

Checklist for Reviewing a Detailed Site Investigation

This guidance document provides a summary of the general types of information expected in detailed site investigation (DSI), a detailed checklist, and an outline for a summary required by the ministry. In general, a detailed site investigation should:

- identify which substances are causing, or threaten to cause, adverse effects on human health or the environment and provide any applicable information on their form;
- identify the specific areas, depths, and degree of contamination at the site, including areas and extent of migration if applicable;
- evaluate contamination relative to standards in the Hazardous Waste and in the Contaminated Sites Regulations;
- describe the relationship between the detailed site investigation and any prior preliminary site investigation, discussing in particular how the methods of investigation and findings of the preliminary site investigation were used to design and carry out the detailed site investigation;
- provide a compilation and presentation of all field observations, field measurement, and analytical data and laboratory analytical data;
- provide an interpretation and evaluation of the data in a manner that clearly shows:
 - the contamination in soil, groundwater, sediments, or surface water in relation to

- standards in the Hazardous Waste and the Contaminated Sites Regulations; and
- specific areas, depths, and degree of contamination, including migration which may have occurred to adjoining properties; and
- include a summary of the report so it can be entered on the Site Registry in a format specified in a protocol established by a Director under section 64 of the *Environmental Management Act*.

Checklist

The checklist in Appendix 1 highlights some (but not necessarily all) important features of a good detailed site investigation. This should be considered as guidance only. Some features are legally required, but not all are relevant in all cases. Environmental consultants and others using the attached checklist when conducting and reviewing preliminary site investigations should also consider site-specific factors and the usefulness of information provided in the detailed site investigation.

An outline of a review summary is provided in Appendix 2. The summary should include a brief discussion for any question listed in the checklist not marked with a "Y".

The "Section" column of the checklist makes occasional reference to other ministry guidance documents. "SCS" refers to Technical Guidance document 12 "Statistics for Contaminated Sites" which contains a set of numbered documents on specific statistical issues.

Please note that the checklist is a dynamic document that is modified on the basis of input received. We welcome comments on suggested improvements to format and contents and we will continue to work to provide a document that is relevant to users.

Disclaimer

This checklist does not replace the *Environmental Management Act* or its regulations. It does not list all provisions relating to preliminary site investigations. If there are differences or omissions in this document, the Act and regulations apply.

For more information, contact the Environmental Management Branch at site@gov.bc.ca

Appendix 1 Detailed Site Investigation Checklist

Section	Checklist	Status Y/N
<p>SUMMARY</p> <p><i>Important information</i></p>	<p>1. Does the investigator:</p> <ul style="list-style-type: none"> a) identify who the major participants are in the investigation; b) provide important facts and study results at the beginning of the report; c) provide a clear understanding of the data contained within the body of the report; and d) discuss the results of any preliminary site investigations? 	
<p><i>Sampling information</i></p>	<p>2. Does the summary:</p> <ul style="list-style-type: none"> a) state how representative the sampling pattern and analysis is of property soil conditions; b) specify the probabilities of false positive and false negative answers; c) identify what the chemical analysis program focused on; and d) indicate how reliable the sampling methodology and laboratory analysis was? 	
<p>OBJECTIVES</p> <p><i>Goals</i></p>	<p>3. Are the goals:</p> <ul style="list-style-type: none"> a) of the investigation clearly stated; b) in compliance with the scope of work agreed upon with the client; and c) consistent with ministry goals and objectives?..... 	
<p>SITE HISTORY & DESCRIPTION</p> <p><i>Description of the site</i></p>	<p>4. Has the investigator:</p> <ul style="list-style-type: none"> a) specified the dates when site visits were conducted; . b) provided a site map, including land use, relevant buildings found on site, dimensions in metres and area of the property in hectares; c) included natural features such as lakes, rivers, streams found at least partially within the boundaries of the property; d) included constructed features such as, underground storage tanks, lagoons, ditches, sumps within buildings, and waste storage areas; e) provided a reasonable substitute if no site map is available; f) provided an area topographic map of 1: 20 000 or larger; and g) included a scaled aerial photograph of the site and adjacent environs? 	

<i>Climatic conditions</i>	<p>5. For DSIs are:</p> <ul style="list-style-type: none"> a) annual precipitation records provided; b) along with a description of seasonal variations in precipitation; and c) estimates of infiltration rates provided? 	
<i>Ground water</i>	<p>6. Has:</p> <ul style="list-style-type: none"> a) the depth to ground water from the ground surface and the depth and thickness of multiple aquifers been calculated; b) seasonal ground water fluctuation been documented; c) the lithology and vertical permeability of the unsaturated zone been described; and d) the stratigraphy, structure, geometry, porosity, hydraulic conductivity, storage properties, transmissivity, and groundwater flow direction of the saturated zone been described? 	
<i>Wells</i>	<p>7. If monitoring wells have been installed near the disposal areas previous to this investigation,</p> <ul style="list-style-type: none"> a) have the monitoring results been reviewed; b) have data been included that indicate why and when a monitoring well was installed and by whom; and .. c) has any previous geotechnical investigative work been identified and reviewed? 	
<i>Soil types and soil depths</i>	<p>8. Has the investigator:</p> <ul style="list-style-type: none"> a) provided soil survey information at a scale of 1:20 000 or larger; b) contacted soil survey personnel, or local soil scientists; c) provided an on-site map and appropriate cross-sections showing soil types, soil depth and other soil parameters that may be related to location and extent of contaminants; and d) shown the relationship between groundwater and soil in cross-section? 	
<i>Basic preliminary information about liability</i>	<p>9. Does the investigator:</p> <ul style="list-style-type: none"> a) provide adequate information about any court or administrative actions, ministry orders, Federal charges under the <i>Fisheries Act</i> etc., orders; and..... b) surmise whether there will be any potential litigation in this case?..... 	

<p>DATA</p> <p><i>Goals of the study</i></p>	<p>10. Has the investigator discussed the following about the goals of the study:</p> <ul style="list-style-type: none"> a) what are the goals of the detailed site investigation;... b) will analysis of the populations identified in the study lead to achieving these goals; and c) are the goals extensive enough to identify the Area(s) of Environmental Concern (AEC)? 	
<p>Populations</p> <p>For additional information see: Identifying Populations, SCS No. 7</p>	<p>11. For detailed site investigations has the investigator:</p> <ul style="list-style-type: none"> a) used historical and other preliminary site investigation information to help delineate separate populations; b) attempted to identify how many contaminant distributions there are; and c) attempted to identify background levels in the surrounding area for contaminants that occur naturally or that may have been deposited by non-point sources?..... 	
<p>Plans</p> <p>For additional information see: Sampling Plans, SCS No. 12</p> <p>Technical Guidance On Contaminated Sites 1. Site Characterization and Confirmation Testing, revised June 2005.</p>	<p>12. For detailed site investigations:</p> <ul style="list-style-type: none"> a) does the investigator explain the rationale behind the sampling plan; b) does the sampling plan reflect the potential sources, pathways, and receptors of contaminants; c) does the plan reduce the potential of type I and type II errors; d) has the investigator over-sampled to compensate invalidated results (broken bags, lost labels, etc.); e) has the investigator avoided collecting composite samples for preliminary site investigations;..... f) has the investigator provided rationale for using composites or a combination of composite and discrete samples; g) has the investigator detailed the procedures used to collect, record, confirm and verify the data base; h) does the investigator provide an adequate location of each sample (e.g. has the sample grid been tied into UTM co-ordinates); i) has the investigator determined the background soil conditions for the parameters being investigated; j) does the investigator provide rationale for choosing the area used to represent ambient conditions? 	

<p>For additional information see: Estimating a Global Mean, SCS No. 9</p>	<p>13. If previous studies have been used in the detailed site investigation:</p> <ul style="list-style-type: none"> a) have the data been summarized and presented in the report; b) have the data been used to add to the density of sampling locations; c) has the source of additional data been identified and its use justified; and d) has the investigator given reasons for including or excluding data from previous studies?..... 	
<p>For additional information see: Randomization, SCS No. 16</p>	<p>14. Has the investigator:</p> <ul style="list-style-type: none"> a) used a regular grid with a randomly-located origin to estimate contaminant distribution in non-AECs; ... b) collected the number of samples needed to conform with the level of confidence require to establish contaminant levels in non-areas of environmental concern (non-AECs); and c) used the coefficient of variation to determine if non-AECs have been unaffected by local AECs?..... 	
	<p>15. For the sampling plan has the investigator:</p> <ul style="list-style-type: none"> a) oriented the sample grid in the direction (if known) of flow of the pollutant, which may relate to site topography or a wind direction; b) selected random samples, locations and/or starting points using procedures based on uniform random numbers; and c) included a random number table? 	
<p>For additional information see: Stockpiling, SCS No. 14</p> <p>Technical Guidance On Contaminated Sites 1. Site Characterization and Confirmation Testing, revised June 2005.</p>	<p>16. For the detailed site investigation of stockpiles has the investigator:</p> <ul style="list-style-type: none"> a) designed a sampling program that ensures a fair representation of the contaminant concentrations in the entire pile; b) based the stockpile classification on at least five separate analyses; and c) determined if the material within the pile is sufficiently homogenous to warrant classifying the entire under a single classification? 	

	<p>17. For investigations of groundwater:</p> <ul style="list-style-type: none"> a) has the investigator used any groundwater data available from preliminary site investigations;..... b) have at least 3 monitoring wells been used with at least one located up-gradient of groundwater flow; .. c) have samples been collected at least 24 hours after the development of a well; d) have groundwater samples been collected after wells have been purged; and e) has integrity testing of underground storage tanks near sensitive receptors such as potable water supplies been carried out? 	
<p><i>Protocol</i></p> <p>For additional information see: Statistical QA/QC, SCS No. 11</p>	<p>18. Has the investigator:</p> <ul style="list-style-type: none"> a) included the original quality assurance plan; b) run a complete check of all data against original records; c) provided documentation of reliability of any data that is significant to the study's conclusions; d) shown that that no systematic bias has been used during the sampling procedure, including collection, preparation and analysis; e) shown that the analytical methods used for all samples are acceptable to the ministry; f) used control charts to monitor and control the accuracy and precision of the analyses for large studies with more than 100 samples; g) used a t-test to determine whether the average of repeat analyses is significantly different from the established reference value; h) used paired analyses of duplicates of the same material especially where suspected contaminant levels are believed to be at their highest concentrations; i) shown that paired analyses of sample material split in the field shows a rank and linear correlation of 0.95 or greater for metallic and inorganic contaminants, and 0.90 or greater for organic contaminants; j) followed recommended ministry lab services QA/QC protocols; and k) documented any corrective action taken if QA/QC reveals significant bias or high imprecision? 	

	<p>19. For AECs:</p> <ul style="list-style-type: none"> a) has investigator ensured that the spacing between samples is smaller than the range of correlation; and b) has the investigator used multi-stage sampling plans to detect and identify the extent of hot spots, including fine grids and step-outs? 	
<p>EXPLORATORY DATA ANALYSES</p> <p><i>Non-parametric method</i></p> <p>For additional information see: Non-parametric methods, SCS No. 5</p>	<p>20. For detailed site investigations, has the investigator:</p> <ul style="list-style-type: none"> a) made all distribution assumptions explicit in the report; b) used non parametric methods to show data that is not normally distributed; c) used percentile-based statistics, such as quartiles and the median to supplement the more traditional mean and standard deviation; and d) used box plots as an alternative to histograms especially when comparing two or more groups of data?..... 	
<p><i>Univariate descriptions</i></p> <p>For additional information see: Univariate Description, SCS No. 1</p>	<p>21. For univariate distributions, has the investigator:</p> <ul style="list-style-type: none"> a) made all distribution assumptions explicit in the report; b) documented the integrity of the data; c) made use of graphical representations of the data, such as histograms, or probability plots; d) used summary statistics that describe the centre, location, spread, and shape of the univariate distribution; and e) used logarithmic scaling, if the data are skewed, to make graphical presentations more informative?..... 	
<p><i>Bivariate Descriptions</i></p> <p>For additional information see: Bivariate Description, SCS No. 2</p>	<p>22. For bivariate distributions, has the investigator</p> <ul style="list-style-type: none"> a) made all distribution assumptions explicit in the report; b) documented the integrity of the data; and c) used scatter plots that display the relationship between pairs of variables and linear and rank correlation coefficients that summarize the strength of the relationship?..... 	

<p><i>Spatial Description</i></p> <p>For additional information see: Spatial Description, SCS No. 3</p>	<p>23. Has the investigator used:</p> <ul style="list-style-type: none"> a) contour maps and cross-sections to show spatial distribution of contaminants; b) graphical displays that present the available data in their spatial context; c) sample values for data on maps or cross-sections; d) colours, grey scales, or symbols to high-light the locations of the highest sample values; e) kriging for the purpose of interpolation and not extrapolation; and f) quadrants or other forms of local statistics to assist the reader in understanding and evaluating decisions about statistical populations and trends? 	
<p><i>Outliers</i></p> <p>For additional information see: Outliers, SCS No. 8</p>	<p>24. For all distributions has the investigator:</p> <ul style="list-style-type: none"> a) used rank correlation as an alternative to linear correlation to reduce sensitivity to outliers when summarizing the relationship between two variables; b) used probability plots, scatter plots and data postings to identify outliers; c) determined whether the existence of outliers requires that any critical assumptions need to be modified; d) determined the reasons for the existence of the outlier; e) documented the reasons for and provided all relevant information about any outlier value that has been discarded; and f) taken a new sample at a random location within one metre of a discarded outlier sample? 	
<p>STATISTICAL ANALYSIS AND INTERPRETATION</p> <p><i>Assumptions</i></p>	<p>25. Has the investigator</p> <ul style="list-style-type: none"> a) described the statistical tools and procedures used to analyze and interpret the data along with their underlying assumptions; b) included calculations and assumptions for population standard deviations estimated for the purposes of a confidence interval calculation; c) provided rationale for method used to deal with non-detectable data; d) used a nonparametric alternative as a way of checking the sensitivity of the conclusion to the distribution assumption; and e) included a statement about the uncertainty of all estimated or predicted values? 	

<p><i>Calculations</i> For additional information see: Distribution Models, SCS No. 4</p>	<p>26. Has the investigator: a) calculated percentiles in normal, lognormal or exponential distribution models; and b) described how percentiles were calculated?</p>	
<p><i>Probability maps</i> For additional information see: Spatial Description, SCS No. 3</p>	<p>27. Have probability maps been included to show that there is less than a 5% chance of making a false negative error about the quality of material?</p>	
<p>CONCLUSIONS AND RECOMMENDATIONS <i>Conclusions</i> For additional information see Technical Guidance On Contaminated Sites 2 Statistical Criteria for Characterizing a Volume of Contaminated Material, revised June 2005.</p>	<p>28. Has the investigator: a) provided clear and unambiguous conclusions with specific references to the analysis and interpretations that support them; b) accompanied each conclusion with a discussion of how it is affected by any underlying assumptions, by the accuracy and precision of the available sample data and by the uncertainty in estimated or predicted values; c) classified material based on the data being demonstrably representative of one population; and, for that data set: the upper 90th percentile of the sample concentrations is less than the criterion concentration; and the upper 95 percent confidence limit of the average concentration of the samples is less than the criterion concentration; and no sample within the data set has a concentration exceeding two times the criterion concentration?</p>	
<p><i>Recommendations</i></p>	<p>29. Has the investigator: d) provided clear and unambiguous recommendations; e) informed the client of any other issues of potential concern outside of the goals of the study; and..... f) provided rationale with any recommendations, for further investigation?</p>	
<p>REFERENCES <i>Complete Information</i></p>	<p>30. Has the investigator referenced: a) all data sources, previous studies and other sources (including interviews) that contributed information to the study; and b) any technical literature that provides additional detail on procedures used in the study?</p>	

<p>APPENDICES</p> <p><i>QA/QC</i></p> <p>For additional information see Statistical QA/QC, SCS No. 11</p>	<p>31. Has the investigator provided:</p> <ul style="list-style-type: none"> a) analytical laboratory results, either in printed form or on a diskette (Excel preferred) (mandatory requirement); b) laboratory QA/QC procedures, sampling protocol and the results of check analyses (mandatory requirement); c) drill logs and test pit logs (mandatory requirement); and..... d) a site map showing sampling locations (mandatory requirement)? 	
<p><i>Documentation</i></p>	<p>32. Has the investigator included:</p> <ul style="list-style-type: none"> a) details of statistical computations omitted from the main body of the report; and b) the name and version of the computer software used for the data base compilation and the statistical analysis, or a brief description and a reference for any other non-commercial software used in the study? 	

Appendix 2

Detailed site investigation Summary

Using the information gleaned from the preceding checklists, please provide the ministry with a summary containing the following information:

Summary

- investigation work quality and thoroughness
- the need for additional investigation
- the need for a site visit by ministry staff
- levels of certainty
- compliance with the ministry's legislation, regulations and policy, criteria and guidelines, and
- sign-off sheets appropriately signed.

Statement of objectives

Description of investigation

- including what parameters were tested and why

Rationale for Sampling Program

- sampling locations and parameters
- sampling rationale

Data Presentation

- chemistry data
- hydrogeologic data
- other

Data Interpretation and Evaluation

- areas of environmental concern
- areas not of environmental concern
- contaminant migration
- level of confidence

Recommendations

- need for further investigation
- assessment of recommendations