the LSRA will use pre-existing values that have been provided by the MOE and the models used to generate the values have been accepted the MOE.

Based on the above a LSRA could likely be accepted by the MOE for the 200 Beverley Street property provided necessary soil and ground water remediation activities are carried out.

If a LSRA is used a decision will have to be made by the City of Guelph as to final land use (i.e. Residential/Parkland/Institutional (RPI) or Industrial/Commercial/Community (ICC)). The final decision will impact on the volume of contaminated soil and, therefore, the cost to remediate the site. The 200 Beverley Street Property Use Study, completed in 2004 for the City of Guelph identifies a variety of land use configurations that would be acceptable to the City and the local community.

The extent of soil excavation using the RPI standards is shown on Drawing 49520-RAP-2.3. The extent of the soil impact is less than would be used under MOE Table 1. The extent of excavation for the entire property is approximately 32,494 m^2 and the total volume of soil removed would be approximately 53,966 m^3 or approximately 62% of the soil on the property. If the property is severed to the north of Kingsmill Avenue approximately 6,877 m^2 of the eastern portion of the former IMICO property would be impacted. Given an average depth of approximately 1.85 m there would be approximately 12,722 m^3 of soil removed. Within the western portion of the property an area of approximately 25,617 m^2 would be excavated and given an average depth of 1.61 m a total of 41,243 m^3 of soil would be removed from the property. This represents approximately 58% of the soil on this portion of the property.

The extent of impacted soil using the ICC criteria is shown on Drawing 49520-RAP-2.4. The extent of excavation is reduced from the use of the residential MOE Table 2 standards but still occupies approximately 57% of the site. Approximately 49,956 m^3 of impacted soil would have to be removed from the site. As may be seen metals are the major parameter group of concern on the site. On the eastern portion of the property an area of 6,804 m^2 would have to be excavated which result in the removal of 12,587 m^3 of soil. On the western part of the property an area of approximately 23,210 m^2 would have to be excavated. Using an average depth of 1.61 m there would be 37,368 m^3 of soil to be excavated or approximately 52% of the property.

2.3 LIMITED SCOPE RISK ASSESSMENT WITH ELEVATED ZINC

Metals are the major contaminant of concern at the former IMICO property. Raising the standards for this group by using the information contained in previously completed MOE reports and conducting a LSRA would reduce the volume of impacted soil on the site requiring removal.

Previously released documents address the level of contamination in the area surrounding the former IMICO site. These documents are entitled:

- *Phytotoxicological Investigation in the Vicinity of International Malleable Iron Company (IMICO) Guelph, Ontario on April 19, 1990.* Report prepared by Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment, dated February 1992.

- *Technical Memorandum, Phytotoxicological Sampling of Survey Sites 8 and 11 – IMICO, Guelph (1995).* Technical Memorandum Standards Development Branch, Phytotoxicology Section, Ontario Ministry of the Environment, dated January 26 1996.

- *Evaluation of Soil Contaminant Concentrations in the Vicinity of a Former Foundry Site in Guelph, Ontario for Potential Human Health Effects*, Ontario Ministry of the Environment, Memorandum to Guelph District Office from Mario Pagliarulo, Standards Development Branch, dated 20 January 2006.

The above documents, which were prepared by the Ontario Ministry of the Environment, examined the surficial soil in the vicinity of the IMICO property on three occasions in order to determine the impact from previous site activities while the IMICO facility was in operation. Copies of these documents are attached in Appendix A for reference.

Soil samples were obtained from the upper 5 cm of the soil profile at 15 locations in the vicinity of the IMICO property. On a second occasion sampling was carried out on two nearby sites over the 0-5 cm and 15 to 20 cm depth intervals. Given that the metal concentrations on the IMICO property were found to be variable throughout the soil profile during this and previous investigations it could be extrapolated that the same conditions would exist off the IMICO site.

Therefore, the concentrations found off-site at surface could be expected to be found throughout the soil profile.

The collected samples were analysed for metals and compared to the Decommissioning Guidelines that were in place at that time. The background zinc concentration in the immediate area, based on mapping provided in the cited reports ranges between 750 ug/g and 950 ug/g while the current MOE Table 2 standard is 600 ug/g. In addition, a number of other parameters were elevated and are above the current MOE Table 1 Standards. These include antimony, cadmium, lead and arsenic. The background antimony and cadmium values are less than the RPI and ICC MOE Table 2 concentrations while the detected lead concentrations is greater than the current RPI concentration but less than the current MOE Table 2 ICC values.

It was determined that the parameters are elevated throughout the area and that these elevated concentrations typically could not be directly attributed to past activities on the IMICO property.

Given the above information, that has been verified by the MOE, a case could be made that the new property specific standards for the 200 Beverley Street site should, as a minimum, reflect the background values found during these assessments. Further sampling, testing and analyses may need to be carried out to define the appropriate zinc background concentration for the Beverley Street area of Guelph. Using the information provided in the above noted documents DCS has tentatively proposed using a background value of 800 ug/g for zinc and the current MOE Table 2 industrial/commercial/community standard for all other metals. It is noted that MOE 2006 calculations indicate a zinc standard of 1,700 ug/g is sufficient to be protective of human health in a residential landuse scenario at a nearby site.

The extent of impact using a LSRA and elevated background levels for zinc is shown on Drawing 49250-RAP-2.5. As may be seen the extent of impact is reduced from previous scenarios but is still considerable. Across the entire property an area of 22,993 m^2 is considered impacted and given an average depth to bedrock across the site of 1.65 m, a total of 38,588 m^3 of impacted soil is present.

On the eastern portion of the property an area of approximately 6,539 m^2 is impacted and, given a soil depth of 1.85 m, a total volume of 12,097 m^3 of impacted soil would have to be removed from the site.

On the western portion of the property the total area of impacted soil has been greatly reduced using the LSRA and an elevated cleanup value for zinc. A total area of approximately 16,454 m^2, with a resulting volume of 26,491 m^3 will have to be excavated and removed from the property. This represents approximately 37% of the soil on this portion of the property.

2.4 FULL SCOPE RISK ASSESSMENT

Completion of a full scope risk assessment is an option which should be seriously considered for the 200 Beverley Street site. This risk assessment would determine the appropriate contaminant cleanup concentrations (property specific standards) for both human health and ecological receptors for the specific landuse configuration and receptor exposure scenarios proposed for the site. Given the site specific nature of the analyses and the risk management measures implemented, higher contaminant concentrations can be permitted on the property, thereby reducing remediation costs.

A Risk Assessment (RA) is completed in order to determine whether or not the measured on-site concentrations of contaminants pose an unacceptable risk to on and off site human and ecological receptors. Following completion of the RA a RSC is to be filed on the MOE's Environmental Site Registry. Therefore, the RA must be completed in accordance with O.Reg. 153/04 – Records of Site Condition. The key steps in completion of an RA are:

- Environmental Site Characterization;
- Development of a Conceptual Site Model;
- Preparation and Submission to the MOE of a PreSubmission Form (PSF);
- Human Health Risk Assessment (HHRA);
- Ecological Risk Assessment (ERA);
- Development of Property Specific Standards (PSS);
- Development of a Risk Management Plan (RMP);
- Submission of a RA report to the MOE for its review;

- Revision of the RA report addressing the MOE review comments; and

- Submission of a revised RA report to the MOE for its further review.

The last two steps are repeated until the RA is accepted, but in our experience the revised RA report is generally accepted with only minor additional revisions.

Once the RA is accepted by the Ministry, and any remediation or implementation of Risk Management Measures required by the Risk Management Plan are completed, then a RSC can be prepared and filed on the MOE's Environmental Site Registry.

Further details of the requirements to be completed in preparation of a full risk assessment are provided below.

2.4.1 Environmental Site Characterization and Conceptual Model

An environmental site characterization must be completed prior to the start of the RA process. Numerous investigations have been completed on the site culminating with the DCS Phase II ESA which has been previously referenced. The information gathered through the process is used as a basis for describing the site and developing the conceptual site model. The Conceptual Site Model provided a simplified description of the geologic, hydrogeologic and contaminant conditions that will be present along with the potential contaminant pathways to the anticipated receptors. This conceptual site model is used to describe the site for the PreSubmission Form (PSF) that is submitted to the MOE for their approval prior to the start of the RA process.

2.4.2 Preparation of the PSF

As the first approval stage in conducting a risk assessment, a Pre-Submission Form (PSF) must be submitted by the RA property owner to the Ministry for review in advance of the RA report. Conducting a risk assessment includes compiling property characterization and receptor characterization information in the PSF. The QP_{RA} should develop the PSF with a team of experts who possess the expertise required to address all exposure pathways and receptors of potential concern.

The PSF provides an opportunity to confirm with the Ministry that the risk assessment approach and general scope as described in both narrative and visual forms (conceptual site model) are appropriate for the site and contaminants being considered.

The QP_{RA} must prepare the PSF for the property owner, based on the results of the Phase I ESA, and Phase II ESA and any other information that the QP_{RA} considers relevant. The Ministry will prepare a letter of response that indicates the review timeline required for the RA approach, as well as comments concerning the scope of the RA. The purpose of the PSF is to:

- Identify the RA property and ownership;
- Identify the risk assessment team technical leads and self declaration of the QP_{RA};
- Confirm that a Phase I ESA and Phase II ESA have been conducted as prescribed by the RSC Regulation;
- Provide the proposed scope of the risk assessment including a preliminary conceptual site model and hazard identification of the RA property by:

    1. Describing the RA property setting, contaminant sources, potential COCs, transport pathways, exposure pathways (including the results of any screening level assessment, if performed), and human and ecological receptors,
    2. Including a summary of key data that supports the conceptual model,
    3. Proposing the collection of additional data, if required, and
    4. Proposing an approach for proceeding with the risk assessment that will determine the timeline for risk assessment review.

The PSF provides the ministry with a general view on the approach to the risk assessment and the risk assessment team at an early stage.

2.4.3 HHRA, ERA and Development of PSS

The heart of a RA is the completion of the human health risk assessment (HHRA), ecological risk assessment (ERA) and subsequent development of property specific standards (PSS) based on the conclusions of the HHRA and ERA. Data bases of toxicity information of the contaminants of concern are researched to obtain the most up to date information, and the increased risks to the various receptors due to exposure to the contaminants are calculated using formulae approved by the MOE. The MOE has established a maximum permissible risk factor and if the calculated risk for a particular contaminant exceeds that value, then the existing situation is judged unacceptable and risk management measures (RMM) are warranted. However, if the calculated risk is lower than the risk factor, then a PSS can be developed that is proportionately higher than the generic standard listed in Table 2. For those contaminants where a RMM is required to reduce receptor exposures to acceptable levels, then PSS can be developed for the case after implementation of the RMM.

2.4.4 Development of Risk Management Measurements (RMM)

A component of any RA is the development of RMM and the preparation of a Risk Management Plan, signed and sealed by a professional engineer or geoscientist. The RMM may include design and implementation of engineered controls such as physical barriers and venting systems, administrative controls such as barring construction over certain areas of the site, or simple monitoring of RA sites where the contaminants of concern are not present in concentrations exceeding the PSS. For the subject site, it is hoped that the RA will conclude that no engineered controls are required for the site, and that only monitoring of indoor air and of ground water will be required, to ensure that unsafe levels of contaminants do not arise in the future. The key elements of the RMM would be incorporated into the MOE Certificate of Property Use (CPU) prepared for the site.

2.4.5 Preparation and Submission of RA Report

Upon completion of the site characterization, HHRA and ERA, development of PSS and a Risk Management Plan, all these elements are consolidated in a single document, accompanied by background factual information, and submitted to the MOE for its review. The duration of the MOE's review is expected to be 16 weeks to 22 weeks.

2.4.6 Revision of RA Report and Re-Submission to the MOE

After receipt of the MOE review comments on the RA report, one of three scenarios will occur. The first is that the MOE accepts the RA report as originally submitted and no further work on the RA is required (this is extremely unlikely). The second is that the MOE has provided a series of comments, but feels that responding to the comments will be quite simple, and 'stops the clock' during the 16 week review period, allowing the consultant to prepare an Addendum addressing the comments. The third and most likely scenario is that the MOE provides a list of comments and asks that the RA report be revised and resubmitted, starting a new 16 to 22 week review period. The revised report must contain a section specifically dealing with the MOE review comments and how they were addressed.

The review process can continue indefinitely, but in our experience it normally lasts only two cycles.

2.4.7 Preparation of a Certificate of Property Use and Record of Site Condition

Once the RA has been accepted by the MOE, it may be possible to proceed immediately to the preparation and filing of a RSC on the MOE's Environmental Site Registry. However, if the RA's Risk Management Plan requires that remediation of contaminated media is required, or if implementation of engineered controls is required, to lower risk levels to acceptable values, then filing of the RSC may have to be deferred until completion of these activities. Where risk management measures are required the MOE will prepare a Certificate of Property Use (CPU) which will be referred to in the RSC for the site.

Contrary to RSCs based solely on Phase I and II ESAs, the MOE reviews drafts of the RSCs to ensure that the risk management measures called for in the RA are appropriately described on the RSC. This process can take several weeks or months.

2.4.8 Applicability to the City of Guelph

The RA process will minimize the volume of soil and ground water to be treated or otherwise managed at the site. The results of an RA will result in allowable contaminant concentrations greater than the MOE Table 2 standards (i.e. greater than the potable water standards) under O.Reg. 153/04. Given that Section 4.3.6 of the City Official Plan states:

The entire City area is considered to be a recharge area for public and private potable water supply. In order to protect this valuable water resource, the City will introduce conditions of development approval that:

1. *Protect wetlands and other areas that make significant contributions to ground water recharge;*
2. *Ensure that storm water management systems protect water quality and quantity;*
3. *Prohibit the extraction of mineral aggregates in significant ground water recharge areas;*
4. *Require all storage of liquid waste, petroleum, fuels, fertilizers and related chemicals be provided for in properly designed and engineered containment areas;*
5. *Require impact studies where proposed development has the potential to affect ground water resources;*
6. *Restrict the placement of underground storage tanks;*
7. *Require that contaminated properties be restored to the appropriate condition in compliance with Ministry of the Environment Guidelines;*
8. *Place restrictions on land use in areas of greatest risk to contamination of ground water resources. Uses that may be restricted include, but are not limited to: industrial landfills, lagoons or other putrescible waste disposal facilities, asphalt and concrete batching plants, the storage or processing of chemical products, gasoline or oil depots and service stations, and vehicle salvage, maintenance and service yards.*

and Section 5.6.4 states:

It is the intent of the City that all contaminated properties be cleaned-up to a level that protects human health by meeting soil and water quality criteria set out by the Ministry of the Environment in the publication "Guidelines For Use At Contaminated Sites In Ontario" (as revised from time to time); a record of site conditions will also be required.

It is noted that the above guidelines have since been superceded by the site condition standards given in O.Reg. 153/04. There is nothing implicit in the Official Plan that states that the Risk Assessment process may not be used on any site within the City of Guelph. At least two RAs have been previously completed and accepted by the MOE within the limits of the City of Guelph.

One RA, completed as a Site Specific Risk Assessment (SSRA), was for 40 Wellington St West. At the time of the SSRA O.Reg. 153/04 was not in place and the property was subject to the old *Guidelines for Uses at Contaminated Sites in Ontario*, requirements for coarse grained soils and potable ground water. New property specific standards were developed for the parameters given in the following table. Also included is the risk assessment standards, the guideline values accepted at the time and the current O.Reg. 153/04 standards.

Soil

Contaminant Name	**New RA Standard**	**GUCSO Table A**	**O.Reg. 153/04 Table 2**
Arsenic	174	40	40
Beryllium	1.9	1.2	1.2
Copper	342	225	225
Ethylbenzene	16	0.28	0.28
Xylenes	151	25	25
Zinc	642	600	600
Petroleum Hydrocarbons (Gas +Diesel)	340	100	NA
Petroleum Hydrocarbons (Heavy Oils)	6800	1000	NA

NA – Not Applicable as there are no equivalent standards under O.Reg. 153/04

Ground Water

Contaminant Name	**New RA Standard**	**GUCSO Table A**	**O.Reg. 153/04 Table 2**
1,1-Dichloroethane	320	70	70
1,1- Dichloroethylene	51	5.0	5.0
CIS-1,2- Dichloroethylene	10000	70	40
Ethylbenzene	370	2.4	2.4
1,1,1- Trichloroethane	1200	200	200
1,1,2- Trichloroethane	30	5.0	5.0
Trichloroethylene	25000	50	50
Vinyl Chloride	1900	0.5	0.5
Petroleum Hydrocarbons (Gas +Diesel)	620	1000	NA
Petroleum Hydrocarbons (Heavy Oils)	2100	1000	NA

NA – Not Applicable as there are no equivalent standards under O.Reg. 153/04

As may be seen the new standards developed by the SSRA are frequently well above the current O.Reg. 153/04 standards for a potable ground water use site, as given in MOE Table 2.

The second RA was completed at the University of Guelph at their former Hazardous Waste Storage Area. This assessment was completed in 2006 and therefore subject to O.Reg. 153/04. At this location the RA provided maximum allowable concentrations for parameters that do not have a standard value under O.Reg. 153/04. The reasoning for adding these parameters is not known.

Based on the above information the City of Guelph may proceed with a Risk Assessment for the 200 Beverley Street site, if it desires, as it is not explicitly denied by the Official Plan. At least two risk assessments have been previously completed within the City of Guelph limits with an MOE acknowledged RSC being issued.

The volume of soil which will require excavation and off site disposal as a result of a full scope risk assessment can not be readily determined without completing the risk assessment analyses. Such an analyses would need to take into consideration the proposed final configuration of the site and the human and ecological receptors anticipated to be present on the site. As Drawing 49520-RAP-2.3 shows only limited areas of the western portion of the site being VOC or petroleum hydrocarbon impacted, it is anticipated that clean soil covers, and asphalt or concrete hard surfacing would be suitable risk management barriers to minimize exposure to primarily heavy metal impacts. The removal of impacted soils from the site and/or the control of surface water infiltration to protect the underlying ground water quality are considered key elements of the risk assessment and risk management plan.

3.0 PRELIMINARY REMEDIATION ACTION PLAN – GROUND WATER

3.1 AREAS OF CONTAMINATED GROUND WATER

Under O.Reg 153/04 the 200 Beverley Street site is considered to be a shallow soil condition site in that the overburden is less than 2 m in thickness. Therefore the property is a potentially sensitive site and MOE Table 1 is considered to be the applicable generic standard at the property. Synthetic leachate tests carried out at the site did not assist in confirming that MOE Table 1 background standards are not applicable. Therefore a LSRA would have to be carried out, as a minimum to determine if the site is suitable for the use of the generic MOE Table 2 site condition standards for a potable ground water use area.

For the purposes of this ground water discussion it has been assumed that the former IMICO property will be severed into eastern and western portions. The tentative line describing this severing is assumed to extend northward from the east side of Kingsmill Avenue to the north property line. Cleanup of the impacted soil on both portions of the property can be completed to the appropriate standards. However, as the ground water contamination source in the eastern portion of the property likely originates off-site remediation of the ground water in the area can not be readily carried out and has not been considered in this Remedial Action Plan. The remedial action plan focuses on the ground water quality impacts within the western portion of the site. It has been assumed that the ground water impacts within the eastern portion of the site will be dealt with under a separate program, which would likely include risk assessment, that would address both on site and off site impacts.

If the generic background standards are considered the ground water contaminant exceedances of current MOE Table 1 are shown on Drawing 49520-RAP-3.1 and the proposed MOE Table 1 exceedances are shown on Drawing 49520-RAP-3.2. The main ground water impacts will be from metals which are present throughout a large portion of the site. Numerous metals were found but the primary impacts were from lead and zinc. Impacts from PAHs are mainly present in four areas: at the west central property boundary, at the north central property boundary, a pocket in the south portion (where PCB impact above Table 1 are also observed) and throughout much of the eastern portion of the site. VOC impacts above current MOE Table 1 standards are observed in ground water in the south central portion of the site and in the south eastern portion of the property. Using the proposed MOE Table 1 standards VOC ground water impacts are effectively present throughout at least the southern half of the site.

If potable ground water land use standards are applied to the site the contaminant areas where current MOE Table 2 standard exceedances are present are shown on Drawing 49520-RAP-3.3 and the proposed standards are shown on Drawing 49520-RAP-3.4. MOE Table 2 exceedances for metals in the ground water are found in a pocket in the central area of the site as well as at the central north boundary of the site. PHC and PAH MOE Table 2 standard exceedances have been identified in small pockets in the central portion of the property. A second pocket of PAH impacts above MOE Table 2 standards was identified at the west central property boundary. Both potable ground water quality standard drawings indicate that there is extensive metals, PAH, VOC and petroleum hydrocarbon contamination within much of the eastern portion of the site. No PCB ground water concentrations above the potable standards were reported.

As may be seen on the drawing the selection of the current or proposed O.Reg 153/04 standards will impact on the extent and therefore volume of impacted ground water. The applicable ground water standards will be dependent on the selection of the appropriate soil standard.

In summary, the contaminants which have been identified to be exceeding the MOE standards at the site can be grouped into two major categories: inorganic and organic. The only inorganic contaminant grouping is metals but there are four chemical classes in the organic grouping: chlorinated VOCs, PAHs, PCBs and PHCs. The remediation techniques for reducing the existing concentrations to acceptable levels must be selected based upon the categories/classes of contaminants and upon the physical/chemical properties of the individual compounds within each category.

3.2 GROUND WATER REMEDIATION OPTIONS

Before discussing specific treatment technologies it is necessary to distinguish between *in situ* and *ex situ* remediation systems. Generally, *in situ* systems involve treating the ground water in place in the subsurface whereas *ex situ* systems involve removing the contaminated ground water from the ground, providing appropriate treatment and then disposing of the treated ground water either by re-injection to the subsurface or by discharge to a municipal storm or sanitary sewer or off-site via a waste disposal contractor.

The remediation technologies applicable to each class or category of contaminant identified at the Beverley Street property and discussed above are reviewed below.

3.2.1 Metals

Unlike the hazardous organic constituents, metals cannot be degraded or readily detoxified. The presence of metals can pose a long-term environmental hazard. The fate of the metals depends on their physical and chemical properties, the associated waste matrix, and the soil. Significant downward migration of metals from the soil surface occurs when the metal retention capacity of the soil is overloaded, or when metals are solubilized (e.g., by low pH). As the concentration of metals exceeds the ability of the soil to retain them, the metals will travel (leach) downward with migrating surface waters.

In situ treatment methods for metals are limited and generally involve isolation using barriers or some method of solidification (generally applicable to soil treatment) whereby a cement type mixture is injected into the ground and the contaminants in the ground water are immobilized in-place. Neither of these techniques is applicable to an environment where the ground water surface is in bedrock.

Ex situ treatment methods for metals involve removing the ground water from key points in the site (to capture source areas and prevent plume migration) such as purging wells or trenches and then treating the ground water using filtration directly (if the metals are associated with fine particles in the ground water); precipitation and flocculation (followed by clarification and filtration); or ion exchange (similar to a water softener with requirements for acid and/or caustic regeneration). The treatment operations most applicable to the Beverley Street site would be filtration alone or including a precipitation step. Precipitation would involve production of a sludge material (the precipitated metals) which would require off site disposal.

3.2.2 PCBs

PCBs are high molecular weight organic chemicals which have low solubility and tend to be present in ground water regimes in a form bound to fine particulate. Although PCB destruction *in situ* might be accomplished using very aggressive oxidation e.g. Fenton's reagent (hydrogen peroxide with an iron catalyst) it would be very difficult to ensure adequate distribution of the oxidizing solutions in the bedrock. A ground water purge system followed by *ex situ* treatment would be a better alternative. The simplest treatment option, once the ground water is removed, would likely be particle filtration (for PCBs bound to fine soil) followed by granular activated carbon (GAC) for polishing any dissolved PCBs.

3.2.3 PAHs

PAHs are generally biodegradable in soil systems. Lower molecular weight PAHs are transformed much more quickly than higher molecular weight PAHs. The less degradable, higher molecular weight compounds have been classified as carcinogenic PAHs (cPAHs). Therefore, the least degradable fraction of PAH contaminants is generally subject to the most stringent cleanup standards. This presents some difficulty in achieving cleanup goals with bioremediation systems.

Lower molecular weight PAH components are more water soluble than higher molecular weight PAHs. Readily mobilized compounds, such as naphthalene, phenanthrene, and anthracene are slightly water-soluble. Persistent PAHs, such as chrysene and benzo(a)pyrene present even lower water solubility. Pyrene and fluoranthene are exceptions because these compounds are more soluble than anthracene, but are not appreciably metabolized by soil micro-organisms. Other factors affect PAH persistence such as insufficient bacterial membrane permeability, lack of enzyme specificity, and insufficient aerobic conditions. PAHs may undergo significant interactions with soil organic matter.

For *in situ* treatment of PAHs a strong oxidizing system such as Fenton's Reagent would be applicable but the oxidant delivery system to ensure adequate distribution in a bedrock condition (i.e. the potentially limited radius of influence from a single injection point) would limit the systems effectiveness. Biodegradation can be an effective *in situ* treatment for some PAHs but given that benzo(a)pyrene, a very recalcitrant compound, is the main contaminant of concern, biodegradation is unlikely to be effective at the Beverley Street property.

The *ex situ* technologies applicable for PAHs include oxidation and GAC.

3.2.4 PHCs

Petroleum hydrocarbons can be readily treated *in situ* using biodegradation. However, as discussed above, the delivery system for ensuring that oxygen and nutrients reach all locations where the contaminants are present is difficult to impossible to implement in a bedrock condition. Thus *in situ* treatment via biotreatment is not a viable option.

Air sparging is an *in situ* technology in which air is injected through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps to flush (bubble) the contaminants up into the unsaturated zone where a vapour extraction system is usually implemented in conjunction with air sparging to remove the generated vapour phase contamination. This technology is designed to operate at high flow rates to maintain increased contact between ground water and soil and strip more ground water by sparging. This technology is most effective for the BTEX and F1 (C6 to C10) and F2 (>C10 to C16) components of PHC which are volatile but less effective for F3 (>C16 to C34) and F4 (>C34). Also, as discussed above the non-uniform, low conductivity nature of bedrock reduces the effectiveness of *in situ* technologies.

The *ex situ* technologies applicable to treatment of PHCs include air stripping and GAC adsorption. Given that the F3 fraction is of concern in the ground water from the west side of the site, and the relatively low concentrations GAC is the most effective treatment operation for purged ground water.

3.2.5 VOCs

Trichloroethylene and 1,1,1-trichloroethane and their breakdown products have been identified in the ground water of the Beverley Street property at concentrations exceeding the proposed and current MOE Table 1 standards. There were no VOC concentrations detected above the current MOE Table 2 standards on the western portion of the property. Two wells located within the central part of the west portion of the site indicate VOC concentrations exceeding the more stringent proposed MOE Table 2 standards. VOC impacts are present above potable ground water standards throughout a substantial area of the east portion of the site.

Air sparging (accompanied by vapour extraction) is an effective *in situ* treatment technology for VOCs but as discussed above, the bedrock subsurface will inhibit its effectiveness. Similarly, oxidation systems such as peroxide, ozone or permanganate can be effective for *in situ* treatment of non-saturated aliphatic VOCs (e.g. trichloroethylene) – but not for saturated aliphatic VOCs (e.g. 1,1,1-trichloroethane). Again, however, the bedrock subsurface would reduce the effectiveness of the chemical oxidant delivery system.

Air stripping and GAC are the simplest *ex situ* treatment technologies for ground water contaminated with VOCs. A series of ground water recovery wells would need to be installed to permit collection and pumping of the impacted ground water.

3.3 SELECTION OF GROUND WATER REMEDIATION SYSTEM

As evident from the discussion above, *in situ* treatment technology will not be effective on the Beverley Street property where the ground water table is located within the bedrock stratum. Thus, the recommended ground water remediation process will require a ground water extraction system as the first step. Based on the recent ground water chemistry, which indicates that the contaminants are present at relatively low concentrations, it is recommended that the treatment system consist of a particle filter followed by a GAC unit for polishing. Specifically, the treatment system components would include an Influent Tank, a transfer pump, a bag filter and two GAC units in series. The transfer pump would be sized to allow the GAC effluent to carry through to the discharge point.

It is anticipated that the treated water will be discharged to the City of Guelph sanitary sewer system through a 'Pump and Treat Agreement' with the City of Guelph, Environmental Services Department, Wastewater Services Division.

The proposed treatment system provides:

- Removal of fine suspended solids which might contain elevated metals concentrations;
- Removal of fine suspended solids which might contain bound PCB and also provides for removal of dissolved PCB using the GAC;
- Removal of fine suspended solids which might contain bound PAH and also provides for removal of dissolved PAH using the GAC;
- Removal of fine suspended solids which might contain bound PHC and also provides for removal of dissolved PHC using the GAC; and,
- Removal of dissolved chlorinated VOCs using the GAC.

The discharge criteria for a ground water treatment system would be the sanitary sewer concentrations listed in the City of Guelph Sewer Use By-law Number (1996)-15202. Where no criteria are listed in the by-law it is understood that the City Wastewater Services Division will apply the standards listed in the MOE Soil, Ground Water and Sediment Standards for Use

Under Part XV.1 of the Environmental Protection Act, Table 2 for a potable ground water condition. In general, the metals (zinc and copper) have sewer use criteria and the organics would fall under the MOE Table 2 concentrations.

The final design requirement for a ground water treatment system is the flow rate. In the design of the ground water extraction system it is necessary to assess whether a single collection point (e.g. well or trench) is sufficient to prevent any off site migration or whether a more aggressive approach of installing multiple collection points (e.g. in each zone of contamination) to more actively purge the contaminated ground water would be a better option. The rate of ground water recharge into the collection point(s) will then be used to determine the design flow range for the treatment system.

Measurement of ground water flow in a bedrock regime can produce variable results depending upon whether the collection structure had intersected cracks or seams in the bedrock which transport ground water. In the ten monitoring wells installed during the Phase II ESA, six wells recharged at rates such that it was not possible to draw the level down to measure the rate of recharge (possibly indicating a high hydraulic conductivity). Minimal drawdown was attained at three of the wells and sufficient drawdown to permit standard calculation of hydraulic conductivity was only possible at one well.

Before preparing a ground water remediation system design it will be necessary to install a pilot extraction well on site (at a location which will be applicable to the ultimate site remediation program) and conduct an 8 hour to 24 hour pump test to:

- establish the ground water removal rates required to achieve capture of the plume and the extent of the zone of influence around the extraction point; and,

- obtain a measurement of the expected ground water chemistry during an on-going purging situation (frequently, the contaminant levels in a monitoring well are higher than those observed during continual pumping).

The information obtained from this pump test would be used to design the site ground water extraction system and size the filter and GAC treatment units.

3.4 REMEDIATION SYSTEM DESIGN

The extent of the ground water extraction system will be determined following a site pump test. For the final design it will be necessary to provide electrical power to each of the extraction points for extraction pumps and the associated instrumentation. Each extraction well will be installed with level controllers to automatically start and stop the pumps. It will be necessary to install a piping network to direct the extracted ground water to an influent collection tank located in the treatment shed and to direct the treated water to the sanitary sewer. The treatment shed will consist of a prefabricated, insulated and heated structure having a 220 volt, 3 phase electrical supply. The collection tank, particle filter and GAC units will be housed in the shed along with associated pumps and the electrical panel.

The size of the shed will be related to the size of the equipment necessary to handle the design flow of purged ground water. For example, a water flow rate of about 10 L/min would require a 100 cm diameter Influent Tank, a filtration unit with a footprint of about 150 by 250 mm and a GAC set with a footprint of about 600 by 1,200 mm (for 2 units in series) and an overall shed size of about 2.5 by 2.5 m. If the flow rate was at 100 L/min a 120 cm diameter Influent Tank, a filtration unit with a footprint of about 150 by 250 mm and a GAC set with a footprint of about 1,200 by 2,400 mm (for 2 units in series) would be required and the overall shed size would be about 3.0 by 3.5 m.

3.5 OTHER FACTORS

It should be noted that if the pump installed in the well is capable of pumping more than 34 L/min (50,000 L/day) a Permit To Take Water (PTTW) will be required from the Ministry of the Environment. In addition, the legislation (O.Reg 387/04) states that all wells on a property that are used for the same purpose are considered to be one source and therefore subject to a PTTW. As a result no more than 50,000 L/day may be put through a treatment system without a PTTW.

The installation of a treatment system that is capable of handling more than 50,000 L/day would be considered a Category 3 system and would require a detailed hydrogeologic study for the area. This study would be subject to a review by the MOE and possibly the water division of the City to Guelph to confirm that the ground water taking will not impact on the potable water available to the City.

In addition, daily records of the volume of water pumped through the system would have to be maintained and reported to the MOE on a yearly basis. If the volume treated is less than 50,000 L/day this would not be necessary.

Also if high pumping rates are used ground water gradients could be induced that would pull the impacted ground water on the east portion of the property towards the treatment system. This would alter the ground water chemistry and therefore may change the requirements in the design of the treatment system.

4.0 SUMMARY AND CONCLUSIONS

4.1 SUMMARY

The soils and ground water on the 200 Beverley Street property have been impacted by long term industrial use and exceeds the applicable O.Reg 153/04 standards for both MOE Table 1 background standards and MOE Table 2 standards for coarse grained soils in a potable ground water scenario. Due to the environmental concerns associated with the site the property is also subject to a MOE Directors Order. Given the shallow overburden conditions present the property is considered a potentially sensitive site. Therefore, MOE Table 1 background standards are the applicable generic standards for the site. As a result, it will be necessary to remediate and/or manage the soil and ground water environmental impacts on the property to allow for redevelopment of the site.

Based on the results of the Phase II ESA it has been determined that the ground water in the eastern portion of the property is more highly impacted than within the west portion of the site. Groundwater impacts within the eastern portion of the site appear to at least in part originate off site. These off site contaminant issues significantly complicate future ground water remediation activities at the site. Therefore, it is recommended that consideration be given to legally severing or otherwise separating the property on or near a line extending from the east side of Kingsmill Avenue northward to the north property line. The property to the west of this line could be more readily redeveloped for a variety of land uses. More long term ground water remediation activities will likely be required for the eastern portion of the site potentially restricting some of the potential land use options for this area.

Given the above issues less extensive soil remediation activities may be appropriate for the eastern portion of the site, depending on the proposed land use for this area and the overall approach to be taken to soil and ground water remediation and management in this area. In some cases prior to severing of the lands it may be advantageous to transfer some of the impacted soil from the west portion to the east portion of the site.

4.1.1 Soils

Four main scenarios have been considered with regard to soil remediation. These include:

1. Using the currently applicable MOE Table 1 background Standards

2. Completing a LSRA to allow for the use of MOE Table 2 Standards applicable for a potable ground water use area
3. Completing a LSRA for the use of MOE Table 2 Standards plus using the elevated zinc background values
4. Completing a full scope Risk Assessment for the proposed site specific land use

Currently the applicable generic cleanup requirements for the site are MOE Table 1 standards. This is due to the shallow soil conditions across the site of less than 2.0 m in thickness. MOE Table 1 standards reflect background soil conditions across the province and are more onerous than MOE Table 2 standards. Using these standards would result in the order of 79,243 m^3 of impacted soil being removed from the property at substantial cost.

The greatest advantage to this scenario would be that the soil on the property would be completely remediated and there would be no residual environmental liabilities on the site (assuming ground water quality is also addressed). Removal of the impacted soils would also assist in achieving improvements in the underlying bedrock ground water quality.

Completion of a LSRA would potentially allow for the use of MOE Table 2 potable standards to govern site remediation requirements. The site could then be remediated with less soil being removed from the property than for the MOE Table 1 generic cleanup approach. If the lands are to be used for residential/parkland/institutional purposes the soil remediation quantities will be slightly greater than for an industrial/commercial/community land use.

The third option is the completion of a LSRA to meet MOE Table 2 potable standards for all parameters with the exception of zinc for which a higher value would be used due to the existing evidence of elevated background zinc concentrations in the Guelph area. Given that zinc is the primary contaminant of concern on the property a significant reduction in soil remediation volumes would result. There would be little difference between the residential and industrial land uses soil remediation volumes. It is anticipated that the MOE, as well as financial institutions, would look upon this as effectively an enhanced LSRA.

The final option is completing a full scale risk assessment as permitted by the MOE with no special local restrictions or limitations. Some soil remediation activities may be required on the site, however, the quantity of soil involved is not possible to accurately predict without completing the risk analyses. It is anticipated that many soil impacts can be managed on site by placement of asphalt and concrete hard surfacing, clean soil barriers, controls on surface water infiltration and similar risk management measures. The RA will likely be required to ensure that groundwater discharging from the site meets MOE potable ground water quality standards.

Using a full scale RA or LSRA will lower the soil remediation effort required for the site relative to the currently applicable MOE Table 1 background standard clean up. The RSC to be filed with the MOE will indicate if a risk assessment has been completed and along with the Certificate of Property Use (CPU) will identify if any risk management measure needs to be applied at the site.

For general reference the estimated extent of soil exceeding MOE Table 3 non potable industrial standards has been calculated for the site are shown in plan on Drawing 49520-RAP-4-1. Using the average overburden thickness present throughout the site the following soil volumes were calculated.

SOIL AREAS AND VOLUMES EXCEEDING MOE TABLE 3

LOCATION	AREA (m^2)	AVERAGE OVERBURDEN THICKNESS (m)	SOIL VOLUME (m^3)
East Portion	7,506	1.85	13,886
West Portion	14,330	1.61	23,071
Total	**21,836**	—	**36,957**

The above estimated soil volumes represent the quantity of soil, if required to be removed from the site that would not meet industrial fill site acceptance criteria if such a fill disposal site exists within a reasonable distance from the property at the time that soil remediation activities are carried out. If this soil can be segregated, the remaining soil potentially can be disposed of off site at a lower cost than would be required for disposal at a Part V landfill site.

4.1.2 Ground Water

Western Portion of Site

Ground water impacts relative to the current or proposed MOE Table 1 background standards are present throughout most of the western portion of the site and may locally extend off site in some cases. Given the past and present industrial nature of the area, ground water remediation of the site to MOE Table 1 background levels would very difficult and such measures are not considered to be practical.

A more practical approach for the site would be to complete a LSRA justifying the use of MOE Table 2 potable ground water standards at the site. Currently the contaminant impacts exceeding MOE Table 2 are primarily within the limits of the property, however, some PAH impacts are present near the west property boundary adjacent to Stevenson Street. The extent of this PAH impact would have to be confirmed and remediated, as required. Given that the ground water flow is to the south it is possible that this impacted water will eventually migrate to the property line at concentrations above MOE potable ground water quality standards.

In order to prevent the impacted ground water from reaching the property lines recovery well(s) could be installed in the vicinity of the impacts to maintain ground water within the site. Water recovered would be directed to a treatment system and discharged to the sewer. The recovery system should be designed to prevent off site contaminant migration but should also be designed so as to not allow more heavily impacted ground water from the eastern portion of the property being drawn in to the remainder of the site.

Even with the completion of a full scope risk assessment potentially not requiring MOE Table 2 standards to be met within the western portion of the site, it is anticipated that some pump and treat activities will be required to be installed, if only for use on a standby bases, to ensure that ground water leaving the site meets MOE Table 2 potable ground water standards.

The ground water recovery system will require initial well and treatment system installation costs as well as annual costs for the operation of the treatment system. The flow quantity and duration for operation would be best determined after completion of a pump test and detailed design of the treatment system.

Eastern Portion of Site

In the eastern portion of the property the source and extent of the ground water impacts has not yet been fully determined. Information obtained to date, as well as MOE correspondence, suggests that ground water impacts within the east portion of the site originate, at least in part, off site. Some ground water impacts are also present downgradient of the 200 Beverley Street site. Additional investigation work should be completed to define the source area and the full extent of the off site plume.

Given the ground water contaminant concentrations, the presence of the impacts within fractured bedrock and the associated off site impacts, completion of a ground water remediation program limited to within the eastern portion of the 200 Beverley Street site is not practical as there is a high potential for the site to become recontamination by ground water from upgradient areas.

Ex situ methods would likely be the most effective ground water clean up approach within the subject site. These methods could include a series of recovery wells leading to a treatment system which would consist of filtration, precipitation and granulated activated carbon polishing. However, design of such a treatment system for the eastern portion of the site is premature unless a similar ground water treatment system is set up for the lands to the east and northeast. Alternatively, ground water migration from these areas into the eastern portion of the site could be reduced or eliminated by completion of a bedrock grouting program. This approach may be of assistance to the 200 Beverley Street site but potentially could have a negative impact on adjacent lands by altering ground water flow patterns. MOE approval for such a program may be difficult to obtain.

Further ground water quality review should also be carried out to determine if ground water migrating across the site is subject to any appreciable increase in contaminant concentrations. For some contaminants upgradient contaminant concentrations are similar to those downgradient suggesting that the eastern portion of the 200 Beverley Street site is not necessarily contributing to the groundwater impacts. This "reasonable use" scenario should be considered in any future ground water treatment and/or risk assessment approval request.

In conclusion, it is suggested that ground water quality issues within the eastern portion of the site be dealt with separately from the western portion of the property. Both groundwater treatment and/or risk assessment approaches would be suitable to manage the ground water impacts.

5.0 USE AND LIMITATIONS OF THIS REPORT

This report prepared for the City of Guelph does not provide certification or warranty, expressed or implied, that the investigation conducted by DCS uncovered all potential contaminants of environmental concern at the site. The work undertaken by DCS was directed to provide information on potential contamination that might have accrued from its historic use. Based on the results of the investigation, DCS found evidence of chemical parameters in concentrations exceeding the evaluation criteria selected for the site. The test data, chemical analyses and conclusions given in the reports, however, are the results of a sampling of the subsoils and ground water encountered during the program, and based upon the total number of boreholes and monitoring wells performed, is considered to fairly represent the subsurface conditions within each area tested. It should be noted, however, that any assessment regarding the presence of contamination at the site is based on interpretation of conditions determined at specific locations and depths. This assessment cannot warrant that other pockets of contaminated soils are not located on the site. Chemical parameters were chosen based on potential contamination sources and, therefore, results are limited to those parameters tested.

Further, the reports were prepared by DCS for City of Guelph. The material in it reflects DCS' best judgement in light of the information available at the time of preparation, March 2008. Changes to soil and/or ground water quality in the areas investigated can occur following the date of testing. Any use which a third party makes of the report, or reliance on, or decisions to be based on it, is the responsibility of such third parties.

APPENDIX A

MOE PHYTOXICOLOGICAL REPORTS

DCS

Ontario

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January 26, 1996

TECHNICAL MEMORANDUM

Report No.: SDB-070-3511-95TM

TO: R. Pearson, Manager
Phytotoxicology Section

FROM: R. Emerson
Phytotoxicology Specialist

SUBJECT: Phytotoxicology Sampling of Survey Sites 8 and 11 - IMICO, Guelph (1995)

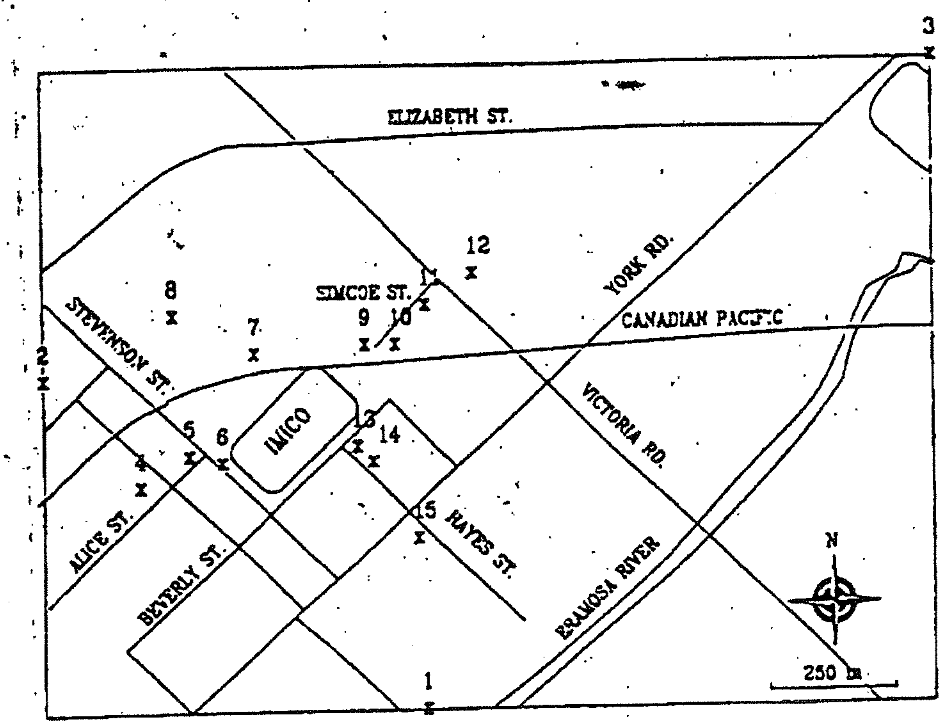
Introduction

On June 22 1995, Mr. J. Cooke of the Ministry of Environment and Energy (MOEE) Cambridge District office requested that the Phytotoxicology Section re-sample the soil at IMICO survey Sites 8 and 11, which were last sampled in 1990 and 1992, respectively. Site 8 was situated at the north end of the open field immediately northwest of IMICO, while Site 11 was situated in the residential area on Simcoe Street. West Central Region MOEE staff requested the sampling in 1995 so that current results could be provided to the property owners.

In 1990, surface soil concentrations of cadmium and selenium at Site 8 and of arsenic and selenium at Site 11 exceeded the Phytotoxicology Section Upper Limit of Normal (ULN) guidelines (see report: ARB-114-90-Phyto). The soil arsenic level at Site 11 was also above the MOEE cleanup guideline. At the request of Cambridge MOEE staff, additional soil sampling was conducted by Phytotoxicology staff along Simcoe St. in May 1992 to determine the extent of the soil arsenic contamination in this residential area. Site 11 was sampled at this time, along with the back lawn on this property and the adjacent boulevard. Numerous other Simcoe St. residential properties also were sampled, as was the rail road right-of-way south of Site 11.

The combined 1990 and 1992 soil results for the Simcoe St. area revealed that the soil arsenic contamination was confined to three residential properties, including Site 11. However, the pattern of the soil arsenic data suggested that IMICO was not likely the source (report: ARB-165-92TM). The 1990 survey also suggested that the elevated cadmium and selenium levels at Site 8 were not likely related to historical IMICO emissions, but it is possible that past materials storage (eg. military equipment) in the vicinity of Site 8 had contributed to the elevated concentrations, based on information that was provided by area residents in 1990. Several of the 1990 sites also exceeded the manganese and zinc ULNs, but the lack of a clear pattern suggested that the elevated soil manganese and zinc levels could not be attributed solely to IMICO. The zinc pattern further suggested that soil zinc levels in the Guelph area are naturally elevated. The 1990 survey sites, including Sites 8 and 11, are shown below.

Soil Survey Sites in the Vicinity of IMICO, Guelph (1990)



Soil Sampling

On June 27 1995, R. Emerson of the Phytotoxicology Section revisited IMICO survey Sites 8 and 11. The residential property at Site 11 (south side of Simcoe Street) was sampled first. From this property, soil was collected at two depths (0-5 and 15-20 cm) from the back lawn (behind residence), as well as from the north end (by street) and the back south end of the east side lawn. The latter site (east side lawn - back) was the original Site 11 (1990). Corresponding soil samples were also collected from a similarly aged residential property (front lawn) upwind and distant from IMICO. This site was sampled as a control site.

At Site 8, only surface soil to a depth of 5 cm was collected. This site was situated at the north end of the open field northwest of IMICO and was just south of a residential backyard. Surface soil also was sampled from a new site (Site 8a) just south of the line of mature trees at about 40-50 meters south of Site 8. The new site was closer to the closed IMICO foundry. Both Sites 8 and 8a were east of what appeared to be an abandoned Brewers Retail outlet.

From all sites, duplicate soil samples were collected with an Oakfield soil corer using standard procedures.

All soil samples were returned to the Phytotoxicology Section processing laboratory, where they were dried, ground, sieved and stored in glass jars. They were then submitted to the MOEE Laboratory Services Branch for analysis of arsenic, cadmium, selenium and other metals.

Analytical Results

The results are summarized in Tables 1 and 2. The data units are µg/g (micrograms per gram, commonly referred to as ppm or parts per million). The results for the Simcoe St. residential property at Site 11 are summarized in Table 1, while Table 2 shows the results for Sites 8 and 8a. The results are compared with the data from the control site and/or with the Upper Limit of Normal (ULN) or Ontario Typical Range (OTR) urban guidelines developed by the Phytotoxicology Section. The OTR guidelines are relatively new and were not available in 1990. ULNs reflect the expected upper limit of normal concentrations in urban areas not influenced by point sources of emissions (see Appendix A). OTRs are similar to ULNs but are developed from a more extensive province-wide data base and so far they are only available for parkland (see Appendix B). A level in excess of the ULN or OTR indicates the likely presence of a source of contamination. The attached tables also show the MOEE soil clean up guidelines, which are applied when contaminated lands are being decommissioned for residential use. Table 2 also shows the commercial-industrial clean up guidelines. The clean up guidelines are based on the most sensitive receptors: human health (cadmium, lead), animal health (copper, molybdenum), and plant health (remaining elements).

Table 1 shows that Site 11 (east side lawn - back) on the Simcoe St. property had antimony, arsenic, barium, magnesium, manganese and zinc concentrations in the surface soil (0-5 cm) and subsoil (15-20 cm) exceeding the ULN or OTR guidelines. The surface soil in the back lawn exceeded only the zinc ULN, while the subsoil exceeded the ULN or OTR guidelines for antimony, arsenic, barium and zinc. Residential cleanup guidelines have been established by the MOEE for four of these elements (antimony, arsenic, barium and zinc). All soil samples from Site 11 exceeded the arsenic and zinc cleanup guidelines, but only the subsoil in the back lawn marginally exceeded the zinc cleanup guideline. Soil arsenic and zinc concentrations greater than the cleanup guidelines are potentially adverse to vegetation. Cleanup guidelines for the other elements were not exceeded and adverse effects would not be expected, even though some elements (including antimony, barium) were elevated above the control data or the ULN/OTR values. Cleanup guidelines have not been established for magnesium and manganese which also exceeded OTR values at Site 11. However, Site 11 magnesium and manganese levels would not be expected to adversely affect soil or vegetation as they are still within the typical range for Ontario parks. Manganese also was elevated at the control site, an indication that the elevated soil manganese levels at Site 11 are not solely attributable to industrial emissions.

The Site 11 soil analysis results were in generally good agreement with the corresponding 1990 survey results. Appendix C shows the results for all survey sites sampled in 1990. The soil samples collected in the 1990 survey were not analyzed for calcium and magnesium. Minor differences between the 1990 and 1995 results would be expected because of natural variation in soil. This may account for selenium at Site 11 not exceeding the MOEE guidelines (2 µg/g) in 1995 (1.6 µg/g), but exceeding the guidelines in 1990 (2.4 µg/g). Therefore, in 1995, only the arsenic and zinc cleanup guidelines were exceeded on this property. The exceedence of the zinc clean up guideline at the control site further reinforces the belief that soil zinc levels in the area are naturally elevated and not likely related to industrial emissions. The 1990 and 1992 results also failed to implicate IMICO as the source of the elevated soil arsenic levels.

Soil cadmium and selenium concentrations at Site 8, as in 1990, marginally exceeded the ULNs, which are the same as the residential cleanup guidelines (Table 2). The zinc ULN also was exceeded. The corresponding commercial-industrial guidelines were not exceeded, with the exception of the zinc guideline. The land-use zoning of this property, although likely commercial-industrial, is unknown and should be verified with the property owner. On average, the soil metal concentrations were marginally higher in 1995 compared to 1990 (Appendix C). The wide-area 1990 survey suggested that the elevated cadmium, selenium and zinc levels at Site 8 were not likely the result of historical emissions from IMICO. Past materials storage in the field may have contributed.

At new Site 8a, about 40-50 m south of Site 8, soil concentrations of all metals were well below the ULN or OTR guidelines. These results suggest that the elevated cadmium and selenium levels at Site 8 are not uniform in the surface soil across the open field, and may be localized in the immediate area of Site 8. It is possible that the surface soil sampled at Site 8a was clean fill added in the past. The owner can likely provide information on the field's history.

Conclusions

The soil sampling in 1995 revealed that the Site 11 residential property had elevated soil concentrations of antimony, arsenic, barium, magnesium, manganese and zinc relative to the ULN/OTR guidelines. Of these elements, only arsenic and zinc were above the residential soil cleanup guidelines and could potentially adversely affect vegetation. Soil selenium levels at Site 11 were below the ULN in 1995. Soil variation may have contributed to the higher levels in 1990. The soil collected at Site 8 in the field northwest of IMICO exceeded the cadmium, selenium and zinc ULNs, but only zinc marginally exceeded the commercial-industrial cleanup guidelines, the likely land-use zoning of the property. Previous years' sampling results suggested that the elevated soil arsenic and zinc levels were not likely attributable to IMICO emissions. Soil zinc levels are suspected to be naturally elevated in the Guelph area.

Table 1: Soil Analysis Results* for Site 11 Residential Property - IMICO, Guelph (1995).

Element	East Side Lawn - Front		East Side Lawn - Back (Site 11)		Back Lawn - Rear of House		Control Location		ULN or OTR	Res. Cleanup Guidelines
	0-5 cm	15-20 cm	0-5 cm	15-20 cm	0-5 cm	15-20 cm	0-5 cm	15-20 cm		
Aluminum	10,000	11,500	15,500	17,500	15,000	15,500	14,500	17,500	27,000**	NG
Antimony	0.7 T	0.7 T	11	10	8	13	1.5	2.0	8.0	25
Arsenic	4	5	43	43	20	23	12	15	20	25
Barium	55	61	220	205	165	210	105	115	180**	1,000
Beryllium	DL	DL	1.0 T	1.0 T	DL	1.0T	DL	1.0 T	0.97**	5
Cadmium	0.8 T	0.8 T	3	3	1.8	2.1	2.1	2.1	4	4
Calcium	7,950	7,300	36,000	37,500	23,000	28,000	27,000	25,500	58,000**	NG
Chromium	19	20	38	33	25	27	31	29	50	1,000
Cobalt	6	6	10	11	9	11	9	9	25	50
Copper	15	14	86	77	57	60	37	42	100	200
Iron	21,500	21,000	27,000	30,000	24,000	26,000	27,500	31,500	35,000	NG
Lead	56	53	415	420	310	395	250	265	500	200
Magnesium	4,450	4,300	19,500	21,500	12,000	14,500	14,000	14,000	16,000**	NG
Manganese	620	675	1,350	1,600	1,100	1,200	1,200	1,600	1,300**	NG
Molybdenum	DL	DL	DL	DL	DL	1.0 T	DL	1.3 T	3	5
Nickel	12	16	28	38	24	30	20	25	60	200
Selenium	0.2 T	0.3 T	1.6	1.5	1.2	1.4	0.7 T	0.7 T	2	2
Strontium	19	17	57	57	53	69	33	33	78**	NG
Vanadium	46	46	43	47	41	43	52	58	70	250
Zinc	155	150	1,150	1,150	695	820	805	905	500	800

* µg/g, dry weight, mean of duplicate samples and analysis. T - Trace measurable amount, interpret with caution. DL - Concentration is below analytical detection limit.
ULN - Phytotoxicology Section Upper Limit of Normal (ULN) urban guideline, see Appendix A
** OTR (Appendix B) substituted for elements where ULN not established. NG - Guideline not established. Note: Shaded values exceed ULN or OTR guidelines.

Table 2: Soil Metal Concentrations at Sites 8 and 8a - IMICO, Guelph (1995).

Parameter	Concentration* in Soil (0-5 cm depth)		ULN or OTR**	Clean-up Guidelines	
	Site 8 (Original)	Site 8a (New Site)		Commercial /Industrial	Residential /Parkland
Aluminum	11,000	5,700	27,000**	NG	NG
Antimony	2	2.3	8.0	50	25
Arsenic	7	7	20	50	25
Barium	120	43	180**	2,000	1,000
Beryllium	DL	DL	0.97**	10	5
Cadmium	6	0.6 T	4	8	4
Calcium	38,000	3,200	58,000**	NG	NG
Chromium	27	12	50	1.000	1,000
Cobalt	6	4	25	100	50
Copper	79	20	100	300	200
Iron	15,000	25,500	35,000	NG	NG
Lead	195	72	500	1.000	200
Magnesium	10,500	1,450	16,000**	NG	NG
Manganese	410	315	1,300**	NG	NG
Molybdenum	2.3	DL	3	40	5
Nickel	21	13	60	200	200
Selenium	2.2	0.4 T	2	10	2
Strontium	74	22	78**	NG	NG
Vanadium	29	22	70	250	250
Zinc	1,050	93	500	800	800

* µg/g, dry weight, mean of duplicate samples and analysis. T - Trace measurable amount, interpret with caution.
DL - Concentration is below analytical detection limit.
ULN - Phytotoxicology Section Upper Limit of Normal (ULN) urban guideline, see Appendix A
**OTR (Appendix B) substituted for elements where ULN not established.
NG - Guideline not established. Note: Shaded values exceed ULN or OTR guidelines.

Appendix A

Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: *Ontario Ministry of the Environment. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section, Air Resources Branch: Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto. ISBN: 0-7729-5143-8.*). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.

Appendix B

Derivation and Significance of the Ontario Ministry of Environment and Energy (MOEE) "Ontario Typical Range" of Chemical Parameters in Soil, Vegetation, Moss bags and Snow

The MOEE "Ontario Typical Range" (OTR) guidelines are being developed to assist in interpreting analytical data and evaluating source-related impacts on the terrestrial environment. The OTRs are used to determine if the level of a chemical parameter in soil, plants, moss bags, or snow is significantly greater than the normal background range. An exceedence of the OTR_{98} (*the OTR_{98} is the actual guideline number*) may indicate the presence of a potential point source of contamination.

The OTR_{98} represents the expected range of concentrations of chemical parameters in surface soil, plants, moss bags, and snow from areas in Ontario not subjected to the influence of known point sources of pollution. The OTR_{98} represents 97.5 percent of the data in the OTR distribution. This is equivalent to the mean plus two standard deviations, which is similar to the previous MOEE "Upper Limit of Normal" (ULN) guidelines. In other words, 98 out of every 100 background samples should be lower than the OTR_{98}.

The OTR_{98} may vary between land use categories even in the absence of a point source of pollution because of natural variation and the amount and type of human activity, both past and present. Therefore, OTRs are being developed for several land use categories. The three main land use categories are Rural, New Urban, and Old Urban. Urban is defined as an area that has municipal water and sewage services. Old Urban is any area that has been developed as an urban area for more than 40 years. Rural is all other areas. These major land use categories are further broken into three subcategories; Parkland (which includes greenbelts and woodlands), Residential, and Industrial (which includes heavy industry, commercial properties such as malls, and transportation rights-of-way). Rural also includes an Agricultural category.

The OTR guidelines apply only to samples collected using standard MOEE sampling, sample preparation, and analytical protocols. Because the background data were collected in Ontario, the OTRs represent Ontario environmental conditions.

The OTRs are not the only means by which results are interpreted. Data interpretation should involve reviewing results from control samples, examining all the survey data for evidence of a pattern of contamination relative to the suspected source, and where available, comparison with effects-based guidelines. The OTRs are particularly useful where there is uncertainty regarding local background concentrations and/or insufficient samples were collected to determine a contamination gradient.

OTRs are also used to determine where in the anticipated range a result falls. This can identify a potential concern even when a result falls within the guideline. For example, if all of the results from a survey are close to the OTR_{98} this could indicate that the local environment has been contaminated above the *anticipated average,* and therefore the pollution source should be more closely monitored.

The OTRs identify a range of chemical parameters resulting from natural variation and normal human activity. ***As a result, it must be stressed that values falling within a specific OTR_{98} should not be considered as acceptable or desirable levels; nor does the OTR_{98} imply toxicity to plants, animals or humans.*** Rather, the OTR_{98} is a level which, if exceeded, prompts further investigation on a case by case basis to determine the significance, if any, of the above normal concentration. Incidental, isolated or spurious exceedences of an OTR_{98} do not necessarily indicate a need for regulatory or abatement activity. However, repeated and/or extensive exceedences of an OTR_{98} that appears to be related to a potential pollution source does indicate the need for a thorough evaluation of the regulatory or abatement program.

The OTR_{98} supersedes the Phytotoxicology ULN guideline. The OTR program is on-going. The number of OTRs will be continuously updated as sampling is completed for the various land use categories and sample types.

Appendix C

Mean[1] Elemental concentrations (ug/g) in the surface soil (0-5cm) in the vicinity of the IMICO foundry, Guelph. April 19, 1990.

Element	Site 1	2	3	4	5	6	7	8	9
Copper	38	30	36	34	42	59	32	69	24
Nickel	14	9.6	10	9.0	11	9.2	7.8	12	12
Lead	160	110	140	140	240	160	120	120	160
Zinc	580	400	1700	660	820	310	1000	1000	460
Iron	24000	18000	14000	14000	14000	18000	18000	14000	20000
Manganese	1100	700	460	360	320	620	360	370	760
Aluminum	16000	12000	9800	9400	10000	12000	8600	9300	13000
Arsenic	9.7	8.2	8.0	10	6.4	7.7	5.7	8.3	6.2
Barium	66	69	70	74	80	70	50	79	73
Cadmium	1.1	1.0	3.6	1.7	1.3	0.96	1.8	6.0	0.98
Chloride	<0.5	6.2	5.3	4.5	8.2	12	5.8	7.4	12
Chromium	16	14	14	14	14	18	10	14	14
Fluoride	60	59	100	140	160	260	92	97	84
Mercury	.075	0.095	0.095	0.095	0.20	0.12	0.09	0.16	0.09
Sodium	100	100	135	180	170	220	120	140	140
Antimony	0.72	1.5	1.2	1.5	3.0	1.6	1.3	1.2	2.2
Selenium	0.7	1.4	1.9	1.9	1.6	0.62	1.4	4.6	0.95
Strontium	21	52	73	78	81	34	44	72	34
Sulphur (%)	0.042	0.09	0.12	0.071	0.099	0.053	0.094	0.18	0.058
Vanadium	44	34	26	26	26	34	27	30	36
Cobalt	10	9.8	9.2	8.1	8.3	8.4	7.0	7.9	8.9
Molybdenum	0.9	0.8	1.6	0.4	0.4	1.6	0.2	BD	BD
Beryllium	0.82	0.65	0.61	0.62	0.52	0.54	BD	BD	0.63

Element	Site 9'	10	11	12	13	13'	14	15	ULN''
Copper	28	40	87	54	38	34	35	40	100
Nickel	10	11	19	16	12	11	12	12	60
Lead	110	200	420	300	280	240	200	160	500
Zinc	320	560	1100	1100	550	520	560	940	500
Iron	18000	23000	27000	27000	22000	19000	20000	22000	35000
Manganese	590	680	1200	1100	650	610	720	980	700
Aluminum	12000	12000	16000	18000	12000	12000	12000	14000	-
Arsenic	5.0	8.2	37	13	6.2	6.2	7.0	6.7	20
Barium	66	92	200	99	92	84	74	80	-
Cadmium	0.81	1.1	2.8	2.0	1.3	1.0	1.1	1.8	4
Chloride	6.1	8.2	8.1	5.3	14	10.2	12	9.2	-
Chromium	12	16	30	20	16	14	14	20	50
Fluoride	88	120	100	68	100	100	100	100	-
Mercury	0.11	0.18	0.26	0.12	0.11	0.10	0.14	0.14	0.5
Sodium	160	140	160	140	200	160	140	140	-
Antimony	1.5	4.7	7.3	7.2	7.4	8.0	5.6	1.6	8
Selenium	0.78	1.8	2.4	1.4	0.72	0.85	0.92	0.76	2
Strontium	40	36	51	32	38	38	38	28	-
Sulphur	0.042	0.075	0.066	0.07	0.062	0.057	0.056	0.052	-
Vanadium	33	35	43	46	38	34	35	39	70
Cobalt	9.2	9.0	12	12	9.5	9.9	10.8	10.5	25
Molybdenum	0.43	BD	0.41	0.8	0.7	0.4	0.5	0.4	3
Beryllium	0.56	0.60	0.83	0.83	0.56	0.60	0.61	0.73	-

[1] Average of duplicate samples ' 5 - 15cm depth '' ULN - Upper Limit of Normal - see Appendix for explanation

BD - Below detection limit

PHYTOTOXICOLOGY SECTION INVESTIGATION IN THE VICINITY OF INTERNATIONAL MALLEABLE IRON COMPANY (IMICO) GUELPH, ONTARIO ON APRIL 19, 1990

FEBRUARY 1992

Ontario
Environment
Environnement

Ministry of the Environment
Ministère de l'Environnement
Ontario

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MINISTRY OF THE ENVIRONMENT
1992 MAR -3 AM 10:01
CAMBRIDGE DISTRICT OFFICE

February 14, 1992

MEMORANDUM

TO: D. Ireland, District Officer
Cambridge District Office
400 Clyde Rd, PO Box 219, Cambridge
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FROM: R.G. Pearson, Manager
Phytotoxicology Section

SUBJECT: **PHYTOTOXICOLOGY ASSESSMENT SURVEY FINAL REPORT (ARB-114-90-PHYTO)**
IMICO - Guelph

Enclosed is the final report of a Phytotoxicology Assessment Survey conducted in your District. A draft copy of this report was reviewed by your staff, and the revised (if necessary) report was approved for printing and release to the public by the ADM, Environmental Sciences and Standards Division. Additional copies of this document *(Phytotoxicology Section Investigation in the Vicinity of International Malleable Iron Company (IMICO) Guelph, Ontario on April 19, 1990 ... PIBS No.1808)* are available through the Public Information Centre (416-323-4321).

For your quick reference, following is an abbreviated report abstract.

ABSTRACT: *Surface soil sampling around IMICO indicated that there has been off site contamination downwind of the smelter. Arsenic and selenium concentrations exceeded the ULN guidelines for urban soil. At one residential site, arsenic and selenium exceeded the decommissioning guidelines.*

POLICY and OPERATIONAL IMPLICATIONS: *The clean-up of contaminated soil on a few residential properties on Simcoe St. should be considered.*

REPORT AUTHOR/CONTACT: *M. Marsh (416-456-2504)*

cc: Director West Central Region
Director IEB
Director Legal Services
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ARB Library
M. Marsh
D. McLaughlin (cover memo only)

ISBN 0-7729-9205-3

PHYTOTOXICOLOGY SECTION INVESTIGATION

IN THE VICINITY OF

INTERNATIONAL MALLEABLE IRON COMPANY (IMICO)

GUELPH, ONTARIO

ON APRIL 19, 1990

Report prepared by:

Phytotoxicology Section
Air Resources Branch
Ontario Ministry of the Environment

ARB-114-90-PHYTO

FEBRUARY 1992

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Background

International Malleable Iron Company Limited operated this foundry on Beverly Street in Guelph since 1912. The foundry site is just under six hectares in size, the bulk of which is occupied by buildings, paved surfaces, and parking areas. From conversations with long time residents and workers, it appears that the foundry has produced a wide range of products over the years and utilized an equally wide range materials, including tanks and artillery after both world wars. In August of 1989, Proctor and Redfern consultants produced a report on the property for IMICO which outlined their environmental investigations on the property. The report concluded that there were elevated levels of cadmium, chromium, molybdenum and zinc on site, as well as pointing out the necessity of registering the PCB storage site. Due to surface and subsurface drainage characteristics the report expressed the possibility of off-site contamination existing, largely through groundwater. It also pointed out that liability rested with the site owner on the basis of existing legislation.

In September of 1989, IMICO laid off any remaining workers (apparently, most had been laid off earlier) and abandoned the property. All officers and directors resigned and there is no one to act for the company. The Bank of Montreal, a creditor holding security on the assets, refuses to take possession of the property.

Local residents are concerned that contamination may extend off site. District Office staff conducted some preliminary soil sampling in January, 1990 in order to partially address the concerns expressed by residents and the media.

On April 19, 1990, at the request of the West Central Region office, Marius Marsh of Phytotoxicology Section conducted an investigation to determine the degree and extent of off-site surface soil contamination in the vicinity of the IMICO property. The following is a report on that investigation. It is noted that this report does not address possible contamination of subsurface soils or of groundwater, nor does it consider organic contaminants.

2 Methods

Surface (0-5 cm) soil samples were collected in duplicate from 12 sites in the vicinity of the foundry as well as from three control locations more removed from the foundry (see Figure 1 and Appendix 3). Samples were also taken in duplicate from the 5-15 cm depth at two locations.

All samples were collected using standard Phytotoxicology sampling techniques (O.M.E., 1983). Samples were delivered to the Phytotoxicology Section sample processing laboratory in Toronto where they were dried and ground before being submitted to the Laboratory Services Branch Trace Inorganics Laboratory for chemical analysis.

3 Results

The results of the chemical analyses of the samples are presented in Table 1. In order to assist in the interpretation and understanding of the spacial distribution of these elements, concentrations of some of the elements were plotted using a contour mapping program (Surfer, ver. 3.0). These contour maps, which are shown in Figures 2-11, give an indication of a likely pattern of distribution of the specific contaminant; however, they should be interpreted with care since accuracy is known only at the 15 sampling stations. (Settings used in "Surfer" were as follows: Kriging using normal search method on the 10-nearest points. Grid size of 25 x 25. Smoothing with tension factor of 2.)

4 Discussion

An examination of Table 1 reveals that, with the exceptions of zinc and manganese, ULN's for the elements tested are exceeded only at Sites 8 for cadmium and selenium and site 11 for arsenic and selenium. Since arsenic concentrations are higher than local background levels at Site 12, the contour map for arsenic indicates a zone of elevated arsenic concentrations just northeast (downwind of prevailing winds) of the IMICO factory (see Figure 2), and implicates IMICO or other factories adjacent to IMICO as possible sources.

Manganese concentrations were also above the ULN at sites 11 and 12; however, one of the three control sites as well as sites 9, 14, and 15 displayed high manganese concentrations, hence there may be local anomalies with respect to this metal which may be of as much significance as the IMICO foundry. The lack of a clear pattern for manganese on the contour map (Figure 3) shows that the observed high concentrations downwind cannot be solely attributed to the foundry. Also, the high concentrations of cadmium and selenium at Site 8 are not matched at stations to the northeast, and hence are unlikely to be a result of emissions from the foundry. They are more likely to have resulted from a very localized source, such as storage of materials in the past. Although the area is now an empty field, residents nearby informed me that it had once been used to hold materials, such as military equipment, prior to smelting.

Although other elemental concentrations do not exceed the ULN's, the contour maps indicate accumulations of antimony, barium, copper, chromium, lead, and mercury, downwind from the foundry, with Site 11 being the site primarily affected (see Figures 4 - 9). The maps indicate the main area affected to be limited in extent.

Zinc is another element for which the distribution is anomalous (see Figure 10). Zinc concentrations exceed the ULN of 500 ug/g at 12 of the 15 sites, including at two of the control sites. Average zinc concentrations at the Guelph Reformatory site (Site 3) were 1700 ug/g. Since previous sampling by the District Office indicated very high zinc at a site on the reformatory grounds about 200m west of Site 3, these values must be regarded as being real, and cannot be attributed to sampling or analytical error. High zinc concentrations encountered in this survey cannot, therefore, be attributed to IMICO.

Although a consultants report concerning conditions on the IMICO site found areas with high molybdenum levels, the current survey did not find evidence of molybdenum contamination in soils off the site.

Fluoride concentrations in the surface soil exhibit a pronounced increase in the area of the foundry. The pattern indicated by the contour map (Figure 11) implies a source to the immediate southwest of IMICO. A factory which produces foundry sand is located across Stevenson St. from IMICO and is a possible source of fluoride.

In view of the ultimate necessity for decommissioning of this site, it should be noted that residential decommissioning guidelines of 25 ug/g for arsenic and 2 ug/g for selenium (O.M.E., 1989b) are exceeded at Site 11 and that the concentrations in this location appear to be a result of emissions at or immediately adjacent to the IMICO foundry. A property by property survey along Simcoe St. and on other properties immediately east and northeast of the factory would be required to delineate the full extent of contamination in a detailed manner appropriate for cleanup activities. The guideline exceedances at Site 8 for cadmium (decommissioning guideline of 4 ug/g) and selenium cannot be as readily attributed to IMICO emissions, and the zinc concentrations in excess of the decommissioning guideline (800 ug/g) would appear to result from factors other than the foundry.

5 Appendices

5.1 Explanation of OME "Upper Limits of Normal" Contaminant Guidelines

Interpretation of concentrations were made based on "Upper Limit of Normal" (ULN) guidelines established by the Phytotoxicology Section, Air Resources Branch (OME, 1989). The ULN was determined by examining an extensive database for soils and vegetation samples collected at sites removed from any point source of contamination. Statistical tests were applied to the data to calculate the ULN value. This ULN value would not normally be exceeded in 99 samples in 100 for background areas. Values which exceed the ULN are considered likely to have resulted from contamination. Values which exceed the ULN do not necessarily imply that the element is toxic at that level. Concentrations which are below the guidelines are not known to be toxic.

It is stressed that the ULNs do not represent maximum desirable or allowable levels of contaminants, but rather serve as guidelines which, if exceeded, flag situations requiring further investigation to determine the significance of the above normal concentrations. Comparisons of sample elemental concentrations with those from control or reference areas may also serve to flag such situations at contaminant concentrations lower than the ULNs.

5.2 References

Ontario Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section, Air Resources Branch; Technical Support Sections - NE and NW Regions.

Ontario Ministry of the Environment, 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section - Air Resources Branch, ARB-138-88-Phyto. ISBN 0-7729-5143-8

Ontario Ministry of the Environment, 1989b. Guidelines for the Decommissioning and Cleanup of Sites in Ontario. Waste Management Branch. Feb. 1989.

5.3 Station Locations

1) About 30 m NE of turn-around at S end of Armstrong Ave.

2) Western corner of Mico Valleriotte Park

3) Guelph Correctional Institute grounds. Between trees at NE corner of lake.

4) 204A Alice St. - backyard.

5) 212 Alice St. - East sideyard.

6) Stevenson St. - on east blvd S. of Alice St. (between hydro poles).

7) Field NW of IMICO. - on E side just N of railway tracks.

8) Field NW of IMICO - at N end just W of ditch and immediately S. of houses.

9) 6 Simcoe St. - West sideyard.

10) 5 Simcoe St. - backyard.

11) 15 Simcoe St. - backyard on east side.

12) 142 Victoria Rd. S. - backyard on north side.

13) 201 - 302 Beverly St. - front blvd.

14) 201 Beverly St. - backyard.

15) 407 York Rd. - S. of driveway.

Former International Malleable

SI WE GU BE 140

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Ontario

January 20, 2006

MEMORANDUM

TO: Kyle Davis, Senior Environmental Officer - Contaminated Sites, Guelph District Office

FROM: Marco Pagliarulo, Regulatory Toxicologist, Standards Development Branch

CC: Dr. Paul Welsh, Supervisor (A) – Human Toxicology and Risk Assessment Group, Standards Development Branch

SUBJECT: Evaluation of Soil Contaminant Concentrations in the Vicinity of a Former Foundry Site in Guelph, Ontario for Potential Human Health Effects

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At the request of the Guelph District Office, Standards Development Branch (SDB) examined the exposure scenario and soil contaminant concentrations found in the residential neighbourhood in the vicinity of a former foundry operated on Beverly Street in Guelph. SDB examined the available soil concentration data (provided by the Guelph District Office) for metals and arsenic for potential human health effects resulting from exposure to these soils. SDB does not address here the suitability of the data used for this evaluation, the extent of contamination, the contamination of groundwater, ecotoxicological effects, nor any organic contaminants.

1.0 Background

International Malleable Iron Company Limited (IMICO) operated a foundry on Beverly Street in Guelph between 1912 and 1989. Local residents were concerned that contamination may extend off-site. MOE conducted soil sampling in the vicinity of the IMICO property.

SDB evaluated the surface soil (0 – 5 cm) arsenic and heavy metal concentrations which are reported in the following documents:

- Phytotoxicology Section Investigation in the Vicinity of International Malleable Iron Company (IMICO) Guelph, Ontario on April 19, 1990. MOE. February 1992.

- Ontario Ministry of Environment – Phytotoxicology Section, June 18, 1993. Phytotoxicology Complaint Investigation: G. Shantz – Guelph (1992).
- Ontario Ministry of Environment – Phytotoxicology Section, June 10, 1993. Phytotoxicology Complaint Report: R. Shufelt – Guelph (1992).
- Ontario Ministry of Environment – Phytotoxicology Section, February 10, 1993. Technical Memorandum: Soil Sampling Results Simcoe Street Residential Area: IMICO, Guelph (1992).

2.0 Determination of Contaminants of Potential Concern (COPCs)

In the following table, the maximum contaminant concentrations measured in surface soil in the vicinity of IMICO are compared to MOE (2004) Table 2 soil standards[1] for residential / parkland / institutional use in a potable groundwater situation. Since MOE soil standards are based on the lower of ecological and health-based standards, the contaminant concentrations exceeding MOE Table 2 soil standards were subsequently compared to MOE's health-based residential soil standards. Where MOE lacks a human health based value, US EPA (2005) Region III Risk-Based Concentrations (RBCs) were used. RBCs were adjusted by multiplying by a factor of 0.4 to account for differences in the methods of derivation of MOE and US EPA soil guidelines. Values derived from US EPA RBCs are indicated with an asterisk (*) (Table 2-1).

N.B. The purpose of soil guidelines and standards is their use as trigger values for further study. Exceedance of these values does not imply risk or that human health effects are expected.

[1] The Guelph District Office of the MOE uses Table 2 as the default soil standards in the Waterloo Region, Wellington and Dufferin Counties due to the reliance on groundwater as a drinking water supply (Personal communication, Kyle Davis, Senior Environmental Officer, Guelph District Office, MOE, Nov. 21, 2005).

Table 2-1: Contaminant Screening of Inorganics

Contaminant	Maximum concentration in neighbourhood near IMICO (ppm)	MOE Table 2 soil standard (ppm)	Health-based residential soil concentration (ppm)
Aluminum	18,000	n/av	31,200*[a]
Antimony	7.4	13	n/n
Arsenic	49	20[b]	n/n
Barium	200	750	n/n
Beryllium	0.83	1.2[b]	n/n
Cadmium	6	12	n/n
Chromium (total)	30	750	n/n
Chloride	18	n/av	3120*[a]
Cobalt	12	40	n/n
Copper	87	225	n/n
Fluoride	260	n/av	1880*
Iron	27,000	n/av	9200*
Lead	420	200	200
Manganese	1200	n/av	640*
Mercury	1.3	10	n/n
Molybdenum	1.6	40	n/n
Nickel	19	150	n/n
Selenium	4.6	10	n/n
Sodium	515	910[c]	n/av
Strontium	180	n/av	18,800*
Sulphur	1800	970[c]	n/av
Vanadium	46	200	n/e
Zinc	1700	600	1000[d]

n/av = Soil standard is not available.

n/n = Comparison to health-based residential soil value is not necessary because maximum soil concentration in IMICO neighbourhood does not exceed MOE Table 2 soil standard (based on lower between ecological and health-based) or background.

* Values derived from US EPA RBCs are indicated with an asterisk.

[a] Soil guidelines for aluminum and chloride are from US EPA Region III RBC table issued April 2005 because the October 2005 table did not include these contaminants.

[b] For arsenic and beryllium, the MOE Table 2 soil standards are based on the 97.5th percentile of background concentrations in Ontario soils.

[c] For sodium and sulphur, there are no MOE or US EPA Region III soil criteria. The numbers shown are the 97.5th percentiles of background concentrations in old urban parkland in Ontario (MOE 1993).

[d] The value of 1000 ppm is a ceiling concentration selected for all metals on the basis of odour. The health-based soil standard for zinc of 16,000 ppm.

As a result of the contaminant screening, the following contaminants of potential concern (COPCs) were selected. Iron (Fe), lead (Pb), manganese (Mn), and zinc (Zn) were selected to be carried forward in this evaluation because maximum soil concentrations exceeded health-based soil criteria. Sulphur (S) and arsenic (As) were also selected to be carried forward because they exceeded background soil concentrations. The remaining contaminants were not carried forward.

3.0 Evaluation of Soil Concentrations of Contaminants

3.1 Evaluation of Soil Concentrations of Contaminants which are Essential Elements

Of the COPCs selected, iron (Fe), manganese (Mn), and zinc (Zn) are regarded as essential dietary elements. The receptors considered are children and adults. To evaluate whether the concentrations of these contaminants may cause health effects, intakes of these contaminants occurring via incidental soil ingestion is compared to dietary reference values in children (Table 3-1a) and in adults (Table 3-1b). Soil ingestion rates of 80 mg/day for children and 20 mg/day for adults were assumed (Health Canada 2004a). For Fe and Zn, estimated background intakes are recent mean dietary estimates for the US (Ervin et al. 2004). For Mn, mean dietary estimates were obtained from Health Canada (2004b). Tolerable upper intake levels (ULs) are maximum levels for daily nutrient intake from food, water, and supplements that are likely to pose no risk of adverse effects (National Academy of Sciences, 2004).

Table 3-1a: Comparison of Intakes from Soil Ingestion to Dietary Reference Values in **Children**

Contaminant	Maximum contaminant concentration in soil (ppm)	Estimated background intake (mg/day)	Tolerable upper intake level (UL) (mg/day)	Contaminant intake from soil ingestion		
				mg/day[a]	as a % of estimated background intake	as a % of UL
Iron (Fe)	27,000	12.9 – 14.4	40	2.16	15 – 17 %	5.4 %
Manganese (Mn)	1200	1.84 – 2.78	2 – 3	0.096	3.5 – 5.2 %	3.2 – 4.8%
Zinc (Zn)	1700	8.1 – 10.6	7 – 12	0.136	1.3 – 1.7 %	1.1 – 1.9%

[a] Contaminant intake from soil ingestion is calculated using the maximum contaminant concentration in soil and a soil ingestion rate of 80 mg/day.

Table 3-1b: Comparison of Intakes from Soil Ingestion to Dietary Reference Values in **Adults**

Contaminant	Maximum contaminant concentration in soil (ppm)	Estimated background intake (mg/day)	Tolerable upper intake level (UL) (mg/day)	Contaminant intake from soil ingestion		
				mg/day[a]	as a % of estimated background intake	as a % of UL
Iron (Fe)	27,000	14.8 – 15.8	45	0.54	3.4 – 3.6 %	1.2 %
Manganese (Mn)	1200	4.20 – 4.59	11	0.024	0.52 – 0.57 %	0.22 %
Zinc (Zn)	1700	10.6 – 12.4	40	0.034	0.27 – 0.32 %	0.085 %

[a] Contaminant intake from soil ingestion is calculated using the maximum contaminant concentration in soil and a soil ingestion rate of 20 mg/day.

For Fe, Mn, and Zn, the estimated intakes from soil ingestion (at maximum concentrations found in soil in the neighbourhood in the vicinity of the former IMICO foundry) were significantly lower than background intakes and were only a fraction of the tolerable upper intake levels (ULs) in both children and adults. Since the potential intakes of these COPCs from soil ingestion are much less than background dietary intakes with respect to ULs, these COPCs at the reported maximum soil concentrations are unlikely to represent a human health concern.

3.2 Evaluation of Soil Concentrations of Arsenic (As), Lead (Pb), and Sulphur (S)

Concentrations of As, Pb, and sulphur in soil in the vicinity of the former IMICO foundry are summarized below for surface soils (0 – 5 cm) (Table 3-2). The data were calculated from concentrations reported in the documents mentioned in section 1.0 above.

Means and medians were used to represent central tendency estimate (CTE) concentrations. UCLs (95% upper confidence limits) of the mean were used to represent reasonable maximum estimate (RME) concentrations. UCLs were calculated using ProUCL version 3.0 software available on line from the US EPA (2004). Lead concentrations are compared to the Table 2 soil standard (MOE 2004) which is based on human health. Arsenic concentrations are compared to the Table 2 soil standard (MOE 2004) which is based on the 97.5th percentile of background. Sulphur concentrations are compared to the 97.5th percentile of background sulphur concentrations in old urban parkland (MOE 1993) because there are no MOE or US EPA Region III soil criteria.

Table 3-2: Mean, Median, and UCL Concentrations of Arsenic, Lead, and Sulphur in Surface Soils

Contaminant	MOE soil criteria (ppm)	Sample size	Mean soil concentration (ppm)	Median soil concentration (ppm)	95% UCL soil concentration (ppm)
Arsenic	20	50	12	8.2	18
Lead	200	18	**206**	165	**245**
Sulphur	970	16	764	680	927

The mean, median, and UCL As and sulphur concentrations were below their respective soil criteria. Mean and UCL Pb concentrations exceeded the Pb soil standard. A total of 6 out of 18 samples (33%) exceeded the Pb soil standard.

4.0 Discussion

4.1 Arsenic

Of the samples, 5/50 (10%) exceeded the As soil standard. The UCL concentration of 18 ppm is lower than the MOE Table 2 soil standard. In addition, the maximum concentration of 49 ppm is within background ranges. In Ontario, background As concentrations can be as high as 61 ppm in urban parkland soil (MOE 1993) and as high as 79 ppm in soils categorized as old urban land use (MOE 2000). Furthermore, higher concentrations of As were found not to be excessive in other communities. In the village of Deloro, Ontario, soil As concentrations averaged 111 ppm and ranged up to 605 ppm, but urinary As levels (a known biological indicator of As exposure) in Deloro residents were almost identical to a control population from a nearby community without elevated soil As levels.

4.2 Lead

The Pb concentrations measured in the vicinity of IMICO ranged from 110 to 420 ppm. The UCL of 245 ppm exceeds the soil Pb standard of 200 ppm. Of the soil samples, 6/18 (33%) exceeded the Pb soil standard. However, these Pb concentrations are within the range of Pb concentrations generally found in older urban residential communities. Typical urban background Pb concentrations across the US often exceed 500 ppm because of the extensive use of Pb in urban areas (US EPA 1998).

Furthermore, concentrations of Pb in the range of those in the neighbourhood near IMICO were not found to be excessive in other communities. In an assessment currently being conducted for a community in Ontario, soil Pb concentrations of over 400 ppm correspond to only a 5% probability that a child will have a blood Pb level exceeding the current level of concern of 10 µg/dL (MOE 2005). In the US, lead is considered a hazard only if there are greater than 400 ppm of lead in bare soil in children's play areas or 1200 ppm average for bare soil in the rest of the yard (US EPA 2001).

4.3 Sulphur

Soil sulphur concentrations measured in the vicinity of IMICO ranged from 345 to 1800 ppm. The UCL of 927 ppm is below the 97.5th percentile of background sulphur concentrations in old urban parkland (970 ppm) and is below estimated normal background levels in the US of 1000 ppm (USDI, 2004). Of the soil samples, 3/16 (19%) exceeded the 97.5th percentile of background soil sulphur concentrations in old urban parkland in Ontario (MOE 1993). Since sulphur is a natural component of the environment, US EPA has waived the environmental fate data requirements for its registration for use as a pesticide or a soil amendment; it becomes incorporated into the natural sulphur cycle (US EPA, 1991).

Sulphur is known to be of low toxicity and poses very little if any risk to human health (US EPA, 1991). In Texas, sulphur is one of the soil contaminants that does not require the calculation of a human health protective concentration limit (PCL); soil sulphur concentrations are acceptable as long as the concentration is not high enough to raise soil acidity to the extent that corrosivity occurs or the soil is unable to support vegetation (TNRCC, 2003).

For comparison with dietary intakes, the intakes occurring via soil ingestion can be estimated using assumed soil ingestion rates of 80 mg/day for children and 20 mg/day for adults (Health Canada 2004a). At the maximum soil sulphur concentration of 1800 ppm, intake would be 144 µg/day for children and 36 µg/day for adults. There is no specific recommended dietary intake for sulphur other than the amino acids of which sulphur is a part; approximately 850 mg/day are thought to be needed for basic turnover of sulphur in the body (Haas, 1992). Compared to dietary intakes, the intake from incidental soil ingestion is negligible.

5.0 Conclusions

In summary, the reported concentrations of the soil contaminants in the neighbourhood near the former IMICO foundry are not expected to represent a potential for human health effects. Regarding the COPCs which are essential elements, estimated intakes from incidental soil ingestion were significantly lower than background intakes and were only a fraction of the tolerable upper intake levels (ULs) in both children and adults. Soil concentrations of the remainder of the COPCs are generally within background ranges and are not associated with excess exposure as determined by biological indicators (blood or urine).

Regarding Pb, given that the soil concentrations are typical for older urban communities where blood Pb levels are not elevated, these soil Pb concentrations are not expected to cause health effects. Given that the concentrations of As are generally within background ranges, the soil concentrations of As are not expected to cause human health effects. Given that sulphur is known for having low toxicity, that the intake of sulphur from soil ingestion is several times lower than dietary intake, and that the UCL is below the 97.5th percentile of background in old urban parkland, the soil concentrations of sulphur are not expected to cause human health effects.

There are some limitations in this evaluation of soil contaminant concentrations. The extent of contamination on individual properties cannot be determined by the few samples per property (usually only 1 sample) reported in the documents used for this analysis. Also, soil contaminant concentrations were reported for the top 5 cm of surface soil only. Data for contaminant concentrations below 5 cm is not reported but is relevant to human health. Moreover, the soil sampling and analyses are outdated (circa 1992). Further sampling to characterize contaminant concentrations may be needed to address these limitations.

6.0 References

Ervin RB, Wang C_Y, Wright JD, and Kennedy-Stephenson J. 2004. Dietary intake of selected minerals for the United States Population: 1999-2000. Advance Data from Vital and Health Statistics 341:1-8. US Department of Health and Human Services, Centers for Disease Control and Prevention. April 27, 2004.

Haas, 1992. The Complete Guide to Diet and Nutritional Medicine. Elson M. Haas, M.D. Published by: Celestial Arts, Berkeley, California, March 1, 1992.

Health Canada 2004a. Contaminated Sites Program – Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). Environmental Health Assessment Services, Safe Environments Programme, Health Canada. September 2004.

Health Canada 2004b. Average dietary intakes (µg/kg bw/day) of trace elements for Canadians in different age/sex groups for Total Diet Study from 1993 to 1999. Bureau of Chemical Safety, Health Products and Food Branch, Health Canada. Online: www.hc-sc.gc.ca/fn-an/surveill/total-diet/index_e.html Last accessed Nov. 9, 2005. (Body weights obtained from Health Canada)

Table 1. Mean[1] Elemental concentrations (ug/g) in the surface soil (0-5cm) in the vicinity of the IMICO foundry, Guelph. April 19, 1990.

	Site								
Element	1	2	3	4	5	6	7	8	9
Copper	38	30	36	34	42	59	32	69	24
Nickel	14	9.6	10	9.0	11	9.2	7.8	12	12
Lead	160	110	140	140	240	160	120	120	160
Zinc	580	400	1700	660	820	310	1000	1000	460
Iron	24000	18000	14000	14000	14000	18000	18000	14000	20000
Manganese	1100	700	460	360	320	620	360	370	760
Aluminum	16000	12000	9800	9400	10000	12000	8600	9300	13000
Arsenic	9.7	8.2	8.0	10	6.4	7.7	5.7	8.3	6.2
Barium	66	69	70	74	80	70	50	79	73
Cadmium	1.1	1.0	3.6	1.7	1.3	0.96	1.8	6.0	0.98
Chloride	<0.5	6.2	5.3	4.5	8.2	12	5.8	7.4	12
Chromium	16	14	14	14	14	18	10	14	14
Fluoride	60	59	100	140	160	260	92	97	84
Mercury	.075	0.095	0.095	0.095	0.20	0.12	0.09	0.16	0.09
Sodium	100	100	135	180	170	220	120	140	140
Antimony	0.72	1.5	1.2	1.5	3.0	1.6	1.3	1.2	2.2
Selenium	0.7	1.4	1.9	1.9	1.6	0.62	1.4	4.6	0.95
Strontium	21	52	73	78	81	34	44	72	34
Sulphur (%)	0.042	0.09	0.12	0.071	0.099	0.053	0.094	0.18	0.058
Vanadium	44	34	26	26	26	34	27	30	36
Cobalt	10	9.8	9.2	8.1	8.3	8.4	7.0	7.9	8.9
Molybdenum	0.9	0.8	1.6	0.4	0.4	1.6	0.2	BD	BD
Beryllium	0.82	0.65	0.61	0.62	0.52	0.54	BD	BD	0.63

	Site								
Element	9*	10	11	12	13	13*	14	15	ULN**
Copper	28	40	87	54	38	34	35	40	100
Nickel	10	11	19	16	12	11	12	12	60
Lead	110	200	420	300	280	240	200	160	500
Zinc	320	560	1100	1100	550	520	560	940	500
Iron	18000	23000	27000	27000	22000	19000	20000	22000	35000
Manganese	590	680	1200	1100	650	610	720	980	700
Aluminum	12000	12000	16000	18000	12000	12000	12000	14000	-
Arsenic	5.0	8.2	37	13	6.2	6.2	7.0	6.7	20
Barium	66	92	200	99	92	84	74	80	-
Cadmium	0.81	1.1	2.8	2.0	1.3	1.0	1.1	1.8	4
Chloride	6.1	8.2	8.1	5.3	14	10.2	12	9.2	-
Chromium	12	16	30	20	16	14	14	20	50
Fluoride	88	120	100	68	100	100	100	100	-
Mercury	0.11	0.18	0.26	0.12	0.11	0.10	0.14	0.14	0.5
Sodium	160	140	160	140	200	160	140	140	-
Antimony	1.5	4.7	7.3	7.2	7.4	8.0	5.6	1.6	8
Selenium	0.78	1.8	2.4	1.4	0.72	0.85	0.92	0.76	2
Strontium	40	36	51	32	38	38	38	28	-
Sulphur	0.042	0.075	0.066	0.07	0.062	0.057	0.056	0.052	-
Vanadium	33	35	43	46	38	34	35	39	70
Cobalt	9.2	9.0	12	12	9.5	9.9	10.8	10.5	25
Molybdenum	0.43	BD	0.41	0.8	0.7	0.4	0.5	0.4	3
Beryllium	0.56	0.60	0.83	0.83	0.56	0.60	0.61	0.73	-

[1] Average of duplicate samples * 5 - 15cm depth ** ULN - Upper Limit of Normal - see Appendix for explanation

BD - Below detection limit

Figure 1: Station Locations for Soil Sampling, IMICO, Guelph, April 19, 1990.

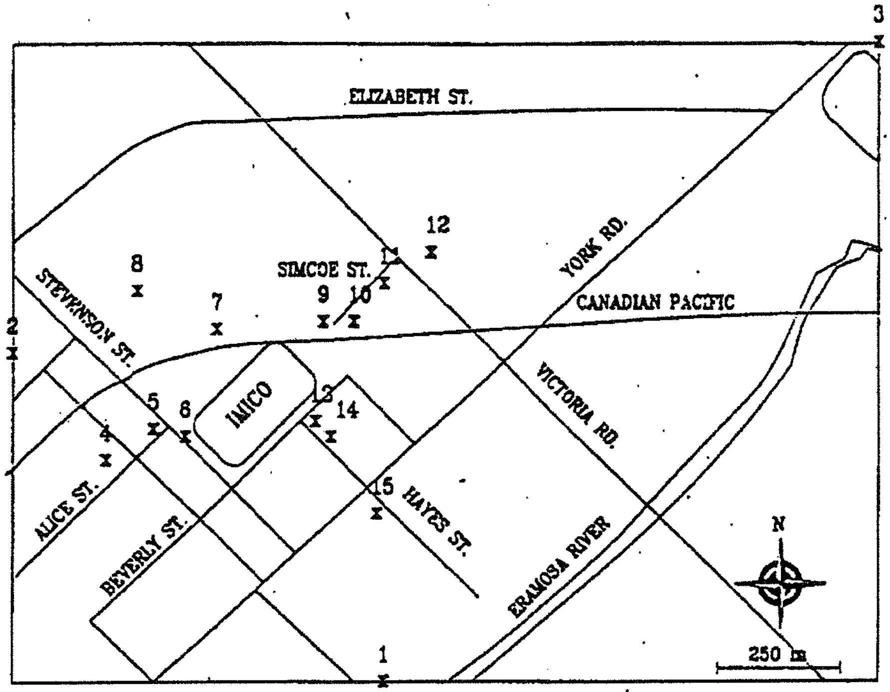


Figure 2: Contour Map of Surface Soil Arsenic Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

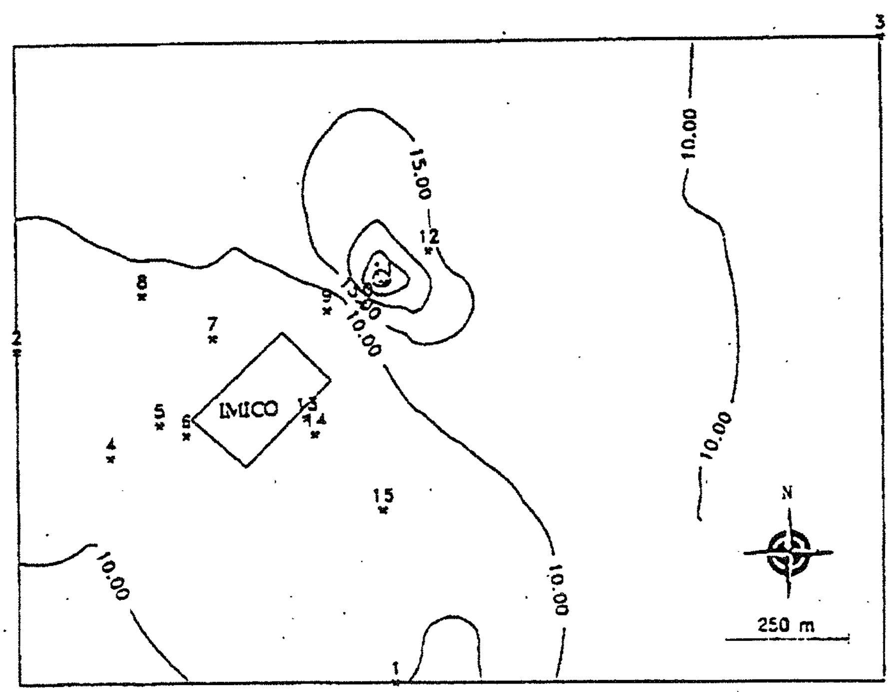


Figure 3: Contour Map of Surface Soil Manganese Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

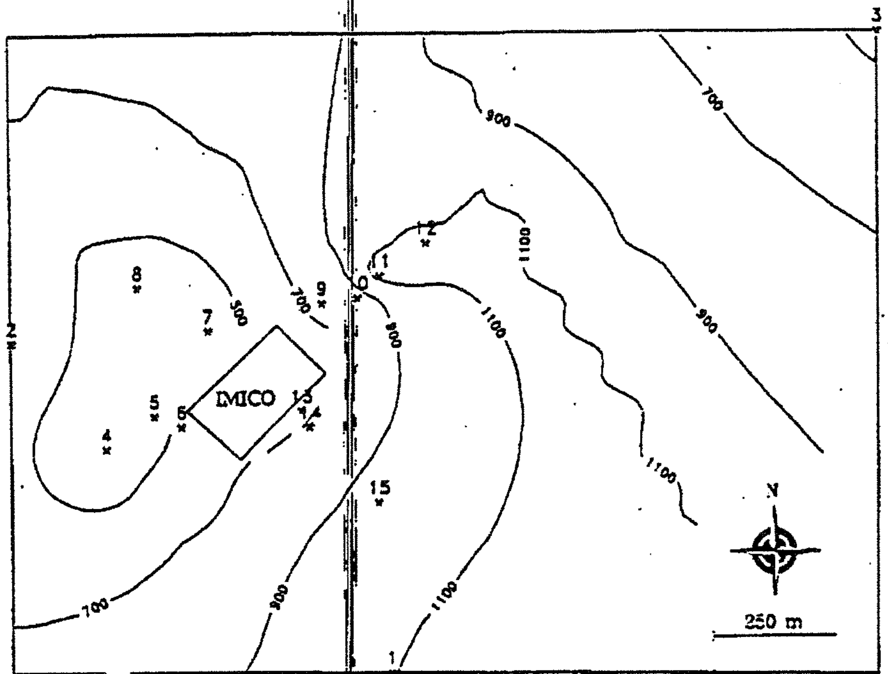


Figure 4: Contour Map of Surface Soil Antimony Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

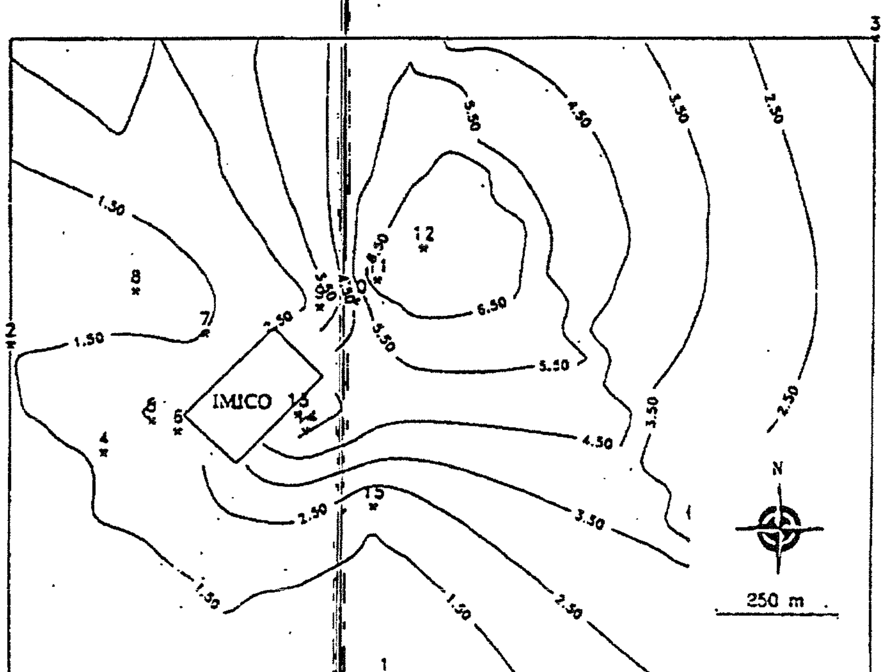


Figure 5: Contour Map of Surface Soil Barium Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

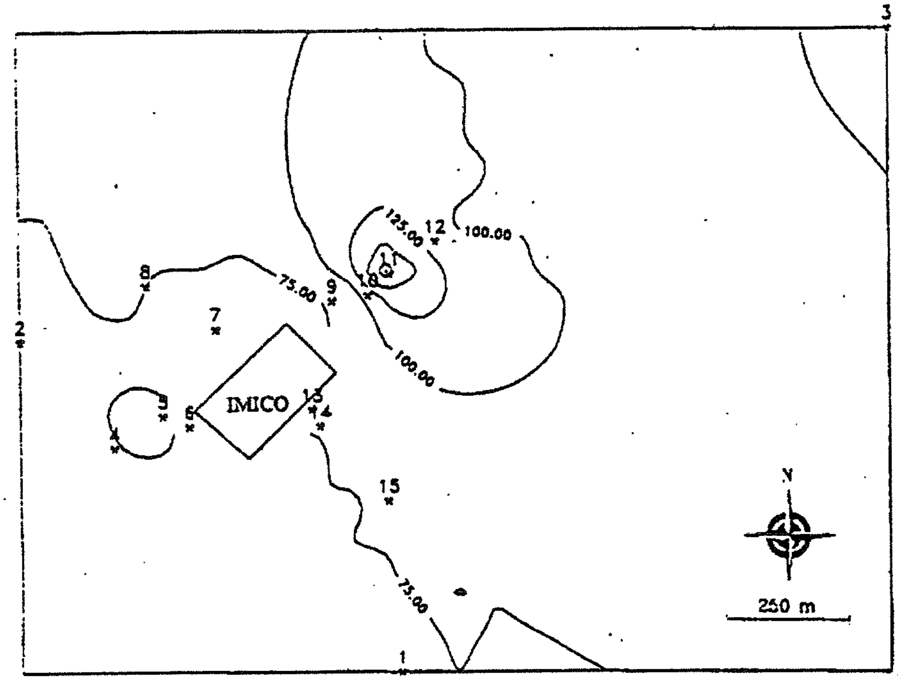


Figure 6: Contour Map of Surface Soil Copper Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

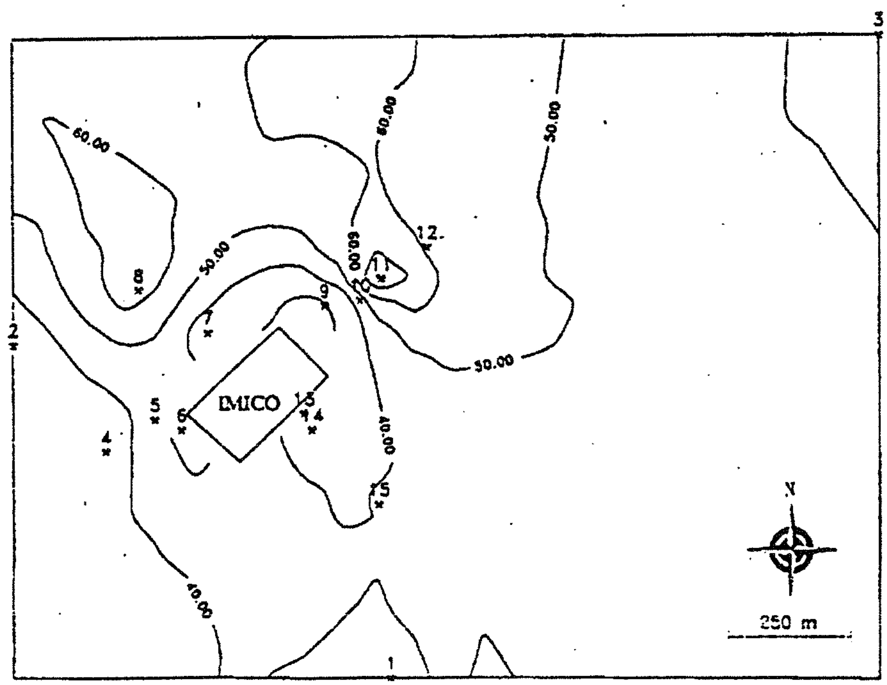


Figure 7: Contour Map of Surface Soil Chromium Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

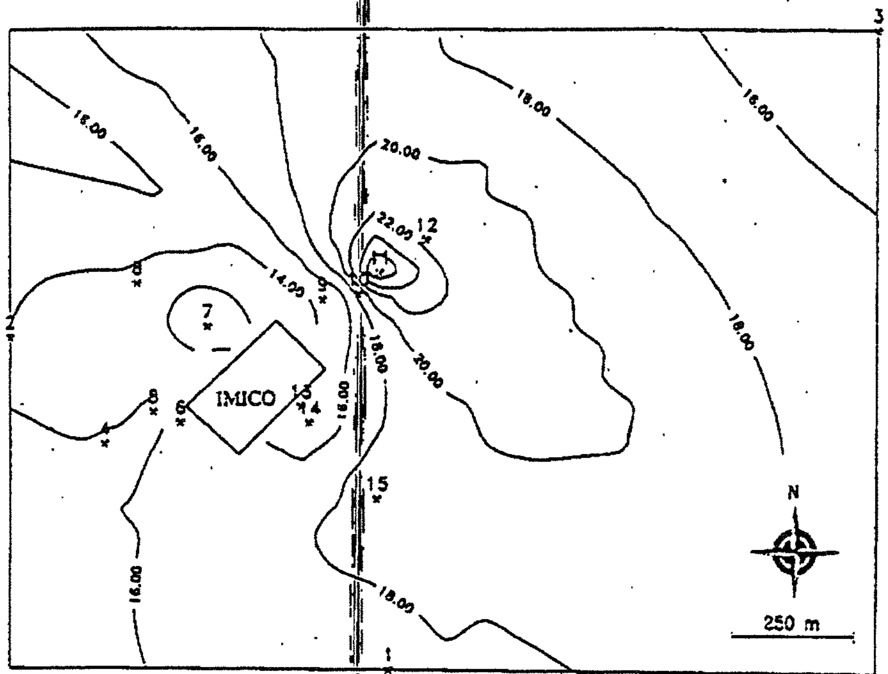


Figure 8: Contour Map of Surface Soil Lead Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

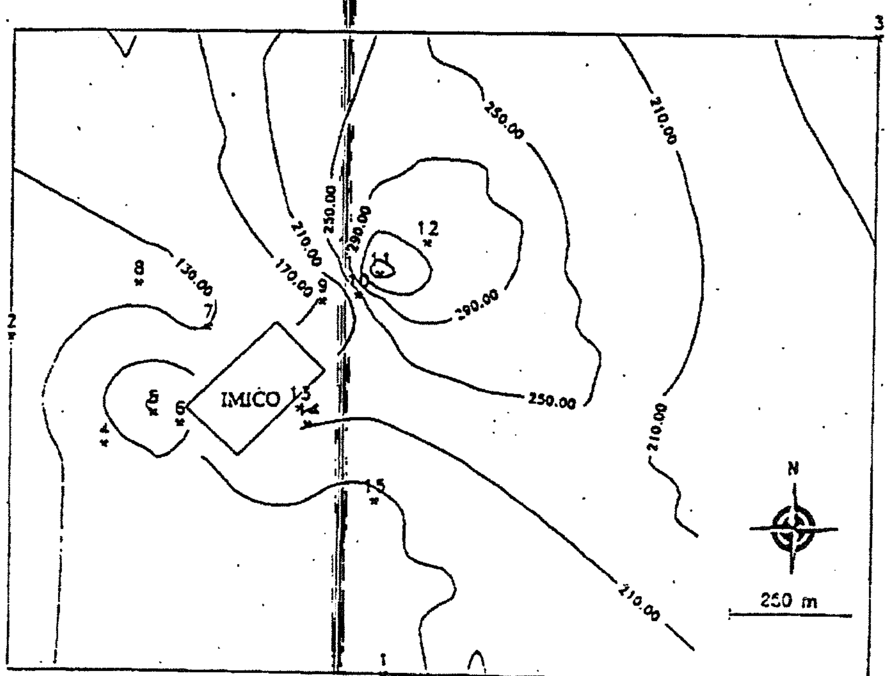


Figure 9: Contour Map of Surface Soil Mercury Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

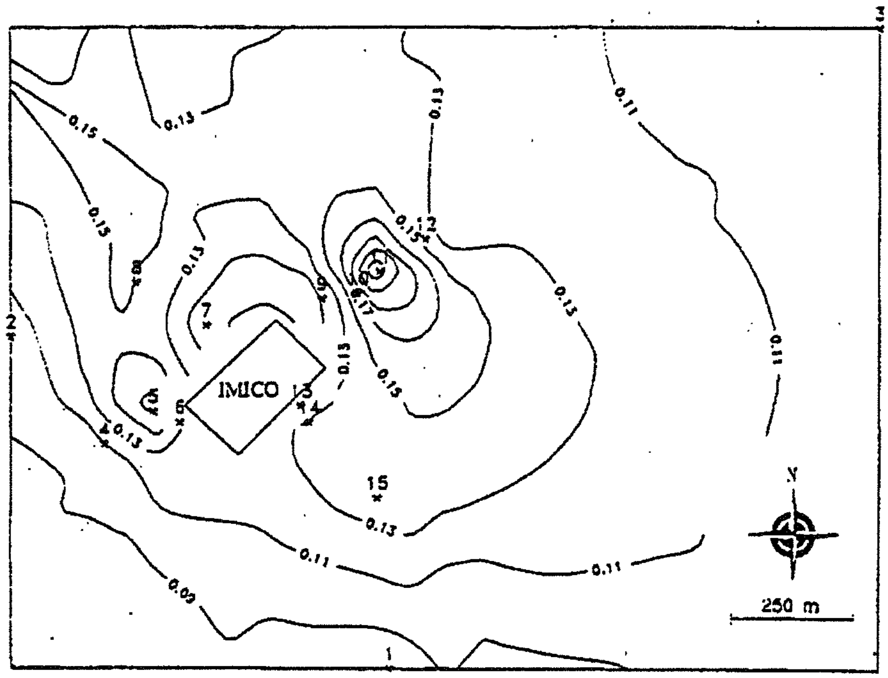


Figure 10: Contour Map of Surface Soil Zinc Concentrations (ug/g). IMICO, Guelph, April 19, 1990.

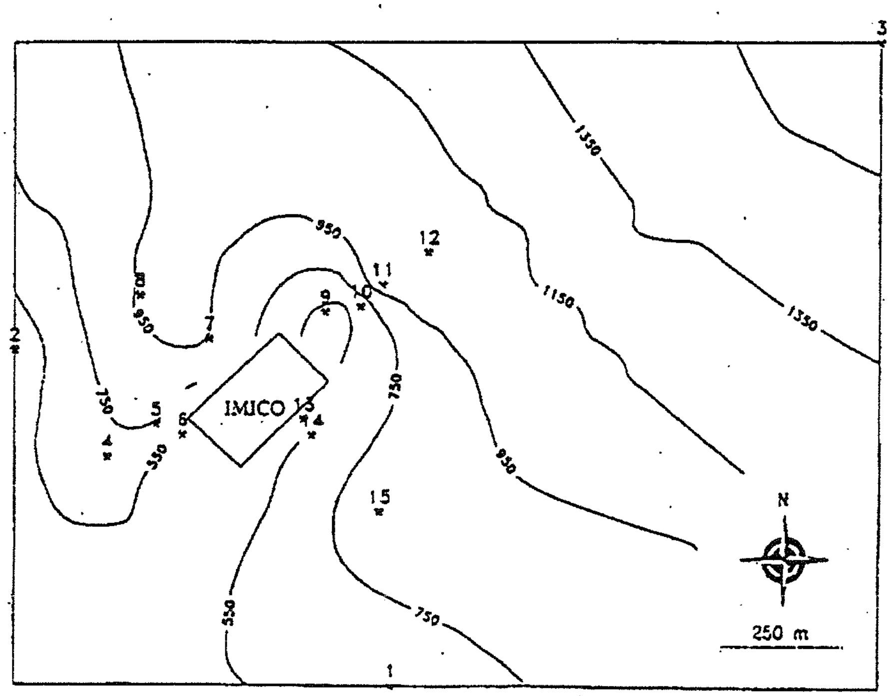
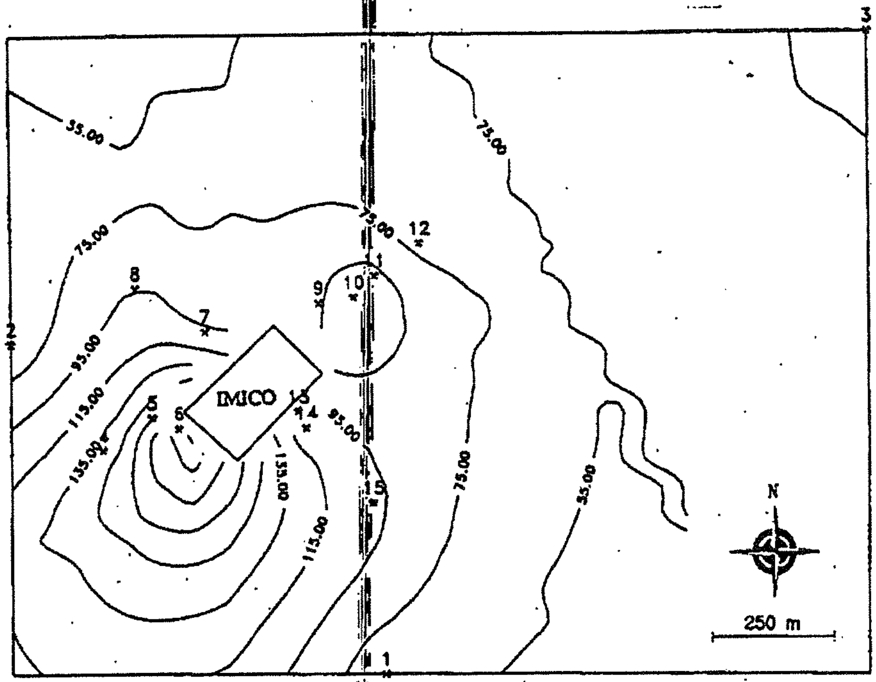
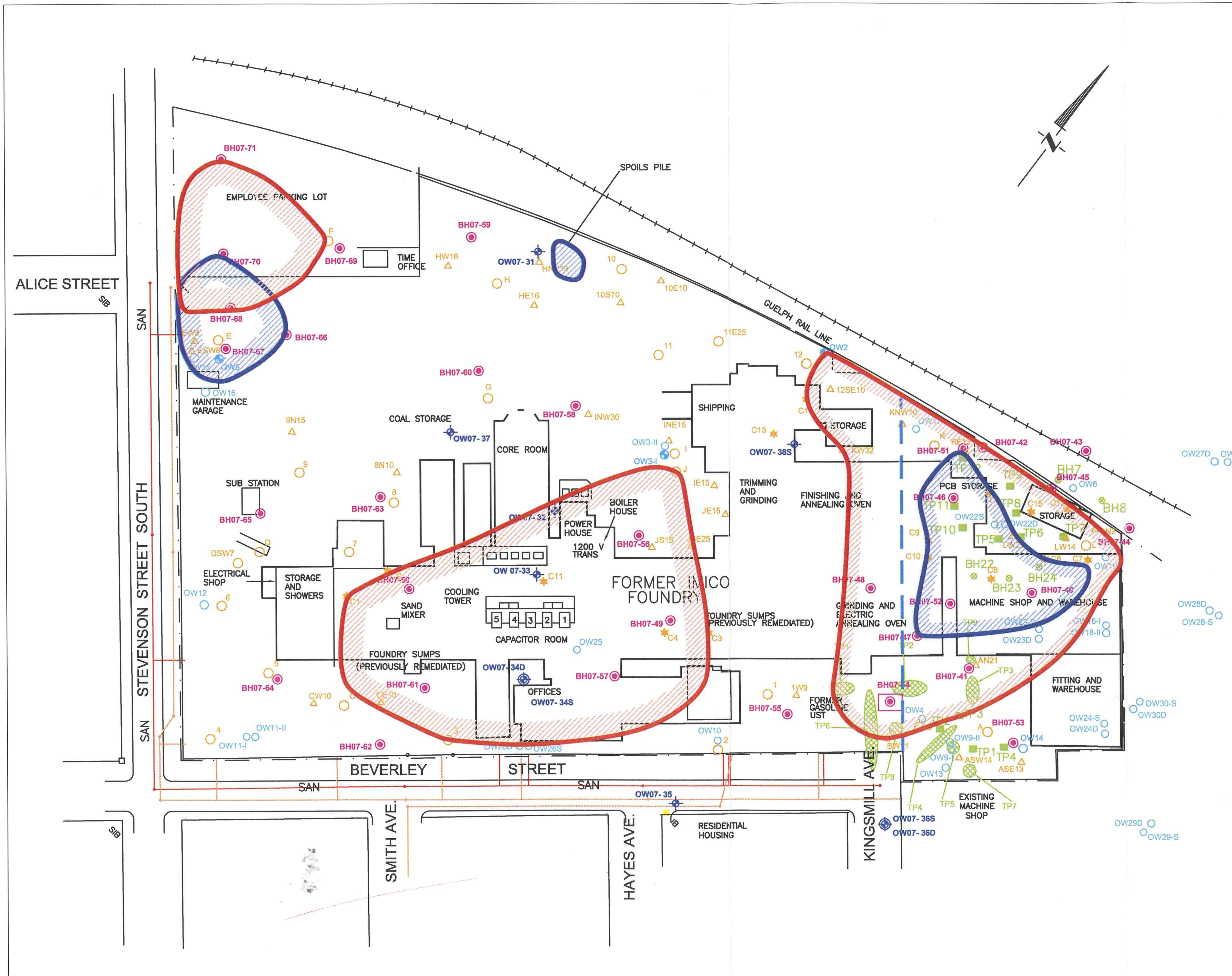


Figure 11: Contour Map of Surface Soil Fluoride Concentrations (ug/g). IMICO, Guelph, April 19, 1990.





LEGEND:

SAMPLING LOCATIONS - DCS

- OW 07-36S — SHALLOW MONITORING WELL IN ROCK
- OW07- 36D — DEEP MONITORING WELL IN ROCK
- BH07-39 — SHALLOW BOREHOLE

SAMPLING LOCATIONS - OTHERS

- L — TEST PIT LOCATION (BY PROCTOR & REDFERN),1990.
- 10S70 — TEST PIT LOCATION (ADDITIONAL BY PROCTOR & REDFERN),1990.
- C10 — CORHOLE LOCATON (BY PROCTOR & REDFERN),1990.
- OW3-I — MONITORING WELL (BY PROCTOR & REDFERN), 1990.
- OW6 — MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.
- TP9 — TEST PIT (BY GARTNER LEE), 2000.
- TP10 — TEST PIT (BY GARTNER LEE), 1999.
- BH7 — BOREHOLE LOCATION (BY GARTNER LEE), VARIOUS YEARS.

- METALS EXTENT OF IMPACT
- PHCs EXTENT OF IMPACT
- ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

REFERENCE:

- * ENVIRONMENTAL INVESTIGATION, INTERNATIONAL MALLEABLE IRON COMPANY, 200 BEVERLEY STREET, CITY OF GUELPH - BY PROCTOR AND REDFERN LIMITED, JUNE 1991.
- * SUPPLEMENTAL HYDROGEOLOGIC INVESTIGATION, FORMER IMICO SITE - BY GARTNER LEE LIMITED, MARCH 1999.
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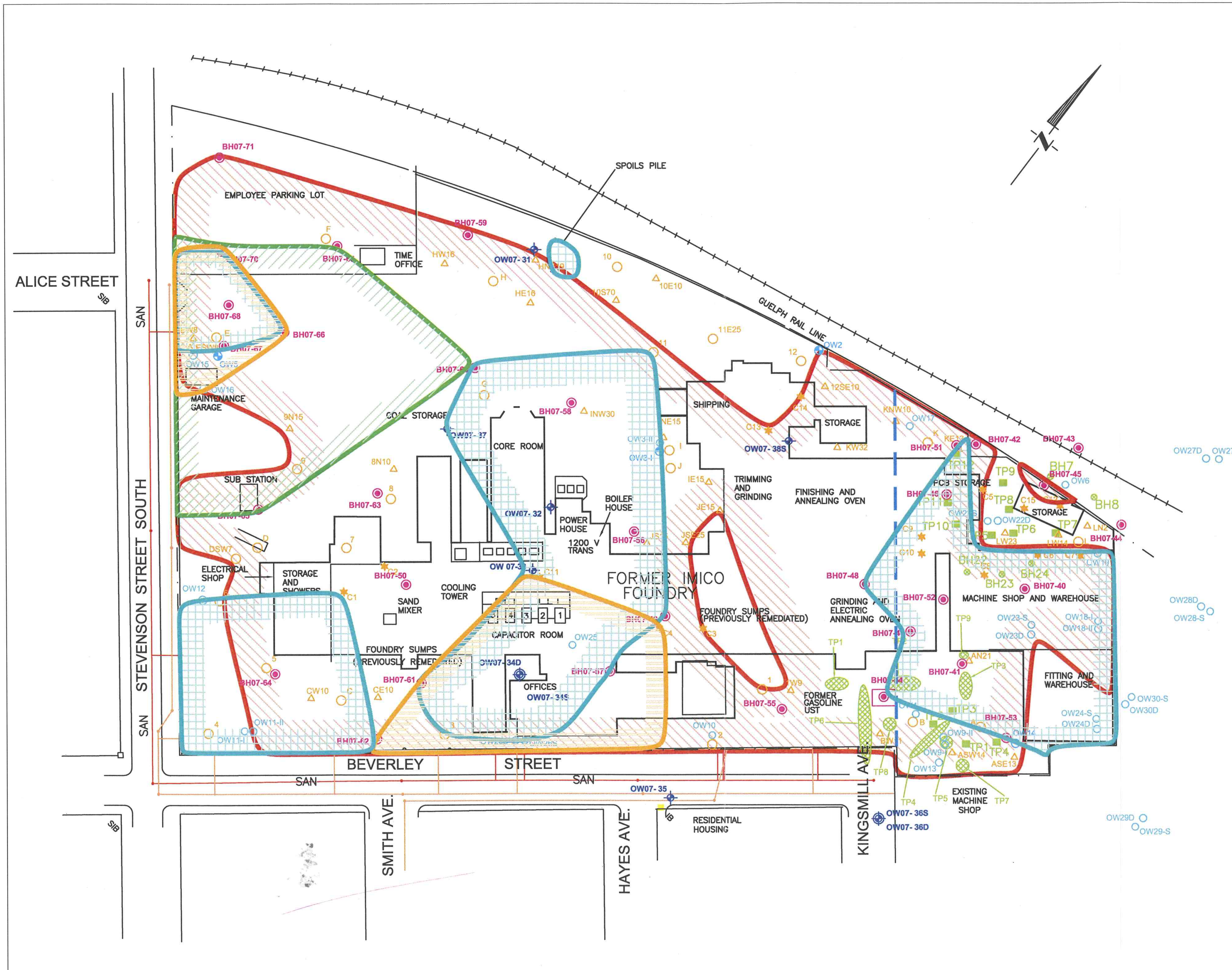
FORMER IMICO PROPERTY
PRELIMINARY REMEDIAL ACTION PLAN

POTENTIAL OFFSITE DISPOSAL SOILS, EXCEEDANCES CURRENT MOE TABLE 3 INDUSTRIAL STANDARDS

MAR. 2008	1:1250	49520-RAP-4.1



LEGEND:

SAMPLING LOCATIONS - DCS

- OW 07-36S — SHALLOW MONITORING WELL IN ROCK
- OW07- 36D — DEEP MONITORING WELL IN ROCK
- BH07-39 — SHALLOW BOREHOLE

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- OW3-I — MONITORING WELL (BY PROCTOR & REDFERN), 1990.
- OW6 — MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.
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- BH7 — BOREHOLE LOCATION (BY GARTNER LEE), VARIOUS YEARS.

- METALS EXTENT OF IMPACT
- PAHs EXTENT OF IMPACT
- PCB EXTENT OF IMPACT
- VOCs EXTENT OF IMPACT
- ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

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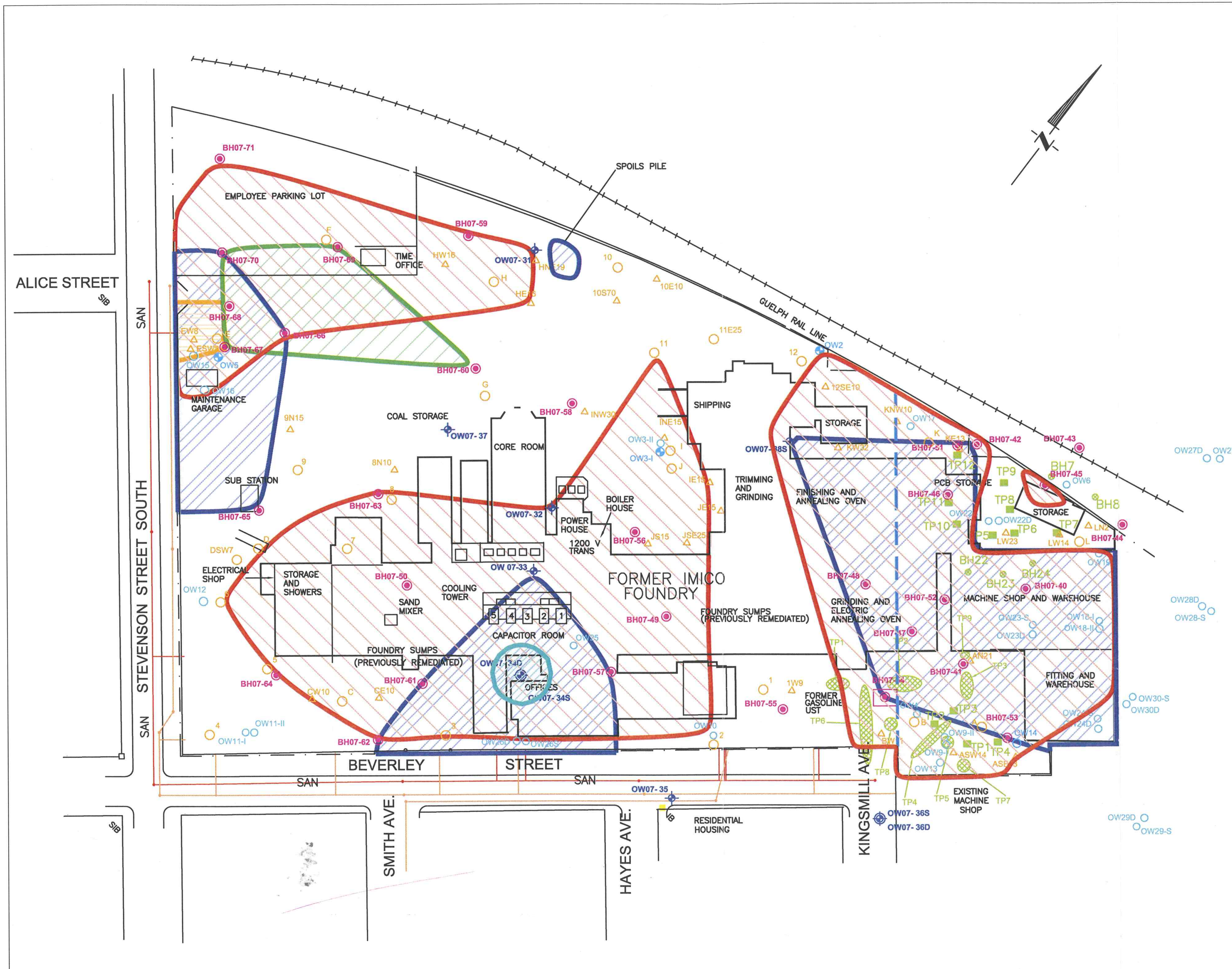
PRELIMINARY REMEDIAL ACTION PLAN

EXTENT OF SOIL IMPACTS,
PROPOSED MOE TABLE 1 STANDARDS

MAR. 2008	1:1250	49520-RAP-2.2



LEGEND:

SAMPLING LOCATIONS - DCS

OW 07-36S	SHALLOW MONITORING WELL IN ROCK
OW07- 36D	DEEP MONITORING WELL IN ROCK
BH07-39	SHALLOW BOREHOLE

SAMPLING LOCATIONS - OTHERS

L	TEST PIT LOCATION (BY PROCTOR & REDFERN),1990.
10S70	TEST PIT LOCATION (ADDITIONAL BY PROCTOR & REDFERN),1990.
C10	COREHOLE LOCATON (BY PROCTOR & REDFERN),1990.
OW3-I	MONITORING WELL (BY PROCTOR & REDFERN), 1990.
OW6	MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.
TP9	TEST PIT (BY GARTNER LEE), 2000.
TP10	TEST PIT (BY GARTNER LEE), 1999.
BH7	BOREHOLE LOCATION (BY GARTNER LEE), VARIOUS YEARS.

METALS EXTENT OF IMPACT

PCB EXTENT OF IMPACT

VOCs EXTENT OF IMPACT

PHCs EXTENT OF IMPACT

PAHs EXTENT OF IMPACT

ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

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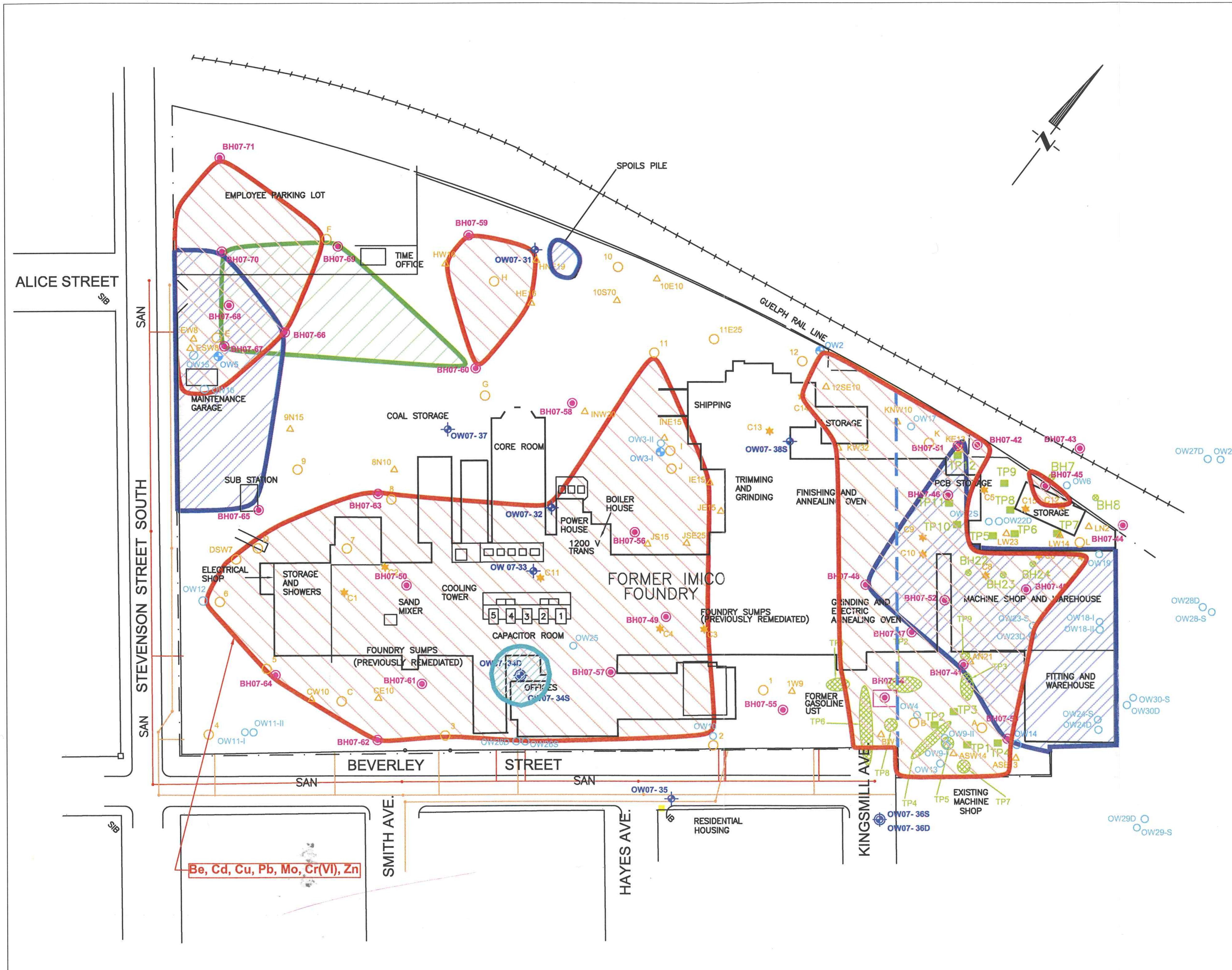
FORMER IMICO PROPERTY

PRELIMINARY REMEDIAL ACTION PLAN

EXTENT OF SOIL IMPACTS, LIMITED SCOPE RISK ASSESSMENT, MOE TABLE 2 RESIDENTIAL STANDARDS

MAR. 2008	1:1250	49520-RAP-2.3



LEGEND:

SAMPLING LOCATIONS - DCS

- OW 07-36S — SHALLOW MONITORING WELL IN ROCK
- OW07-36D — DEEP MONITORING WELL IN ROCK
- BH07-39 — SHALLOW BOREHOLE

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- METALS EXTENT OF IMPACT
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- PHCs EXTENT OF IMPACT
- PAHs EXTENT OF IMPACT
- ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

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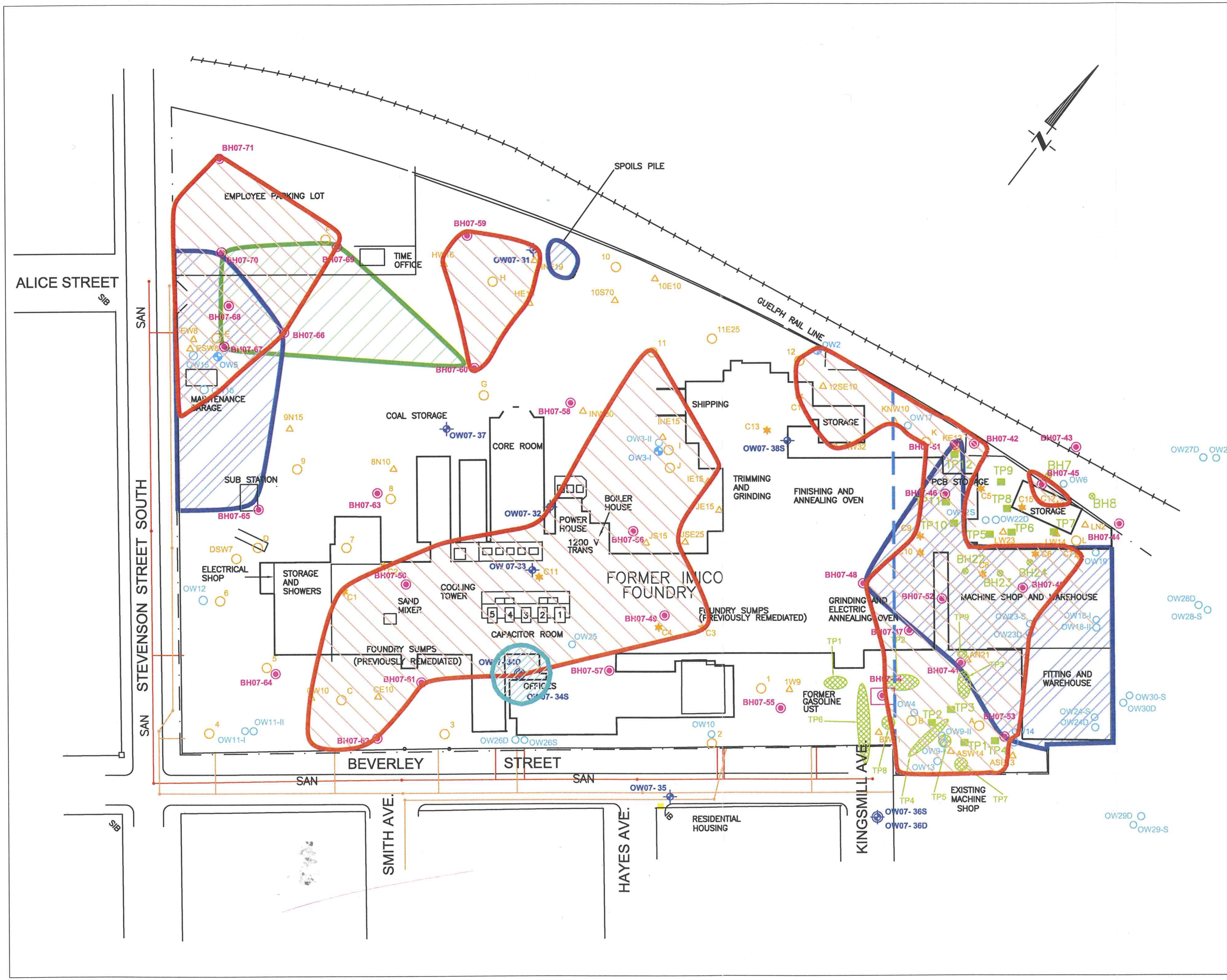
FORMER IMICO PROPERTY
PRELIMINARY REMEDIAL ACTION PLAN

EXTENT OF SOIL IMPACTS, LIMITED SCOPE RISK ASSESSMENT, CURRENT MOE TABLE 2 INDUSTRIAL STANDARDS

MAR. 2008	1:1250	49520-RAP-2.4



LEGEND:

SAMPLING LOCATIONS - DCS

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- METALS EXTENT OF IMPACT
- VOCs EXTENT OF IMPACT
- PHCs EXTENT OF IMPACT
- PAHs EXTENT OF IMPACT
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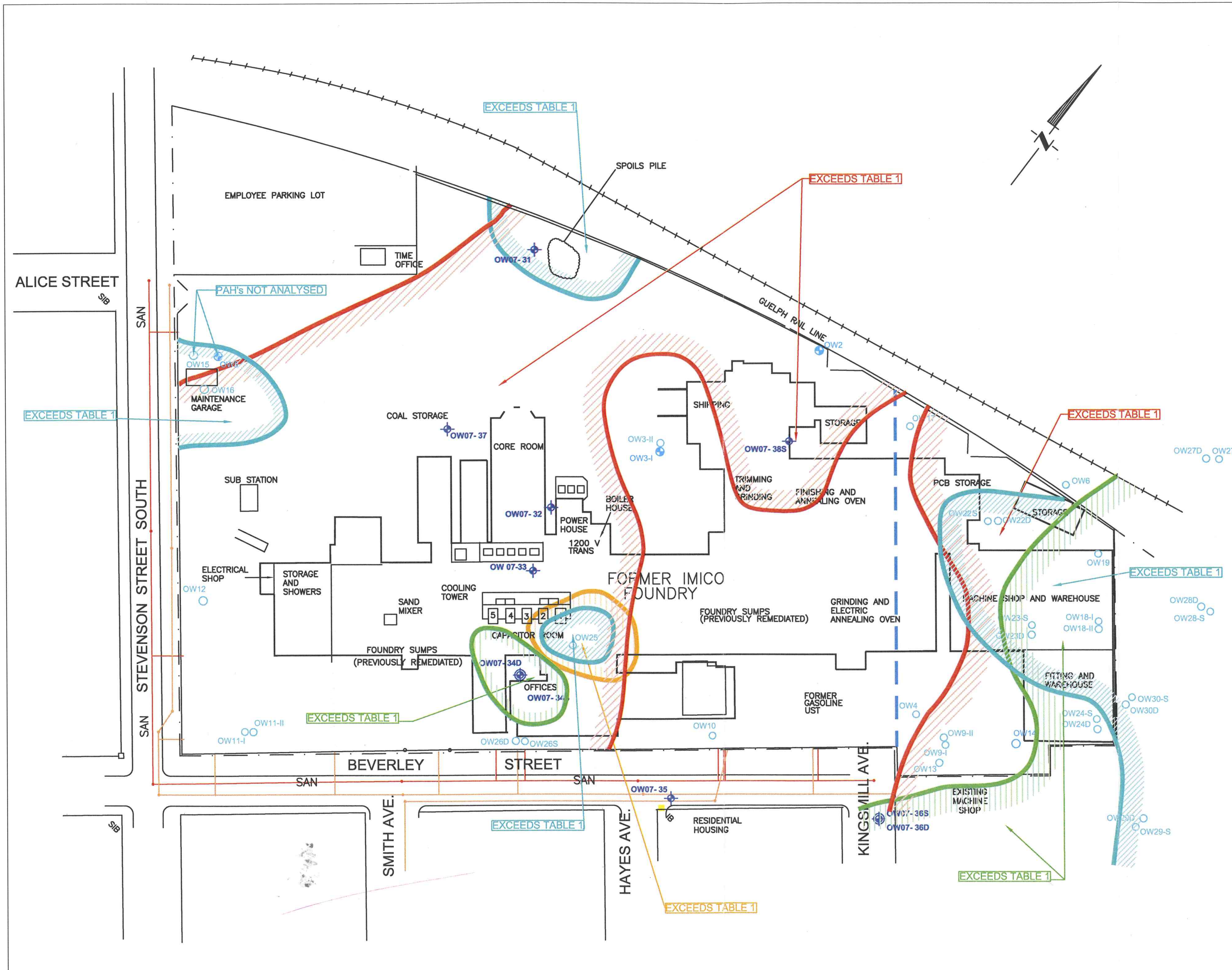
FORMER IMICO PROPERTY
PRELIMINARY REMEDIAL ACTION PLAN
EXTENT OF SOIL IMPACTS, LIMITED SCOPE RISK ASSESSMENT, MOE TABLE 2 ICC STANDARDS PLUS ELEVATED BACKGROUND ZINC VALUES

MAR. 2008	1:1250	49520-RAP-2.5



LEGEND:

SAMPLING LOCATIONS - DCS

- OW 07-36S — SHALLOW MONITORING WELL IN ROCK
- OW07-36D — DEEP MONITORING WELL IN ROCK

SAMPLING LOCATIONS - OTHERS

- OW3-I — MONITORING WELL (BY PROCTOR & REDFERN), 1990.
- OW6 — MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.

- METALS EXTENT OF IMPACT
- PCB EXTENT OF IMPACT
- PAHs EXTENT OF IMPACT
- VOCs EXTENT OF IMPACT
- ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

REFERENCE:

* ENVIRONMENTAL INVESTIGATION, INTERNATIONAL MALLEABLE IRON COMPANY, 200 BEVERLEY STREET, CITY OF GUELPH - BY PROCTOR AND REDFERN LIMITED, JUNE 1991.
* SUPPLEMENTAL HYDROGEOLOGIC INVESTIGATION, FORMER IMICO SITE - BY GARTNER LEE LIMITED, MARCH 1999.
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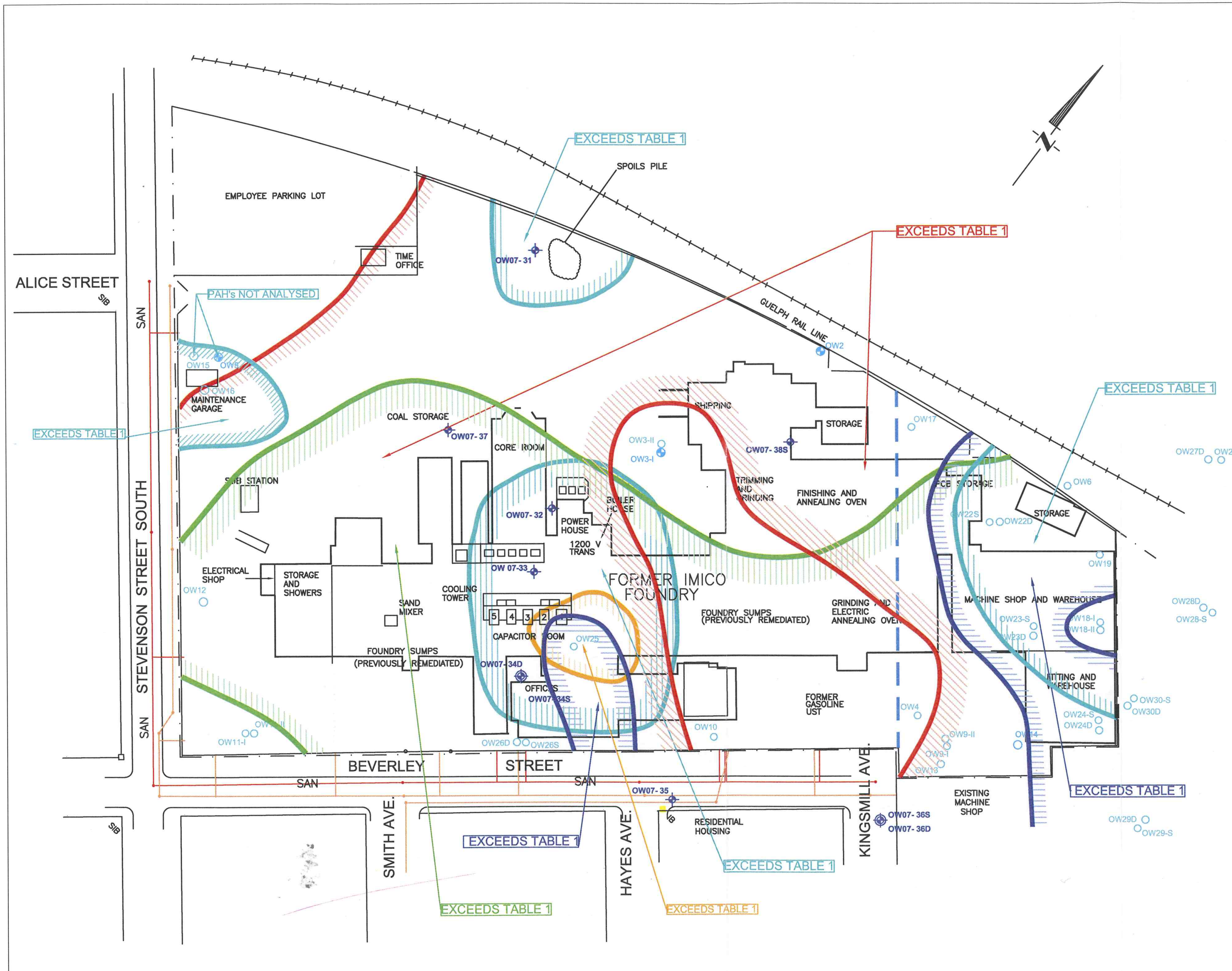
200 BEVERLEY STREET, CITY OF GUELPH

FORMER IMICO PROPERTY
PRELIMINARY REMEDIAL ACTION PLAN

EXTENT OF GROUND WATER IMPACTS, CURRENT MOE TABLE 1 BACKGROUND STANDARDS

MAR. 2008	1:1250	49520-RAP-3.1



LEGEND:

SAMPLING LOCATIONS - DCS

OW 07-36S — SHALLOW MONITORING WELL IN ROCK

OW07- 36D — DEEP MONITORING WELL IN ROCK

SAMPLING LOCATIONS - OTHERS

OW3-I — MONITORING WELL (BY PROCTOR & REDFERN), 1990.

OW6 — MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.

METALS EXTENT OF IMPACT

PCB EXTENT OF IMPACT

PAHs EXTENT OF IMPACT

PHCs EXTENT OF IMPACT

VOCs EXTENT OF IMPACT

ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

REFERENCE:

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* SUPPLEMENTAL HYDROGEOLOGIC INVESTIGATION, FORMER IMICO SITE - BY GARTNER LEE LIMITED, MARCH 1999.
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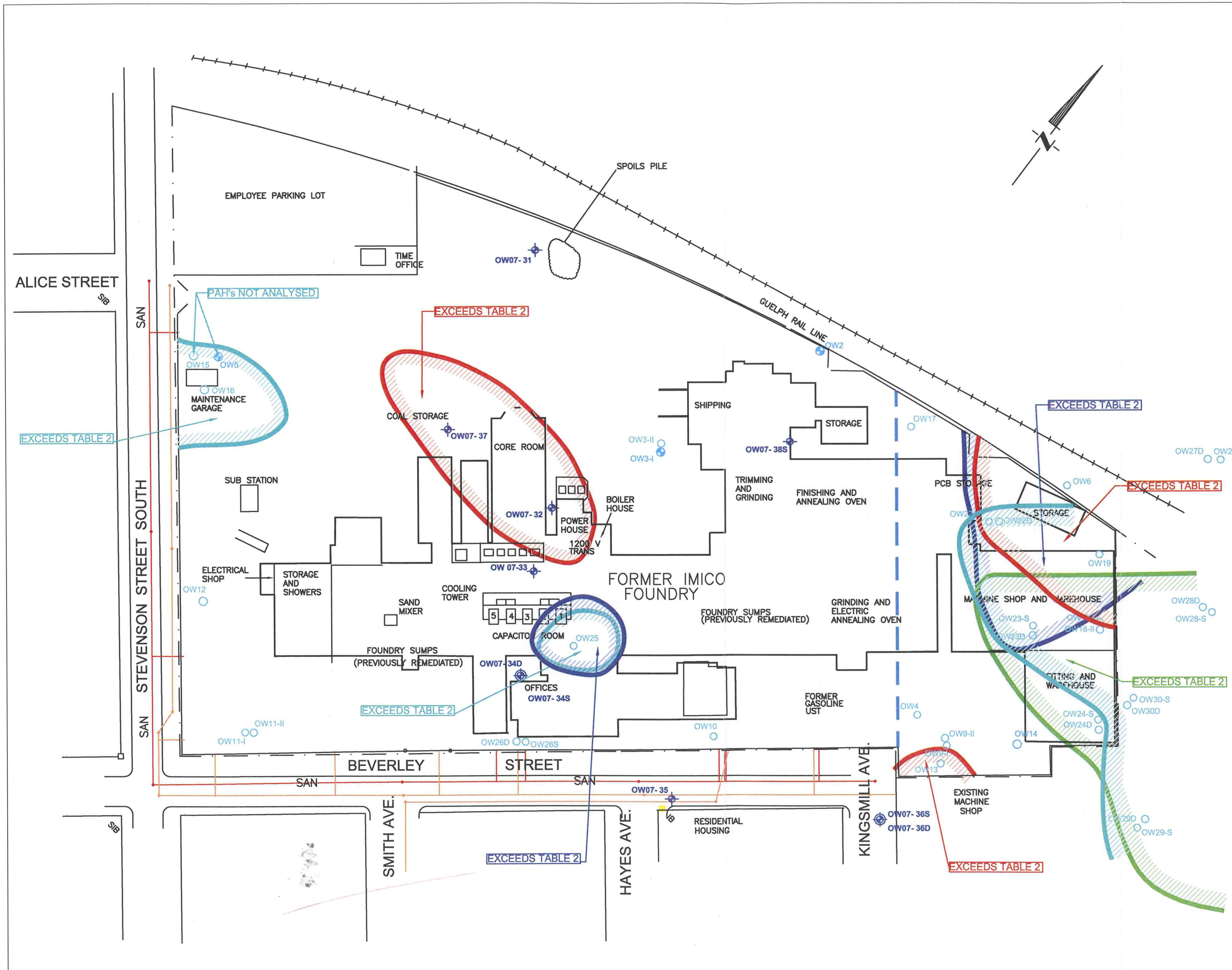
EXTENT OF GROUND WATER IMPACTS, PROPOSED MOE TABLE 1 BACKGROUND STANDARDS

MAR. 2008	1:1250	49520-RAP-3.2



LEGEND:

SAMPLING LOCATIONS - DCS

- OW 07-36S — SHALLOW MONITORING WELL IN ROCK
- OW07-36D — DEEP MONITORING WELL IN ROCK

SAMPLING LOCATIONS - OTHERS

- OW3-I — MONITORING WELL (BY PROCTOR & REDFERN), 1990.
- OW6 — MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.

- METALS EXTENT OF IMPACT
- PAHs EXTENT OF IMPACT
- PHCs EXTENT OF IMPACT
- VOCs EXTENT OF IMPACT
- ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

REFERENCE:

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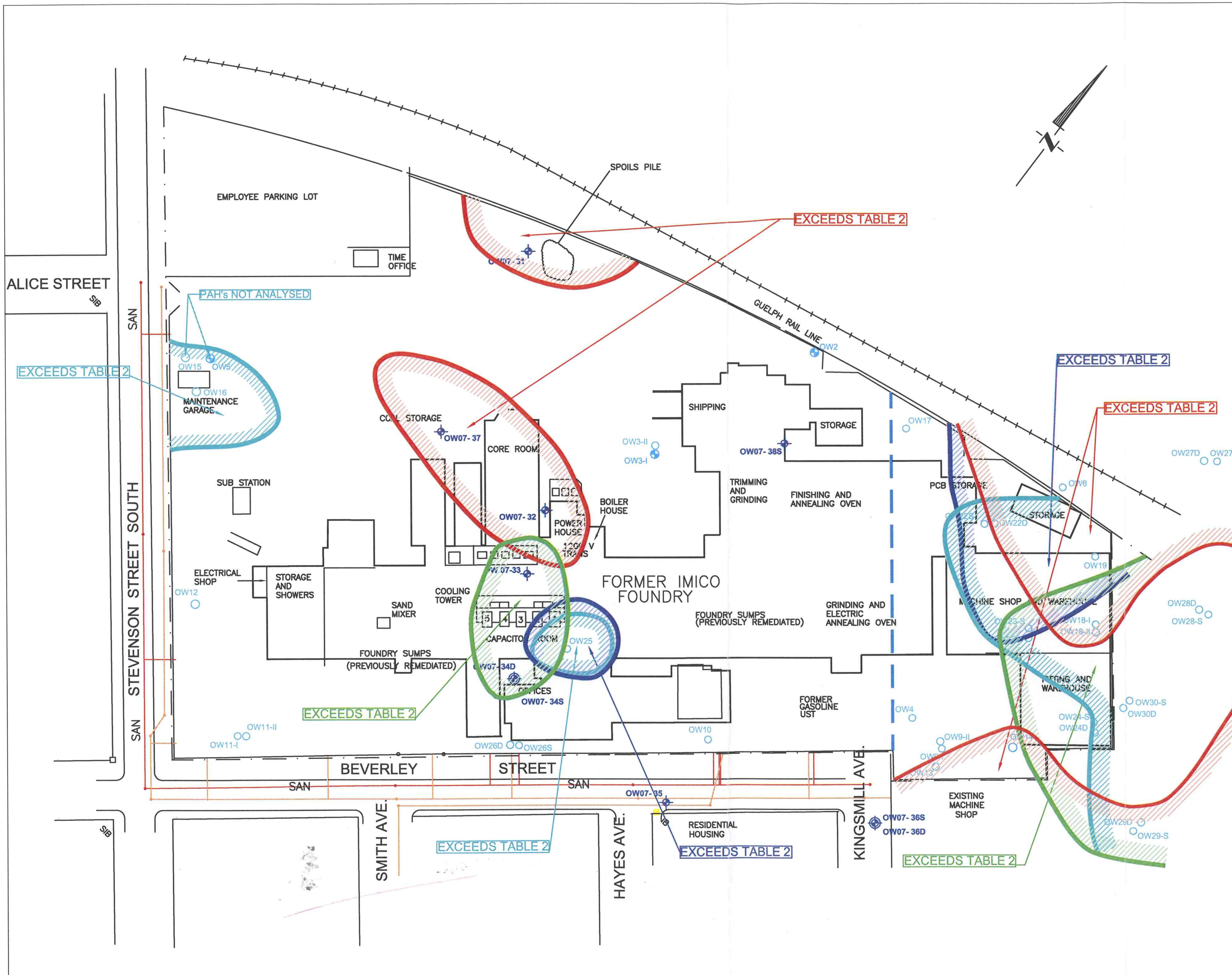
PRELIMINARY REMEDIAL ACTION PLAN

EXTENT OF GROUND WATER IMPACTS, CURRENT MOE TABLE 2 POTABLE STANDARDS

MAR. 2008	1:1250	49520-RAP-3.3



LEGEND:

SAMPLING LOCATIONS - DCS

OW 07-36S — SHALLOW MONITORING WELL IN ROCK

OW07-36D — DEEP MONITORING WELL IN ROCK

SAMPLING LOCATIONS - OTHERS

OW3-I — MONITORING WELL (BY PROCTOR & REDFERN), 1990.

OW6 — MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.

METALS EXTENT OF IMPACT

PAHs EXTENT OF IMPACT

PHCs EXTENT OF IMPACT

VOCs EXTENT OF IMPACT

ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

REFERENCE:

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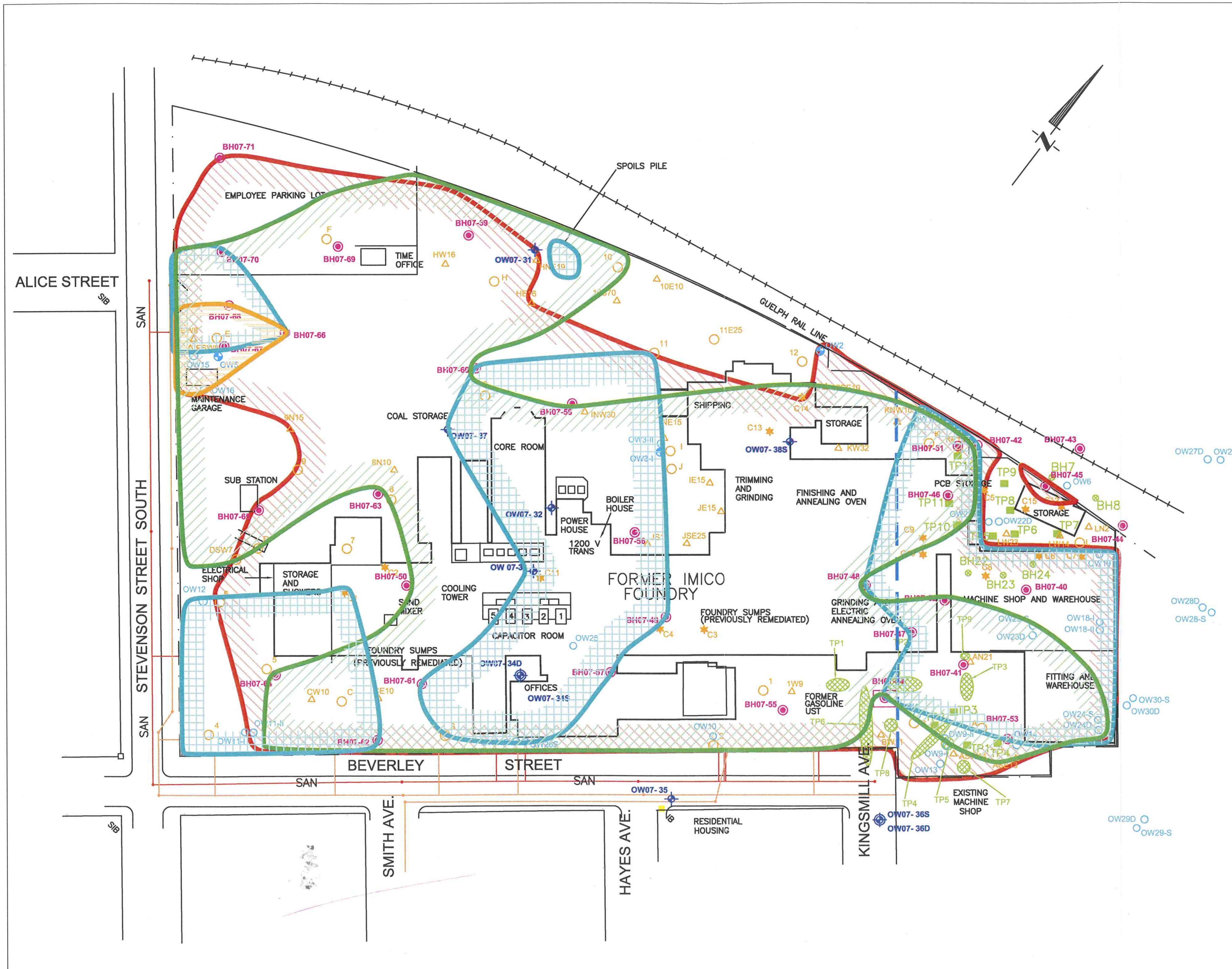
PRELIMINARY REMEDIAL ACTION PLAN

EXTENT OF GROUND WATER IMPACTS, PROPOSED MOE TABLE 2 POTABLE STANDARDS

MAR. 2008	1:1250	49520-RAP-3.4



LEGEND:

SAMPLING LOCATIONS - DCS

OW 07-36S	SHALLOW MONITORING WELL IN ROCK
OW07- 36D	DEEP MONITORING WELL IN ROCK
BH07-39	SHALLOW BOREHOLE

SAMPLING LOCATIONS - OTHERS

L	TEST PIT LOCATION (BY PROCTOR & REDFERN),1990.
10S70	TEST PIT LOCATION (ADDITIONAL BY PROCTOR & REDFERN),1990.
C10	COREHOLE LOCATON (BY PROCTOR & REDFERN),1990.
OW3-I	MONITORING WELL (BY PROCTOR & REDFERN), 1990.
OW6	MONITORING WELL (BY GARTNER LEE), VARIOUS YEARS.
TP9	TEST PIT (BY GARTNER LEE), 2000.
TP10	TEST PIT (BY GARTNER LEE), 1999.
BH7	BOREHOLE LOCATION (BY GARTNER LEE), VARIOUS YEARS.

- METALS EXTENT OF IMPACT
- PAHs EXTENT OF IMPACT
- PCB EXTENT OF IMPACT
- VOCs EXTENT OF IMPACT
- ASSUMED BOUNDARY BETWEEN EAST AND WEST PORTIONS OF THE SITE

REFERENCE:

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EXTENT OF SOIL IMPACTS, CURRENT MOE TABLE 1 STANDARDS

MAR. 2008	1:1250	49520-RAP-2.1