Quality Assurance and Database Management Plan

May, 1996

Prepared for:

Suncor Inc.

Prepared by:

Golder Associates

952-2307

This report is one of a series of reports prepared for Suncor Inc. Oil Sands Group for the Environmental Impact Assessment for the development and operation of the Steepbank Mine, north of Fort McMurray, Alberta. These reports provided information and analysis in support of Suncor's application to the Alberta Energy Utilities Board and Alberta Environmental Protection to develop and operate the Steepbank Mine, and associated reclamation of the current mine (Lease 86/17) with Consolidated Tailings technology.

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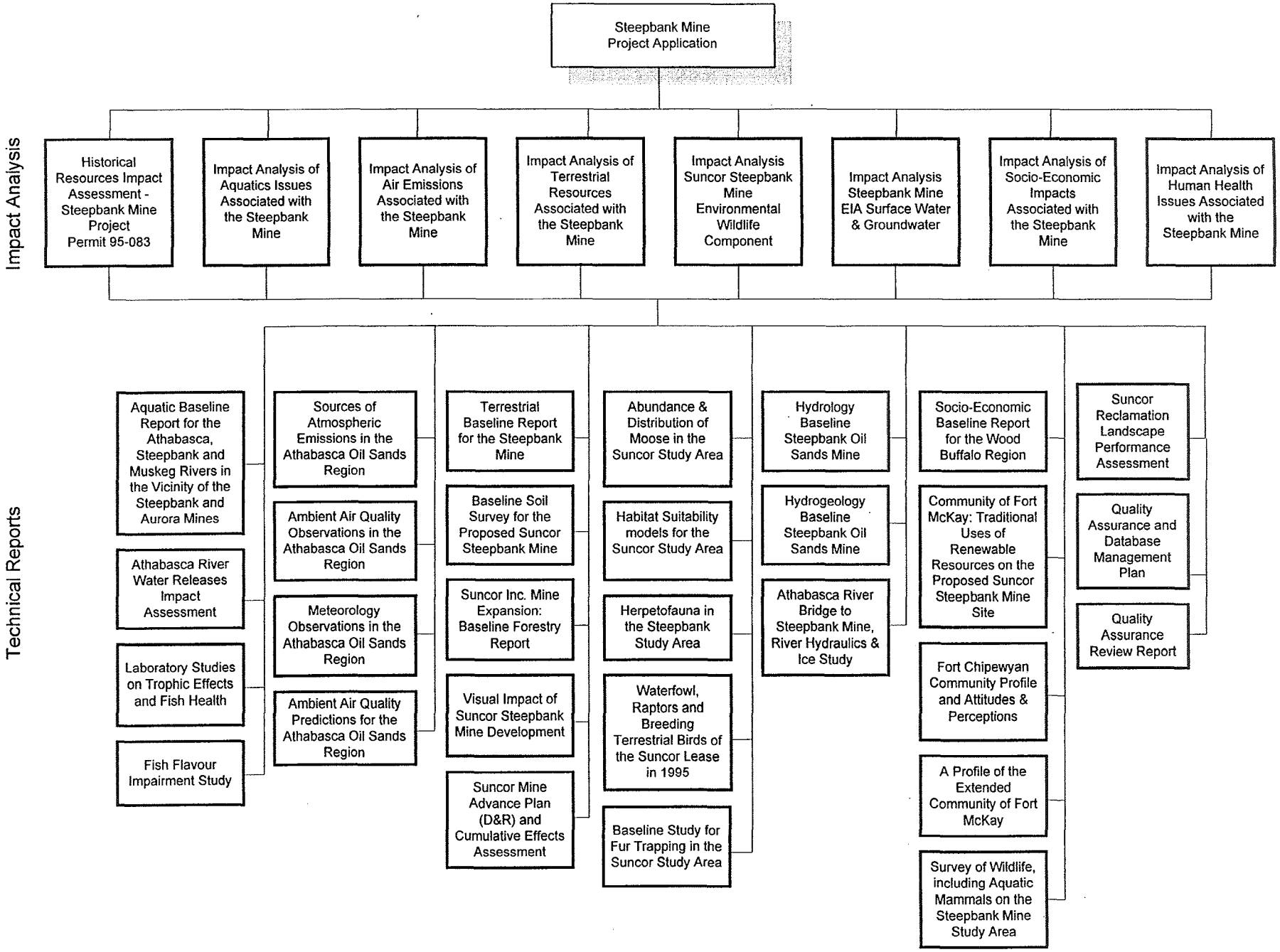

Reports Prepared for the Steepbank Mine Environmental Assessment

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ACKNOWLEDGMENTS

The Quality Assurance Project Plan (QAPP) was prepared by Dr. Judy Crane, EVS Consultants, whereas the Data Management section was prepared by Ms. Corinne Severn, EVS Consultants, and Mr. Michael Raine, Golder Associates. This document was peer-reviewed by Ms. Farida Bishay, EVS Consultants and Mr. Hal Hamilton, Golder. Word processing was provided by Ms. Vickie Duff, EVS Consultants and Carol Brittain, Golder Associates. Ms. Gail Binder, EVS Consultants assisted with report production.

1.0 INTRODUCTION

This combined Quality Assurance Project Plan (QAPP) and Data Management Guidelines (DMG) is designed to ensure data quality for the collection, analysis, and management of a range of environmental samples for the Steepbank Mine Environmental Impact Assessment (EIA). The discipline-specific issues, technical approach, and scope of work for each component of the EIA study are described in detail in Section 9.0.

The QAPP identifies quality assurance (QA) and quality control (QC) procedures that will be implemented to ensure that data are of sufficient quality to be used in support of the EIA. This QAPP has been prepared based on guidance given in "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations: Chemical Evaluations" (U.S. EPA, 1995). Sections 2.0 - 9.0 of this document provide detail on the background and quality assurance requirements for the EIA studies. A glossary of terms used in the QAPP is given at the end of this document.

The Data Management Guidelines describe the division of data management tasks between the EIA team members, the data flow process, and the database structures to be used. These issues are described in detail in Section 10.0.

This document has been produced in a binder format so that, if changes or additions to procedures occur, only those pages containing new information will be distributed. All pages will be dated to ensure that the most current procedures are followed. This current QAPP-DMG supersedes the draft report dated April 7, 1995.

2.0 PROJECT DESCRIPTION

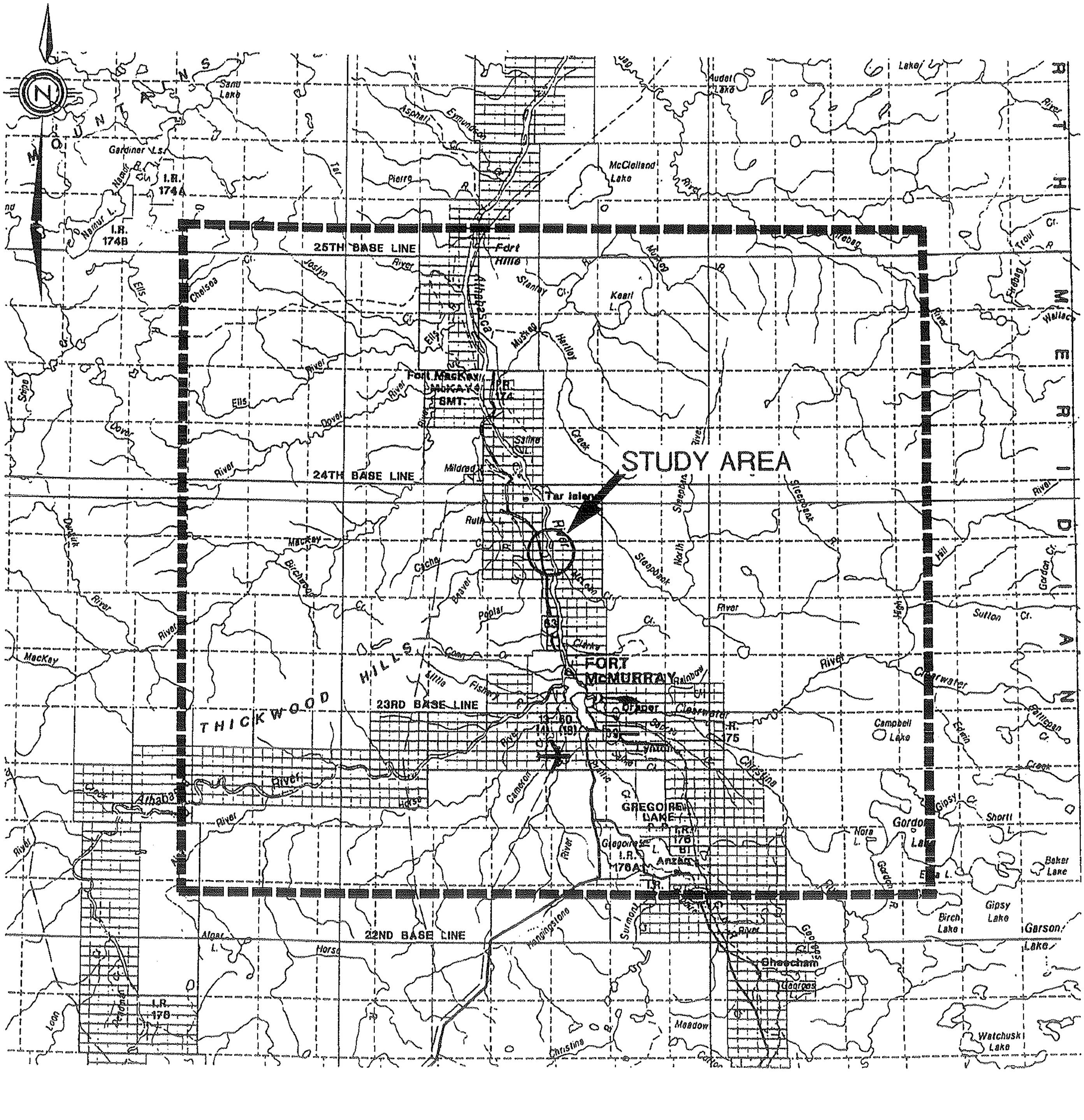
Suncor's proposed Steepbank Mine expansion to a new lease on the east side of the Athabasca River in northern Alberta (Figure 1) will require an EIA to be conducted before approval will be granted from regulatory agencies. As described in the "Suncor Steepbank Mine EIA Project" report (Golder 1995), the EIA study team will consider impacts associated with preparation and development of a new mine on Lease 97 and Lots 1 and 3 (Figure 2). The scope of the new mine investigation could expand to Leases 19 and 25 at a later date; therefore, Suncor wants to collect baseline data from these areas as well. Hydrotransport will be used to move the oil sands via pipeline to the existing extraction facility on Lease 86. A desanding plant may also be built on the new lease along with necessary service facilities for the truck and shovel mining operation. A bridge across the Athabasca River will have to be constructed early in the new mine development process and there will be modifications to both the Primary Extraction and Froth Treatment Plants. In addition to the new mine development, the EIA will have to assess potential impacts related to Reclamation of Leases 86 and 17. Of special concern here is the strategy for final handling of fine tails.

Data collection efforts will be made for the following EIA tasks:

- Aquatics (fisheries/benthos/water quality)
- Hydrology
- Hydrogeology
- Biophysical (terrestrial vegetation/soils)
- Wildlife
- Socio-Economics
- Historical Resources

A number of field surveys will be conducted through January 1996 in support of the aforementioned tasks. Some of the data obtained from the field surveys will be used to conduct a risk/performance assessment. Impact assessment and reporting tasks will be completed by March 1996, and the final EIA report will be completed by the end of June 1996. Additional detail on the environmental assessment framework adopted for this project is given in Golder (1995).

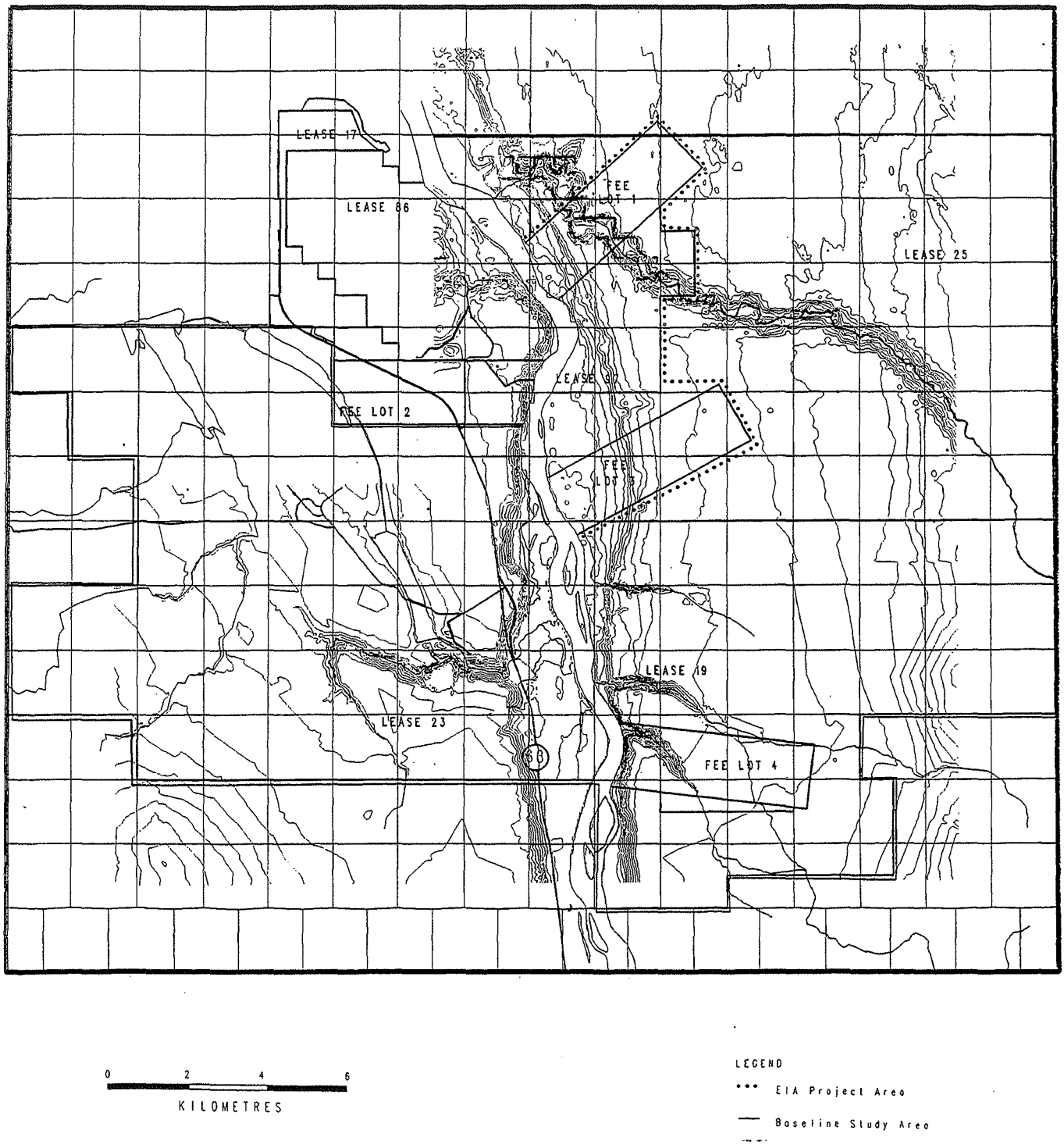
Figure 1 EIA Regional Study Area



NOTE

APPROXIMATE BOUNDARY OF REGIONAL STUDY AREA. THE SCENE CENTRE IS AT 56 55' LAT 111 27' LONG WITH AN AVERAGE RADIUS OF 60km TO THE SCENE BOUNDARY.

Figure 2 Preliminary Local Study Area



3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Project organization and individuals responsible for quality assurance and data management are shown in Figure 3. Responsibilities of these personnel, as well as for the quality assurance officers/principal contacts for contract laboratories are described in the following sections. Addresses and phone numbers of key team members are given in Appendix I.

3.1 Suncor Management

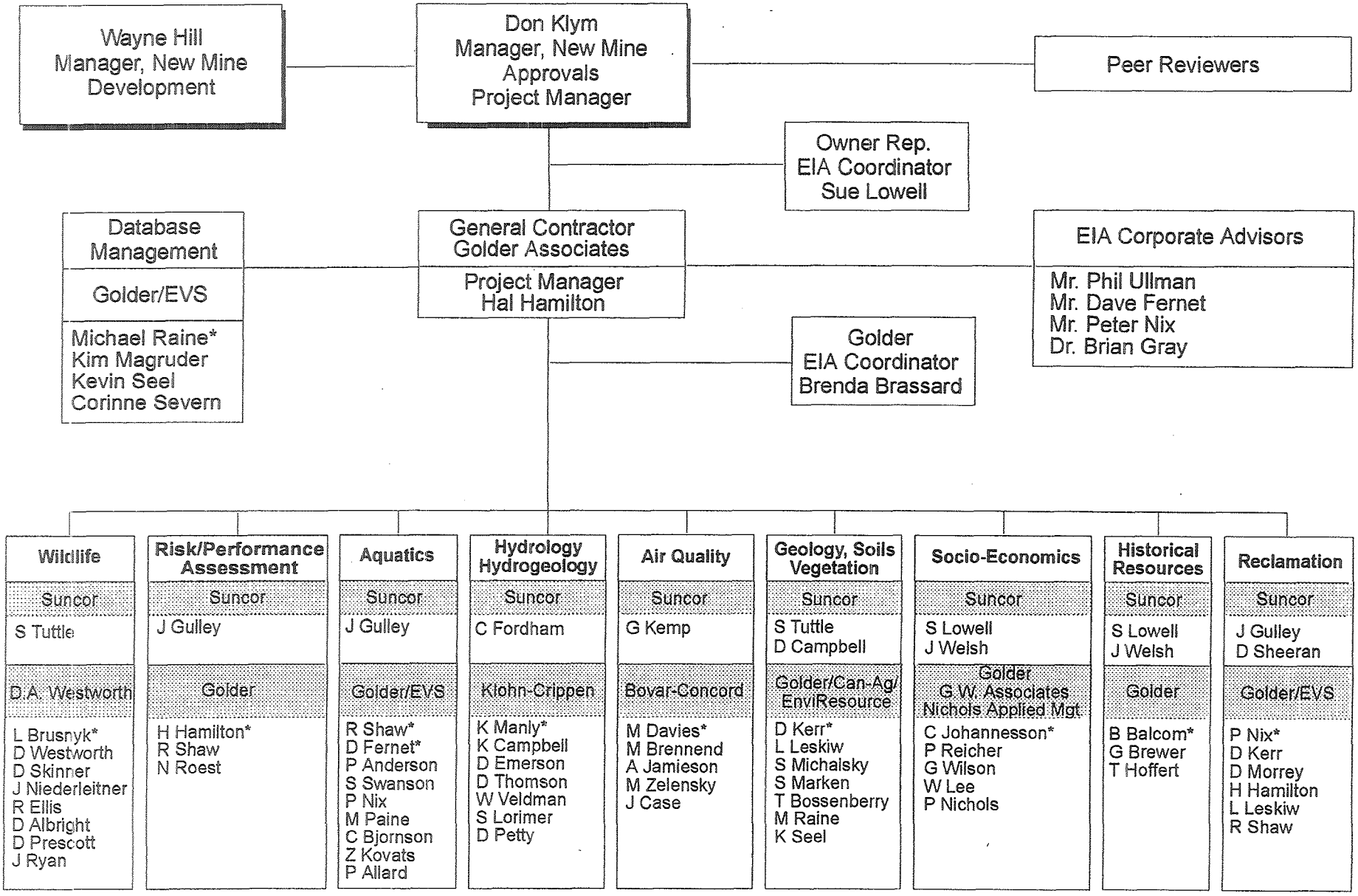
The technical staff at Suncor are responsible for providing the Golder Project Manager and team leaders with technical guidance and direction. The primary technical contacts at Suncor include:

- Don Klym: Suncor Project Manager and Manager of Regulatory Affairs
- Sue Lowell: Suncor EIA Coordinator; Socio-Economics; Historical Resources
- John Gulley: Aquatics; Land Reclamation; Risk/Performance Assessment
- Christopher Fordham: Hydrogeology
- Gordon Kemp: Air Monitoring
- Don Sheeran: Land Reclamation
- Stephen Tuttle: Land Reclamation; Wildlife; Biophysical
- D. Campbell: Biophysical
- Jerry Welsh: Socio-Economics; Historical Resources

3.2 Golder Project Manager

Mr. Hal Hamilton, of Golder Associates Ltd. of Calgary, is the senior project manager for the Steepbank Mine EIA study. Mr. Hamilton will work with Mr. Don Klym and Ms. Sue Lowell of Suncor to ensure the EIA strategy is clearly defined and the discipline task leaders remain focused on dealing with the pertinent issues related to the New Mine development and Lease 86 reclamation. He will be assisted by Ms. Brenda Brassard as the project coordinator. Ms. Brassard will ensure the task definition and cost control systems are implemented. She will also facilitate communication between the discipline groups and Suncor.

Figure 3 Project Team



Golder Associates

3.3 Database Management Team

The Database Management Team, listed in Figure 3, will be responsible for developing the QA program and database structure. The individual responsibilities of each team member are listed in Table 1.

The QA Coordinator has designed activities to provide a formalized system for evaluating the technical adequacy of sample collection and laboratory analysis activities. These QA activities begin before samples are collected and continue after laboratory analyses are completed, requiring ongoing coordination and oversight. Data which has received a QA review will be entered into the appropriate database. Two separate databases have been developed to manage the chemical and aquatic organism enumeration results as well as the spatial data for the EIA. The flow of data among the EIA teams, laboratories, QA Coordinator, and the Data Management Team is given in Figure 4. Additional detail on the evaluation and management of data is provided in Sections 8.0 and 10.0, respectively.

3.4 Team Leaders

The EIA project team is divided into a number of speciality teams, each headed by a Team Leader (see Figure 3). The Team Leaders are responsible for the successful direction and completion of their studies. Each team will be responsible for producing a stand alone baseline studies report. Each team will then conduct and document their own impact analysis under the direction of the Project Manager. The Team Leaders will, along with Suncor, develop and discuss mitigation measures and potential monitoring strategies to evaluate the EIA conclusions. Golder management will integrate this analysis and documentation into the impact assessment section of the EIA document.

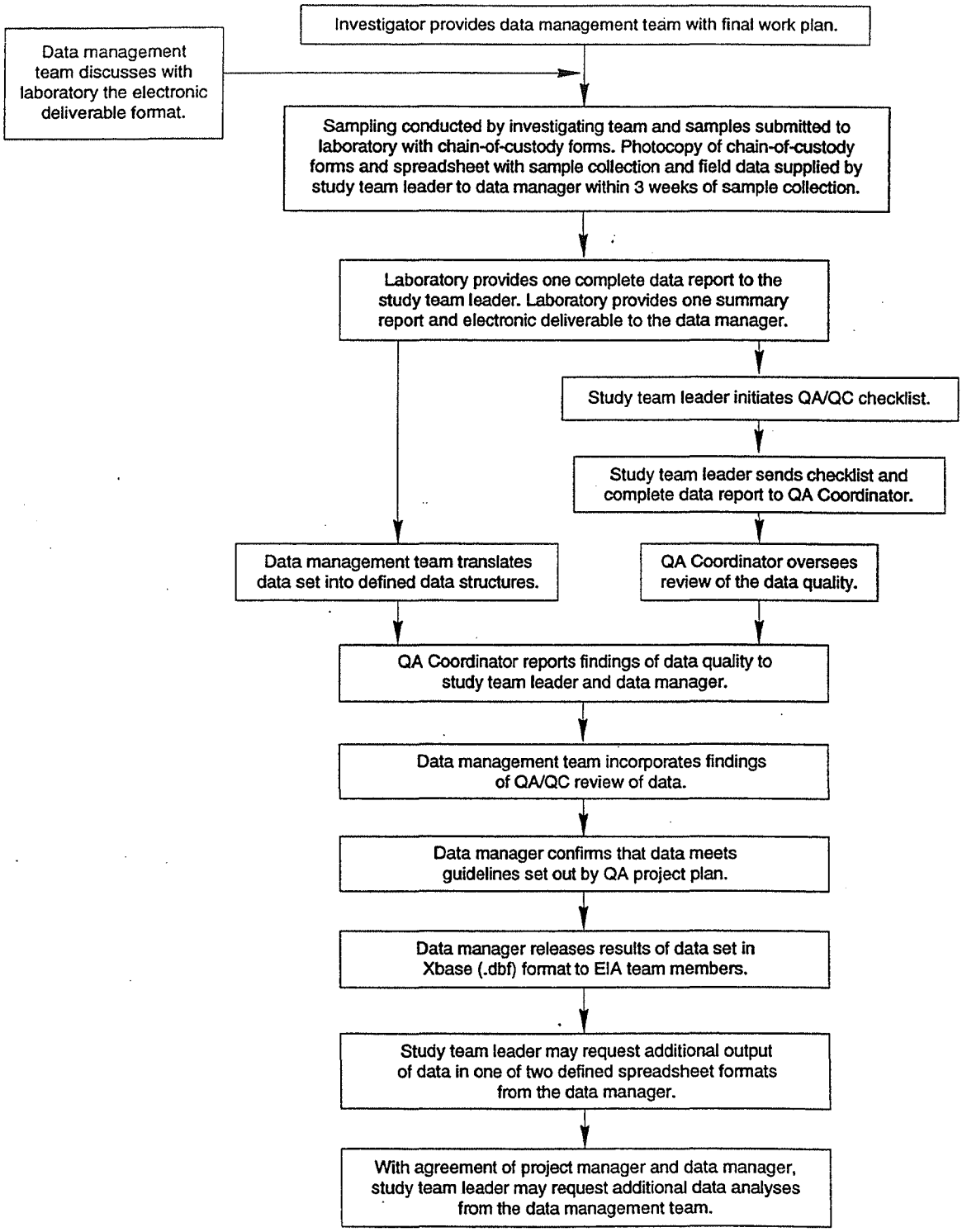
3.5 Contract Laboratories/Sub-Consultants

A number of samples will be sent to analytical/toxicological laboratories and to other sub-consultants for chemical, physical, and biological analyses. The Project Manager from each laboratory/sub-consultant is responsible for ensuring that all analyses performed meet the project data quality objectives specified in this QAPP (see Section 5.6).

Table 1 Project Responsibilities of Database Management Team

Personnel	Responsibilities
QA Coordinator Name: Kim Magruder EVS Consultants Telephone: (206) 217-9337	Provide technical quality assurance assistance; prepare and initially approve the Quality Assurance Project Plan (QAPP); review and direct the implementation of contractor quality assurance plans; ensure data quality objectives (DQOs) are met for all data collected; review 10% of all data from teams and analytical/toxicological laboratories; conduct a field audit of field studies; and notify Golder Project Manager and Team Leaders when problems occur.
Database Manager: Analytical Data and Aquatic Enumerations Name: Corinne Severn EVS Consultants Telephone: (206) 217-9337	Manage the data associated with analytical results and all associated sample collection information including: sample location, sample number, and the date of collection. These data include those related to tissue (fish and vegetation), water, sediment, and soil samples. Also responsible for compiling the results of benthic invertebrate, zooplankton, and phytoplankton enumerations.
Database Manager: Non-chemical Data Name: Michael Raine Golder Associates Telephone: (403) 299-4642	Manage non-chemical data that relate to the disciplines of vegetation, wildlife, soils and landforms, socio-economics, and archaeology and traditional land use, as well as hydrology and other physical measures.
Remote Sensing Specialist Name: Kevin Seel Golder Associates Telephone: (403) 299-5618	Responsible for handling remotely sensed spatial data within Golder's Geographical Information System (GIS) for the non-chemical database.

Figure 4 Data Flow Chart Between EIA Teams, Laboratories, QA Coordinator and Data Management Team



The QA/QC Manager (and/or principal contact) at each laboratory/sub-consultant are identified below:

Chemical Analyses: inorganic analyses and physical parameters

Christine O'Grady, primary contact
Sheldon Stewart, secondary contact
Nancy M. Maxwell, QA/QC Manager
Chemex Labs Alberta Inc.
2021 - 41 Avenue N.E.
Calgary, AB T2E 6P2

Phone: (403) 735-2201 (O'Grady)
(403) 735-2202 (Stewart)
(403) 735-2245 (Maxwell)
Fax: (403) 291-9466

Chemical Analyses: organic analyses, excluding naphthenic acids; MFO analyses

Simone Kanash, primary contact
Doug Johnson, secondary contact
Beth Weitzel, QA/QC Manager
Enviro-Test Laboratories
9936 - 67th Avenue
Edmonton, AB T6E 0P5

Phone: (403) 225-2803 ext. 237 (Kanash)
ext. 247 (Johnson)
ext. 257 (Weitzel)
Fax: (403) 437-2311

Chemical Analyses: soils

Jerry Raduy, primary contact
Keith LePla, secondary contact
Ansar Qureshi, QA/QC Manager
Norwest Labs
9938 - 67 Avenue
Edmonton, AB T6E 0P5

Phone: (403) 438-5522
Fax: (403) 434-8586

Chemical Analyses: QC samples

James Downie, QA/QC Manager
ASL Analytical Service Laboratories Ltd.
1988 Triumph Street
Vancouver, BC V5L 1K5

Phone: (604) 253-4188
Fax: (604) 253-6700

Chemical Analyses: naphthenic acids

Munir Jivraj
Syncrude Canada Ltd
Edmonton Research Center
9421 - 17th Avenue
Edmonton, AB T6N 1H4

Phone: (403) 970-6829 or 970-6888
Fax: (403) 970-6805

MicroTox® Testing

Munir Jivraj
Syncrude Canada Ltd
Edmonton Research Center
9421 - 17th Avenue
Edmonton, AB T6N 1H4

Phone: (403) 970-6829 or 970-6888
Fax: (403) 970-6805

Toxicity Testing (excluding MicroTox® testing)

Gordon Balch, QA/QC Manager
Hydroqual Laboratories Ltd.
#3, 6125 - 12th Street S.E.
Calgary, AB T2H 2K1

Phone: (403) 253-7121
Fax: (403) 252-9363

Biomarker Analyses: retinol in fish

Scott Brown
Freshwater Institute
501 Univeristy Crescent
Winnipeg, MB R3T 2N6

Phone: (204) 938-5009

Biomarker Analyses: sex steriods in fish

Tracy Marchant
University of Saskatchewan
Department of Biology
Veterniary Medicine
Saskatoon, SK S7N 0W0

Phone: (306) 966-4420

Benthic Analyses

Bob Wisseman, Senior Scientist
Aquatic Biology Associates
3490 NW Deer Run Road
Corvallis, OR 97330

Phone: (503) 752-1568
Fax: (503) 754-2460

The contract laboratories are expected to meet the following minimum terms in their negotiated contracts with Golder and any sub-consultants:

1. Statement of work including references to each analytical procedure
2. Per analysis price and total price of the analytical services provided (including any additional costs for electronic data files)
3. Specification of any electronic data files
4. Reporting requirements
5. Implementation of QA/QC procedures, including acceptance of the QAPP data quality requirements, performance evaluation testing requirements, and laboratory and data auditing rights by the QA Coordinator

6. Reference to documentation, chain-of-custody (COC), and sample logbook procedures
7. Turnaround time for deliverables

Changes in the QAPP procedures will not be permitted without written documentation of the reason and a detailed explanation of the intended change. All changes must be approved by the QA Coordinator prior to implementation.

4.0 TERMINOLOGY

Throughout this document, specific terminology will be used to designate whether certain actions must, should, may, can or might be done. These terms are defined as follows:

Must	is used to express an absolute, that is, to state that the test or procedure ought to be designed to satisfy the specified condition, unless the purpose of the test or procedure requires a different design; only used in connection with factors which directly relate to the acceptability of a test or procedure.
Should	is used to state that the specified condition or procedure is recommended and ought to be met if possible; although violation of one "should" is rarely serious, violation of several will render the results questionable.
May	is used to mean "is (are) allowed to".
Can	is used to mean "is (are) able to".
Might	is used to mean "could possibly" and is never a synonym for "may" or "can".

5.0 QUALITY ASSURANCE OBJECTIVES

This QAPP includes appropriate sampling and analysis procedures and outlines project-specific data quality objectives (DQOs) that should be achieved for field observations and measurements, physical analyses, laboratory chemical analyses, and biological tests. The DQOs should be adhered to for the duration of the project to guarantee acquisition of reliable data. Reliable data are also obtained by integrating quality control into all components of the EIA, including development of the study design, implementation of sample collection and analysis, and data evaluation. QC is the routine application of procedures for determining bias and precision. QC procedures include activities such as preparation of replicate samples, spiked samples, blanks; calibration and standardization; and sample custody and record keeping. Audits, reviews and compilation of complete and thorough documentation are QA activities used to verify compliance with predefined QC procedures. These QA activities provide a means for management to track project progress and milestones, performance of measurement systems, and data quality.

The overall quality assurance objectives for this project are to develop and implement procedures to ensure the collection of representative data of known, acceptable, and defensible quality. The data quality parameters used to assess the acceptability of the data are precision, accuracy, representativeness, comparability, and completeness.

5.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as replicate measurements of the same sample. Precision goals are definable for all parameters of this project (e.g., chemical, bioassay, and benthic analyses). Precision can be assessed by duplicate analyses which is expressed as a relative percent difference (RPD). When reference materials are not available or spiking the matrix is inappropriate, precision can be assessed by replicate analyses which is expressed as a percent relative standard deviation (%RSD). All precision measurements are impacted by the nearness of a value to the method detection limit where the percent

error measurements increase (expressed as either %RSD or RPD). The equations used to express precision are as follows:

$$RPD = \frac{|measured\ value - measured\ duplicate\ value|}{(measured\ value + duplicate\ value)/2} x\ 100$$

$$\%\ RSD = (SD\ /\ D_{ave})\ x\ 100$$

$$Where: SD = \sqrt{\left(\frac{\sum_{n=3} (D_n - D_{ave})^2}{(n-1)}\right)}$$

$$D = Sample\ value$$

$$D_{ave} = Average\ sample\ value$$

$$n = Number\ of\ samples$$

5.2 Accuracy

Accuracy is the closeness of a measured or computed value to its true value. Accuracy measurements apply to the chemical analysis portion of this project only. Accuracy measurements are not possible for toxicity testing or benthic sorting because true values do not exist. However, for toxicity testing, the use of negative and positive controls provides evidence for the calibration of the measurement system. For aquatic and terrestrial analyses, taxonomic identifications should be verified by an independent taxonomist. Accuracy may be expressed as the difference between two measured values (expressed as a percent difference), as a percentage of the true or reference value, or as a percent recovery in those

analyses where reference materials are not available and spiked samples are used. The equations used to express accuracy are as follows:

$$Percent\ difference = \frac{(measured\ value - true\ value)}{true\ value} x\,100$$

$$Percent\ recovery\,(true\ vs.\ measured) = \frac{measured\ value}{true\ value} x\,100$$

$$Percent\ recovery\,(spiked\ vs.\ unspiked) = \frac{(spiked\ sample\ result - unspiked\ sample\ result)}{amount\ of\ spike\ added} x\,100$$

5.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. For this program, the compounds selected for analysis have been identified as potential contaminants of concern in the study area. For biological collections/surveys, the species abundance results are a direct measure of the *in situ* biotic community (e.g., benthic invertebrates, wildlife). Other data collections (e.g., soil analyses) will be from representative areas. Careful stratification of the study areas and placement of sampling sites will ensure that representativeness is achieved.

5.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relationship to another data set. For the study area, comparability of data is established through the use of: 1) program defined general methodology and reporting formats; 2) common traceable calibration and reference materials; and 3) participation in an interlaboratory comparison program (for chemical analyses only).

5.5 Completeness

Completeness is a measure of the proportion of data specified in the sampling plan which is determined to be valid. Completeness will be calculated as follows:

$$Completeness = \frac{number\ of\ valid\ measurements}{total\ number\ of\ data\ points\ planned} x100$$

The data quality objective for completeness for all components of this project is 95 percent. Data that have been qualified as estimates because the quality control criteria were not met will still be available for use.

5.6 EIA Data Quality Objectives

Tables 2 - 6 summarize the DQOs for each analysis type. Method detection limits were selected in consultation with the analytical laboratories contracted for this project. Limits for precision, accuracy, and completeness were selected by the QA Coordinator; this information was provided to the analytical laboratories for their feedback, prior to finalization of these tables. A list of target detection limits, obtained by Enviro-Test Laboratories, is given in Appendix II for the following chemicals: PAHs, target substituted PAHs, target PANH compounds, phenolic compounds, and volatile organic compounds.

Table 2 Summary of DQOs for Inorganic Chemicals and Physical Parameters Analyzed in Water Samples

WATER PARAMETER	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
Routine Water Analyses Package #3			500 mL			95%		
			250 mL			95%		
Calcium	mg/L	0.01	500 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Magnesium	mg/L	0.01	500 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Sodium	mg/L	0.01	500 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Potassium	mg/L	0.02	500 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Chloride	mg/L	0.5	500 mL	± 25%	± 25%		Colorimetry	1 (16th Ed., Method 407D)
Sulphate	mg/L	0.5	500 mL	± 25%	± 25%		Colorimetry	U.S. EPA 375.2
Total Alkalinity	mg/L	0.5	500 mL	± 25%	± 25%		Titration	1 (16th Ed., Method 403)
pH	unit	0.01	500 mL	± 10%	± 20%		Meter	1 (17th Ed., Method 4500-H+)
Carbonate	mg/L	0.5	NA	NA	NA		Calculated	1 (16th Ed., Method 403)
Bicarbonate	mg/L	0.5	NA	NA	NA		Calculated	1 (16th Ed., Method 403)
Total Hardness	mg/L	0.5	NA	NA	NA		Calculated	
Specific Conductance	µmhos/cm	0.1	500 mL	± 10%	± 20%		Meter	1 (16th Ed., Method 120.1)
Total Dissolved Solids (TDS)	mg/L	1	NA	NA	NA		Calculated	1 (18th Ed., Method 2540 D&E)
Aluminum	mg/L	0.01	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Barium	mg/L	0.01	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Beryllium	mg/L	0.001	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Boron	mg/L	0.01	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Cadmium	mg/L	0.003	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Chromium	mg/L	0.002	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Cobalt	mg/L	0.003	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Iron	mg/L	0.01	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Lead	mg/L	0.02	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7

Table 2 Continued...

WATER PARAMETER	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
Lithium	mg/L	0.001	250 mL	± 25%	± 25%	95%	ICP	EPA-600/4-79-020, Method 200.7
Manganese	mg/L	0.001	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Molybdenum	mg/L	0.001	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Nickel	mg/L	0.005	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Silver	mg/L	0.002	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Strontium	mg/L	0.002	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Titanium	mg/L	0.003	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Vanadium	mg/L	0.002	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Zinc	mg/L	0.001	250 mL	± 25%	± 25%		ICP	EPA-600/4-79-020, Method 200.7
Nitrate + Nitrite (dissolved)	mg/L	0.003	250 mL	± 25%	± 25%		Colorimetry	1 (17th Ed., Method 4500-N)
Hydride Metals Package #2	mg/L			± 25%	± 25%	95%		
Arsenic		0.0002	250 mL				AA	EPA-600/4-79-020, Method 206.5
Selenium		0.0002	250 mL				AA	EPA-600/4-79-020, Method 206.5
Mercury		0.00005	125 mL				CVAA	1 (16th Ed., Method 303F)
Antimony		0.0002	250 mL				AA	EPA-600/4-79-020, Method 206.5
Ammonia N	mg/L	0.01	250 mL	± 25%	± 25%	95%	Colorimetry	1 (17th Ed., Method 4500-NH_3D)
Total Cyanide	mg/L	0.001	250 mL	± 25%	± 25%	95%	Colorimetry	1 (17th Ed., Method 4500-CNE)
Total Phenolics	mg/L	0.001	125 mL	± 25%	± 25%	95%	Colorimetry	EPA-600/4-79-020, Method 420.2
Organic Carbon	mg/L	0.2	500 mL	± 20%	± 20%	95%	IR	1 (16th Ed., Method 505A)
Total Suspended Solids	mg/L	0.4	500 mL	± 10%	± 20%	95%	Gravimetric	1 (18th Ed., Method 2540 D&E)
Chlorophyll "a"	mg/L	0.001	1 L	± 25%	± 25%	95%	Colorimetry	1 (17th Ed., Method 10200 H)
BOD	mg/L	0.1	500 mL	± 25%	± 25%	95%	Winkler	1 (17th Ed., Method 5210B)
Total Phosphorus	mg/L	0.003	250 mL	± 25%	± 25%	95%	Colorimetry	EPA-600/4-79-020, Method 365.1

Table 3 Summary or DQOs for Inorganic Chemicals and Physical Parameters Analyzed in Soil Samples

SOIL PARAMETER	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
Texture (% sand, silt, clay)	%	0.1	1000 g	± 20%	NA	95%	Hydrometer	
Atterberg limits		-	500 g	± 20%	± 20%	95%	Plasticidy Index	
Available H_20				± 20%	± 20%	95%	Pressure Plate	
EXCAT5 Package			SP 500 g ER 100 g	± 20%	± 20%	95%	AA	
Cation Exchange Capacity	mg/kg	0.1	10 g					4 (Ch. 8, Part 2)
Exchangeable Cations	mg/kg	0.1	10 g					4 (Ch. 8, Part 2)
Exchangeable Sodium %	%	0.01	10 g					4 (Ch. 8, Part 2)
Total Exchangeable Cations	mg/kg	0.1	10 g					4 (Ch. 8, Part 2)
% Base Saturation		-	-					4 (No. 9, Part 2)
T.O.C. & Organic Matter	wt %	0.01	100 g	± 20%	± 20%	95%	Modified Mebius	4 (No. 9, Part 2)
Total Nitrogen	wt %	0.1	SP 500 g ER 100 g	± 20%	± 20%	95%	Combustion	
C:N Ratio		NA	NA	NA	NA	95%	Calculated	
NUTRS Package			SP 500 g ER 100 g	± 35%	± 35%	95%		
Nitrate N (soluble)	mg/L	0.05					Colorimetry	4 (No. 9, Part 2, Method 10-3.2)
Ammonia N (extractable)	mg/L	0.05					ICP	4 (No. 9, Part 2, Method 33-3.2)
Phosphorus		0.02					IC	3 (Section 4.4)
Sulphate (soluble)	mg/L	0.1					IC	4 (No. 9, Part 2, Method 10-3.2)
Avail. Calcium, Magnesium, Sodium	meq/100 g		SP 500 g	± 35%	± 35%	95%	ICP	Ca, Mg: 4 (No. 9, Part 2, Method 10-2.3.1)
by ammonium N acetate extract		0.1	ER 100 g					Na: 3 (Section 4.5)
pH in $CaCl_2$ 1:2 ratio	std. unit	0.01		± 10%	± 20%	95%	Meter	2
Salinity Package #3			SP 500 g ER 100 g			95%		
pH	std. unit	0.01		± 10%	± 20%		Meter	2 (Ch. 7)
Electrical Conductivity (EC)	µmhos/cm	0.1		± 10%	± 20%		Meter	2 (Method 8)

Table 3 Continued...

SOIL PARAMETER	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
% Saturation		-		± 10%	± 20%			4
Calcium	mg/kg	0.01		± 35%	± 35%		ICP	3
Magnesium	mg/kg	0.01		± 35%	± 35%		ICP	3
Sodium	mg/kg	0.02		± 35%	± 35%		ICP	3
SAR		-		NA	NA		Calculated	3
Theoretical Gypsum Requirement	tonnes/ac	0.7		NA	NA		Calculated	5
Total Petroleum Hydrocarbon		0.2	150 g	± 50%	± 50%	95%	IR	EPA 9071A and 3550A
Mercury	µg/kg	0.05	100 g	± 35%	± 35%	95%	CVAA	1 (18th Ed., Method 303F)
ICP - 14 Element Scan*	mg/kg		100 g	± 35%	± 35%	95%	ICP-MS	EPA 200.7
Arsenic		0.0002					ICP-MS	
Barium		0.01					ICP-MS	
Beryllium		0.001					ICP-MS	
Cadmium		0.003					ICP-MS	
Chromium		0.002					ICP-MS	
Cobalt		0.003					ICP-MS	
Copper		0.001					ICP-MS	
Lead		0.02					ICP-MS	
Molybdenum		0.003					ICP-MS	
Nickel		0.005					ICP-MS	
Selenium		0.0002					ICP-MS	
Thallium		0.001					AA	
Vanadium		0.002					ICP-MS	
Zinc		0.001					ICP-MS	

Table 4 Summary of DQOs for Inorganic Chemicals, Organic Carbon, and Chorophyll a Analyzed in Sediment/Tissue Samples

SEDIMENT, TISSUE PARAMETER	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
ICP - 26 Element Profile	mg/kg		500 g	± 35%	± 35%	95%	ICP-MS	EPA SW-846, Method 3050
Aluminum		0.01						
Barium		0.01						
Beryllium		0.001						
Boron		0.01						
Cadmium		0.003						
Calcium		0.01						
Chromium		0.002						
Cobalt		0.003						
Copper		0.001						
Iron		0.01						
Lead		0.02						
Lithium		0.001						
Magnesium		0.01						
Manganese		0.001						
Molybdenum		0.003						
Nickel		0.005						
Phosphorus		0.1						
Potassium		0.02						
Silicon		0.02						
Silver		0.002						
Sodium		0.01						
Strontium		0.002						
Titanium		0.003						
Vanadium		0.002						
Zinc		0.001						
Uranium		0.5						
Hydride Metals Package #2	mg/kg		100 g	± 35%	± 35%	95%		
Total Arsenic		0.002					AA	
Antimony		0.002					AA	
Selenium		0.002					AA	
Mercury		0.00005					CVAA	
Organic Carbon	wt %	0.01		± 20%	± 20%	95%	Modified Mebius	4 (No. 9, Part 2, Method 29-35.3)
Chlorophyll "a"	mg/kg	0.001		± 20%	± 20%	95%	Colorimetry	1 (17th Ed., Method 10200 H, 10300 A&C, 10400A)

References for Tables 2 - 4

Reference No.	Description
1	Standard Methods for the Examination of Water and Wastewater
2	Methods Manual for Forests and Plant Analysis
3	Soil Sampling and Methods of Analysis - McKeague
4	Methods of Soil Analysis Chemical and Microbiological Properties
5	Soil Science Principles and Practices

Table 5 Summary of DQOs for Organic Chemicals Analyzed in Benthic, Fish, Soil, and Water Samples

PARAMETER	MATRIX	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
PAHs[1]	WATER	µg/L	0.02 - 0.04	4 L	20	80	95%	GC/MS	EPA 3510/8270 modified
PAHs	SOIL	µg/g	0.01 - 0.02	100 g	20	80	95%	GC/MS	EPA 3540/8270 modified
PAHs	FISH	µg/g	0.02 - 0.04	100 g	20	90	95%	GC/MS	EPA 3540/3640/8270 modified
PAHs	BENTHIC	µg/g	0.02 - 0.04	500 g	20	80	95%	GC/MS	Polytron\EPA 8270 modified
Volatiles	WATER	µg/L	1 - 200	3 x 40 mL	20	85	95%	GC/MS	EPA 3810/8240 modified
Non-chlorinated Phenolics	WATER	µg/L	0.1 - 20	4 L	25	50	95%	GC/MS	EPA 3510/8270 modified
Total Recoverable Hydrocarbons	WATER	mg/L	1	1 L	20	80	95%	gravimetric/silica	APHA 5520B, F

[1] PAHs includes PAHs, PASHs, and Alkylated PANHs, PAHs, PASHs, and PANHs.

Table 6 Summary of DQOs for MicroTox® Bioassays and Naphthenate Analyses

PARAMETER	UNITS	METHOD DETECTION LIMIT	SAMPLE SIZE	PRECISION	ACCURACY	COMPLETENESS	METHOD	REFERENCE
Acute Toxicity by Microtox Bioassay	IC % Vol. (or Toxic Units*)	N/A (1)	5 g			95%	Bacterial Bioluminescent Assay	Microbics Inc.
Naphthenates	mg/L	1 mg/L**	25 - 75 g			95%	Solvent Extraction with FTIR Quantification	Syncrude

* If IC50 > 100% then not acutely toxic; Toxic Unit (TU) = 100/IC50

** Dependent on volume of extracted sample.

6.0 FIELD PROCEDURES

A number of field surveys, including collection of samples for chemical, physical and biological analyses, will be conducted to support the EIA. This section describes procedures and documentation to be provided for handling and shipment. Documentation will ensure that all sample handling requirements are carried out properly and in a legally defensible manner. Proper chain-of-custody procedures must be used to trace the possession and handling of samples from field collection through analysis to final disposal. Each team involved in field work must have documented procedures for insuring the safety of their workers. General safety procedures for field work are listed in Appendix III. The health and safety plan for the aquatic baseline study is given in Appendix IV.

6.1 Sample Collection

Generation of quality data begins with sample collection, and therefore the integrity of the sample collection process is of concern to the laboratory performing the analyses (either biological, chemical, or physical). Samples must be collected in appropriate clean containers in such a way that no foreign material is introduced into the sample and no material of interest is lost due to adsorption, chemical or biological degradation or volatilization. Methods of transportation and preservation (where applicable) must also be considered. Sample container labels must maintain their integrity even when wet. Because of the different interpretations of dates in the U.S. and Canada (i.e., "11/06/94" could be November 6 or June 11), always spell out the month (e.g., Nov. 6, 1994) when writing dates.

Sufficient volumes of sample must be collected to ensure that tests may be conducted properly, that required detection limits can be met for chemical analyses and that quality control samples can be analyzed. Always confirm in advance the required sample volumes and handling procedures with the laboratory that will be performing the analyses. Costs of collection and transport should be considered so that excessive volumes are not collected.

Sampling procedures for this investigation are to be described in detail in individual sampling plans developed by each team. Upon review of the draft workplan, each Team Leader will be assigned station identifiers for sample collection sites (see Section 10.0). The workplan will also identify the laboratory conducting analyses of the samples and specify the variables that will be measured. After finalizing the

workplan, the field study will commence upon approval of Golder and Suncor Project Managers as well as the QA Coordinator.

6.2 Sample Handling and Custody

Sample custody is a critical aspect of environmental investigations. Sample possession and proper handling of samples must be traceable from the time of sample collection, through laboratory and data analysis, to introduction as evidence. This section provides minimal program requirements for sample handling and chain of custody procedures.

6.2.1 Field Sampling Operations

6.2.1.1 Field Logbook

All pertinent information on field activities and sampling efforts must be recorded in an appropriate (i.e., waterproof) bound logbook. The field project coordinator is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct field activity without relying on the memory of the field crew. All entries must be made in indelible black ink (a pencil can be used in an emergency), with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by making a single-line cross-out of the error, entering the correct information, dating and initialling the change. Upon return to the laboratory, all field notes must be photocopied and placed in the appropriate project file.

Entries in the logbook must include:

- Purpose of proposed sampling effort
- Date and time of starting work
- Names of field supervisor and team members
- Description of each sampling site, including information on any photographs that may be taken
- Location of each sampling site (including applicable navigational coordinates)
- Details of sampling effort, particularly deviations from standard operating instructions

- Clear identification of site names and sample numbers
- Field observations
- Field measurements made (e.g., pH, temperature, flow, dissolved oxygen)
- Sample shipping information

6.2.1.2 Field Quality Control Criteria

Although validation guidelines have not been established for field QC samples, the results are useful in identifying possible problems as a result of sample collection and/or sample processing in the field. The field QC samples that will be collected during this investigation are discussed in this section.

Field Replicates

Field replicates provide information that is useful in assessing sample heterogeneity and variability of contaminant concentrations in the field. Field replicates are prepared by taking two co-located samples alongside the original sampling station (for a total of three samples from the same station). These samples are prepared separately in the field and submitted blind to the laboratory as separate samples. A minimum of one field replicate set will be collected per 20 stations sampled or per sampling event (any continuous sampling period not interrupted by more than two days), whichever is most frequent.

Certified Reference Materials

Analysis of reference materials and certified reference materials provides information on the accuracy of the laboratory performing the analysis. At least one reference material sample will be analyzed for each analyte group, contingent on availability and at the discretion of the QA Coordinator.

Field Blanks

Field blanks are useful in assessing whether or not the samples have been contaminated during sample collection. Field blanks that will be collected during this investigation are discussed in the following sections.

Bottle Blanks

To determine whether or not the sample bottles are introducing contamination to the samples, bottle blanks are submitted with the sediment and soil samples to the laboratory. One bottle blank will be submitted per 50 samples collected, per sampling event, or per bottle lot, whichever is most frequent.

6.2.2 Sample Preservation

Sample preservation requirements must be followed for each type of analyses. For example, sediment samples will be placed in coolers with a sufficient number of ice packs (or crushed ice) to keep them cold through the completion of that day's sampling, and through transport to the laboratories. Samples for other media will have different sample preservation procedures (Appendix V). Each team is responsible for insuring proper preservation techniques are used to preserve the integrity of the samples.

6.2.3 Sample Chain of Custody

Samples are considered to be in "custody" if they are: 1) in the custodian's possession or view; 2) retained in a secured place (under lock) with restricted access; or 3) placed in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). The principal documents used to identify samples and to document possession are chain-of-custody (COC) records and field notebooks. COC procedures will be used for all samples, no matter where in the analytical or transfer process. Figure 5 contains the COC form to be used for the Suncor EIA studies. Revisions to this form must be approved by the QA Coordinator before implementation.

When samples have been collected, they will be submitted with a COC form to the laboratory. Photocopies of the COC forms will be submitted to Brenda Brassard, Golder EIA Coordinator, for filing in the Golder project file.

6.3 Sample Shipping

Appropriate shipping procedures must be used to ensure that COC is maintained, sample containers are properly packaged to prevent damage, and that samples are received within the appropriate time frame so that holding times for analyses can be met.

The designated Field Coordinator for each study will be responsible for all sample tracking and COC procedures for samples in the field, as well as for final sample inventory. The field coordinator will maintain a copy of the sample custody documentation. At the end of each day, and prior to transfer, COC entries will be made for all samples. Finally, information on the labels will be checked against sample log entries and COC forms, and samples will be recounted. All samples will be accompanied by COC forms that will be signed at each point of transfer and will include sample numbers. All COC forms will be filled out in indelible, black ink.

Figure 5 Sample Chain of Custody Record

Field Sampler: (Signature) _____

Phone No._____

Shipment Date:_____

Carrier: _____

Weigh Bill No.: _____

Ship To:

Send Results To:

Project Name: _____ Project No. _____

P.O. No.: _____

Relinquished by: (Signature)	Received at lab by: (Signature)	Date	Time
Relinquished by: (Signature)	Received at lab by: (Signature)	Date	Time
Relinquished by: (Signature)	Received at lab by: (Signature)	Date	Time
Relinquished from lab by: (Signature)	Received by: (Signature)	Date	Time

ANALYSIS REQUEST

Sample ID No.	Sample Description	Date/Time Sampled	Analysis Requested	Sample Condition Upon Receipt

Special Instructions/Comments:

Rush (surcharge): _____ Standard Turnaround Time: _____

PLEASE RETURN WHITE COPY TO GOLDER ASSOCIATES LTD.

Prior to shipping, sample containers will be wrapped in bubble wrap, and securely packed inside the cooler with ice packs. The original signed COC forms will be placed into a zip-locked bag and taped to the outside lid of the cooler. Fiber tape will be wrapped completely around the cooler. On each side of the cooler a "This End Up" label will be attached, a "Fragile - Glass" label will be attached to the top of the cooler (if applicable), and the cooler will be sealed with custody seal tape. Samples will be transported from the sampling area to the designated laboratory by an authorized courier.

7.0 USE OF CONTRACT LABORATORIES/SUB-CONSULTANTS

7.1 Laboratory Documentation

7.1.1 Analytical Request Form

This form (Figure 6) is completed in duplicate for all samples which are being sent from the consultant to the contract laboratories for analysis. It identifies the client, project number, sample name(s), test(s) to be performed and who the results should go to. Send one copy with the sample(s) and submit the other copy to Brenda Brassard, Golder, for the Golder project file. This form is useful for following up on expected or overdue results. All chemical parameters must be cross referenced to the project parameter dictionary (Appendix VI) to ensure the codes are compatible for different parameters.

7.1.2 Laboratory Work Order Form

Upon arrival at the laboratory, a laboratory Work Order (WO) Form must be completed for each sample (or set of samples) that arrive from a client. Any paperwork accompanying the samples must be attached to the Laboratory Supervisor's copy of the WO Form (i.e., COC forms, client's purchase orders, etc.). When testing is complete, this information is transferred to the laboratory project file. If any work is to be done by other contract laboratories this must be recorded and a copy of any related documents attached to the WO form.

Each laboratory will be requested to use the same sample numbering system used to identify samples, based on station and sample identifiers (see Section 10.0), rather than assign a code name to the sample. If a laboratory insists upon assigning their own code names, a list of codes which correspond to the station and sample identifiers must be provided by the laboratory.

Figure 6 Analytical Request Form

Field Sampler: (Signature) _____

Phone No. _____

Shipment Date: _____

Carrier: _____

Weigh Bill No.: _____

Ship To:

Send Results To:

Project Name: _____

Project No. _____

P.O. No.: _____

Sample ID No.	Sample Description	Date/Time Sampled	Analysis Requested

Special Instructions/Comments:

Rush (surcharge): _____ **Standard Turnaround Time:** _____

7.1.3 Data Sheets and Notebooks

Data sheets and other information logs must be filled in completely and legibly. Most data sheets have spaces for information about sample and project identification at the top. It is important that this information is completed for all pages, not just the first one. All entries must be made in indelible black ball-point pen, and initialed by the person making the entry. Never use correction fluid (e.g., Liquid Paper®) or correction tape on data sheets. Make corrections by crossing out the entry with a single line, dating and initialing the new entry and providing a reason for the correction. Having this sort of permanent record of all entries is especially important if the data will be used in legal actions.

The information about a particular test must be complete enough so that testing activities can be reconstructed by someone unfamiliar with the test. Record all observations and any calculations made, particularly for preparing test concentrations. Record these in the notebooks and attach them to the data sheets. Initial and date all entries you make.

All original data sheets and supporting documentation must be filed in the project file at Golder after study completion. This includes tests which were terminated before completion for any reason (i.e., control failure, sample delivery problems). Copies of documentation must also be retained in the laboratory project file.

7.1.4 Laboratory Sample Logbook

All samples received at the laboratory must be logged into a sample logbook. This logbook acts as an additional check that samples have been received and provides information about the status of testing of samples. Samples not entered in this logbook are considered not to have been received.

7.1.5 Reagent Preparation Logs

Documentation of procedures used to prepare various reagents is important to maintain consistency and identify possible errors. Reagent preparation logs are used for recording preparation of synthetic dilution water, chemical samples, reference toxicant stock solutions and other reagents.

7.1.6 Instrument Calibration Logbooks

Instrument calibration is required to confirm that accurate measurements are being made during a test and that equipment is operating correctly. Each piece of equipment must have a logbook (identified by the consultant equipment number) for daily recording of calibration, maintenance, repairs and replacement. Entries must be made each day that an instrument is used; periods when the instrument is unavailable (e.g., for repairs) should be recorded so there are no information gaps. Equipment should be subject to regular inspection and preventive maintenance procedures to ensure proper working order. Calibration logbooks have to be kept on file for five years after the instrument is no longer in operation.

7.2 Sample Handling

7.2.1 Sample Receipt

The QA/QC Officer at each laboratory will ensure that COC forms are properly signed over upon receipt of the samples and note questions or observations concerning sample integrity on the COC forms. The laboratories will contact the QA Coordinator immediately if discrepancies between the COC forms and the sample shipment are discovered upon receipt. The Laboratory QA/QC Officer will specifically note any coolers that do not contain ice packs or are not sufficiently cold (e.g., $4\,^{\circ}C \pm 2\,^{\circ}C$) upon receipt. The laboratory will not dispose of the environmental samples for this project until notified by the QA Coordinator and client in writing.

7.2.2 Intra-Laboratory Sample Transfer

The Laboratory QA/QC Officer will ensure that a sample-tracking record is maintained and that it will follow each sample through all stages of laboratory processing. The sample-tracking record must contain at a minimum the name/initials of responsible individuals performing the analyses, date of sample extraction/preparation, and type of sample analysis.

7.2.3 Inter-Laboratory Sample Transfer

Any samples which are subcontracted out will follow the same COC and sample shipping requirements described in the above sections.

7.3 Sample Archival

All excess sample and extraction/digestion aliquots will be archived by the laboratories. The laboratories will maintain COC procedures and sample integrity for the entire time that the samples are in their possession. Each laboratory will store the archived samples and digestion/extraction aliquots for up to 6 months after the QA Coordinator has completed data validation. After the 6 months has passed, the samples will become the responsibility of Suncor.

7.4 Analytical Procedures

Prior to the analysis of the samples, the laboratory must demonstrate proficiency through the analysis of a blind certified reference material. The results of performance evaluation samples analyzed under the Canadian Association for Environmental Analytical Laboratories (CAEAL) may be used in lieu of the QA Coordinator submitting certified reference materials to the laboratory. The laboratory must also provide written protocols for the analytical methods to be used for sample analysis; calculate method detection limits for each analyte in each matrix of interest and establish an initial calibration curve for all analytes. The laboratory must demonstrate its continued proficiency by participation in interlaboratory comparison studies and repeated analysis of certified reference materials, calibration checks, laboratory reagent blanks, and spiked samples. The laboratory may be audited during the project in order to determine and document if the laboratory has the capability to analyze the samples and is performing in compliance with the QAPP.

7.4.1 Contaminants of Concern and Method Detection Limits

The contaminants of concern, methods of analyses, and their associated targeted detection limits are identified in Tables 2-6 in Section 5.6.

7.4.2 Determination of Method Detection Limits

The method detection limit (MDL) is defined as the lowest concentration of an analyte or compound that a method can detect in either a sample or a blank with 99% confidence. In summary, seven replicate samples are fortified at 1 to 5 times (but not to exceed 10 times) the level expected to be the method detection limit. The MDL is then determined by calculating the standard deviation of the replicates and multiplying by three. All analytical laboratories must supply MDLs for each type of analysis.

7.4.3 Methods of Analyses

All methods of analyses must comply with required methodologies and guidelines, where applicable. Analytical laboratories must have (or be in the process of developing) in-house standard operating procedures (SOPs) for each test used in this project. The specific methods of analyses used for the EIA study are given in Tables 2 - 6 in Section 5.6.

7.4.4 Laboratory Quality Control Criteria

ASL Analytical Services Laboratory will be used to analyze a portion of the quality control samples generated from this project. This will serve as a QC check of the other analytical labs. The percentage of QC samples to be analyzed by ASL will be determined by the project managers from Suncor and Golder in consultation with the QA Coordinator and Team Leaders.

The quality control samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The quality control sample results will then be evaluated to determine if control limits have been exceeded. If control limit exceedances have been identified in the sample group, the QA Coordinator will be contacted immediately and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to the National Research Council Canada; National Institute of Standards and Technology; or other documented, reliable, commercial sources. Standards should be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

The following sections summarize the procedures that will be used to assess data quality throughout sample analysis (e.g., use and frequency of replicates, spikes, blanks, surrogate samples or reference materials, and calibration materials). A summary of the types of QC procedures to be performed by Syncrude for MicroTox® and naphthenic acid analyses are given in Table 7. The QC procedures for other types of analyses are discussed in the following sections.

Table 7 Summary of Quality Control Samples for MicroTox® and Napthenic Acid Analyses

ANALYSIS TYPE	INITIAL CALIB.	ONGOING CALIB.	STD REFERENCE	REPLICATE	MATRIX SPIKES	MATRIX DUPLICATES	METHOD BLANK	SURROGATE SPIKES
Microtox	each set	1 per 3 samples (a)	1 per 10 (phenol std)	1 per 10	N/A	N/A	N/A	N/A
Naphthenates	each batch (b)	1 per 5 samples (c)	1 per 5 (Kodak Naphthenates or Fatty Acids)	1 per 10 (d)	N/A	N/A	1 per 20 (e)	1 per 20

a. Instrument adjustment.

b. Standard Calibration Curve based on Kodak naphthenic acid in Methylene Chloride (0 - 1000 ppm)

c. Standard solutions of naphthenic acids run every 5 samples.

d. Random selections of samples.

e. Solvent and extraction system.

7.4.4.1 Initial Calibration

Multi-point initial calibration will be performed on each instrument at the start of the project, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet control criteria. The number of points used in the initial calibration is defined in each analytical method. Ongoing calibration will be performed daily for organic analyses and for every sample batch for conventional parameters (when applicable) in order to track instrument performance.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately after every continuing calibration verification at a frequency of one continuing calibration blank for every ten samples analyzed at the instrument. If the ongoing calibration is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced to within control specifications. All project samples analyzed while instrument calibration was out of control will be reanalyzed.

7.4.4.2 Standard Reference Materials

Analysis of reference materials and certified reference materials provides information on the accuracy of the laboratory performing the analysis. At least one reference material sample will be analyzed for conventional parameters per ten samples or per group of samples, whichever is most frequent. All certified reference material results must fall within the acceptance range values established for the reference material.

7.4.4.3 Matrix Replicates

Analytical replicates provide information on the precision of the analysis procedures and are useful in assessing potential sample heterogeneity and matrix effects. Analytical replicates are prepared by preparing a subsample and submitting it blind to the analyst to be extracted and analyzed as a separate sample. A minimum of 1 duplicate will be run per sample group or for every 20 samples, whichever is more frequent.

7.4.4.4 Matrix Spikes and Matrix Spike Duplicates

Analysis of matrix spike samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate matrix spike analyses, information on the precision of the

method is also provided for organic analyses. A minimum of 1 matrix spike will be analyzed for every sample group or for every 20 samples, whichever is more frequent. A standard reference material will be used when spiked samples are not appropriate, to assess method accuracy for specific parameters.

7.4.4.5 Surrogate Spikes

All project samples to be analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Recoveries determined using these surrogate compounds will be reported by the laboratories; however, no sample result will be corrected for recovery using these values.

7.4.4.6 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination of samples associated with all stages of preparation and analysis of sample extracts. A minimum of one method blank will be analyzed for every extraction batch for every 10 samples for conventional parameters and at documented frequencies for other parameters.

7.4.5 Data Deliverables

Prior to issuing a final report to Golder Associates, each analytical laboratory must take steps to ensure the data are of acceptable quality. All laboratory personnel are responsible for reporting problems that may compromise the quality of the data to their laboratory manager who will report it to the designated contact from Golder Associates. The QA Coordinator must be informed of all corrective actions, by memorandum, within 5 days of the initial notification.

Each data file must be thoroughly reviewed internally by the analyst and Laboratory QA/QC Officer to ensure completeness of sample chain-of-custody documentation, verification of sample history information and analytical requirements, acceptability of QC data and validity of sample results. The Laboratory QA/QC Officer must certify each page of data with the date and their initials. The Laboratory Project Manager must concur with the data results and sign-off on the report to Golder.

Each analytical laboratory should have a turn-around-time of 2-3 weeks, depending on test type, from the date samples are received at the laboratory to the date the report is delivered to Golder Associates. The test report should describe the materials and methods used, as well as the test results. The report

should clearly state whether the conditions and procedures of the test rendered the results acceptable for use. The assignment of any codes used to qualify the data must be clearly stated. The report must include the following information:

Project Narrative

This summary, in the form of a cover letter, will briefly discuss the results. Any problems encountered during any aspect of analysis must be described. This should include, but not be limited to, quality control, sample shipment, sample storage, and analytical difficulties. Discussion of any problems encountered, actual or perceived, and corresponding resolutions made will be documented in as much detail as necessary.

Chain-of-Custody Records

Legible copies of the chain-of-custody forms will be provided as part of the data package. This documentation will include the time and condition of each sample received by the laboratory. Any additional tracking administered internally by the laboratory shall also be included.

Sample Results

The data package should summarize the results for each sample analyzed. This summary should follow Alberta Environmental Protection or Environment Canada protocols for data reporting, where applicable. The summary will include the following information:

- Field sample identification code and the corresponding laboratory identification code
- Sample matrix
- Date of sample extraction
- Date and time of analysis
- Weight and/or volume used for analysis
- Final dilution volumes or concentration factor for the sample
- Percent moisture in sediment samples
- Identification of the instrument used for analysis
- Method detection limits and instrument detection limits (IDLs)
- Analytical results reported to three significant figures with reporting units identified
- All data qualifiers assigned and their definitions

Quality Assurance/Quality Control Summaries

This section must contain the results of all QA/QC procedures. Each QA/QC procedure summary should include all the information as indicated in the data package section (see above) for each QA/QC sample. No recovery or blank corrections will be applied by the laboratory. Each analytical laboratory will be required to conduct a program of 20% quality control samples for every batch of samples. Quality control samples will include calibration and verification standards, standard reference materials, matrix spikes, duplicates, method and reagent blanks, transportation and storage blanks and glassware proofs. For spiked samples, list the name and concentration of all compounds added, percent recoveries, and range of recoveries.

Electronic Spreadsheet of Test Data

An electronic spreadsheet of the data, including QC data, must be supplied with the final report. The Data Manager will discuss the format of data transfer with each laboratory. A labeled, 3.5 inch diskette should be used, and a record of the data files (and any explanation needed) should be provided.

Original Data

Legible copies of the following original data, while not required to be reported, must be available to the QA Coordinator if an audit is conducted:

- Sample refrigerator temperature log
- Sample extraction, preparation, and cleanup logs
- Instrument specifications and analysis logs for all instruments used on days of calibration and analysis
- Reconstructed ion chromatograms for all samples, standards, blanks, tunes, spikes, replicates and reference materials
- Enhanced spectra of detected compounds with associated best-match spectra for each sample
- Summary of calibration data including reporting the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor (RF), %RSD, percent difference (%D) and retention time for each analyte should be reported as appropriate
- Summary of internal standard areas to show whether they were stable
- Record of the relative retention time of each analyte detected in the samples for both primary and confirmation analyses

- Measurement printouts and quantitation reports for each instrument used including reports for all samples, standards, blanks, tunes, spikes, replicates and reference materials
- Original data quantification reports for each sample
- Original data for blanks and samples not reported

7.5 Biological/Toxicological Procedures

7.5.1 Quality Assurance

A number of biological and toxicological analyses will be performed to support the EIA. At the present time, not all types of analyses have been determined yet (e.g., types of toxicity tests). Each Team Leader must ensure that the sub-consultant they use have documented procedures for QA/QC.

The following sample analyses and quality control criteria will apply to the collection and enumeration of benthic samples:

- Sample Sorting and Sorting Efficiency
- Identification of Organisms
- Data Validation
  - Sample sorting quality control report
  - External taxonomic quality control report
  - Verification report from the outside experts on specimen voucher collection

Specific sample analyses and quality control criteria will need to be determined for the other biological procedures as well. Once all of the types of biological/toxicological studies have been determined, the QA Coordinator will work with the Team Leader and sub-consultant to develop acceptable sample analysis and quality control criteria. In most cases, these criteria will be based on published or documented procedures.

7.5.2 Data Deliverables

All sub-consultants for biological and toxicological work will be responsible for internal checks on data reporting and will correct errors identified during their quality assurance review. Each sub-consultant will be required to report results that are supported by the following:

- A cover letter discussing problems (if any) and procedures
- Summary report for any taxonomic work
- Original data sheets
- COC and transfer logs

In addition, other QA/QC data pertinent to the work must be included. For example, benthic results must include:

- Spreadsheet containing replicate abundance data
- QA results for 20% resorting
- Screening logs

The QA Coordinator will maintain close contact with the sub-consultants to resolve any quality control problems in a timely manner.

8.0 DATA EVALUATION

8.1 Data Review

Upon completion of the sample analyses, the laboratory will supply one complete data package to the study Team Leader (see Figure 4). The laboratory will also supply one summary data report and the electronic deliverable to the Data Manager. The study team leader will initiate the QA/QC checklist and send the complete data package to the QA Coordinator.

The QA Coordinator will review each laboratories' data to ensure the data comply with this QAPP (Figure 7). At least 10% of the sample data and 100% of the laboratory quality control samples will be validated. If transcription errors or other concerns (e.g., correct identification of chemicals in the samples) are found in the initial check on field samples, then data for an additional 10-20% of samples will be reviewed. If numerous errors are found, then the data package will be sent back to the analytical laboratory for corrections prior to completing the QA review.

8.2 Corrective Action Procedures

8.2.1 Corrective Action for Field Sampling

Each Field Coordinator will be responsible for correcting equipment malfunctions throughout the field sampling effort. The QA Coordinator will be responsible for resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. All corrective measures taken will be documented in the field notebook immediately. A corrective actions checklist form (Figure 8) must also be filled out and sent to the QA Coordinator within five days of the action.

Figure 7 Guidance for Data Assessment and Screening for Data Quality

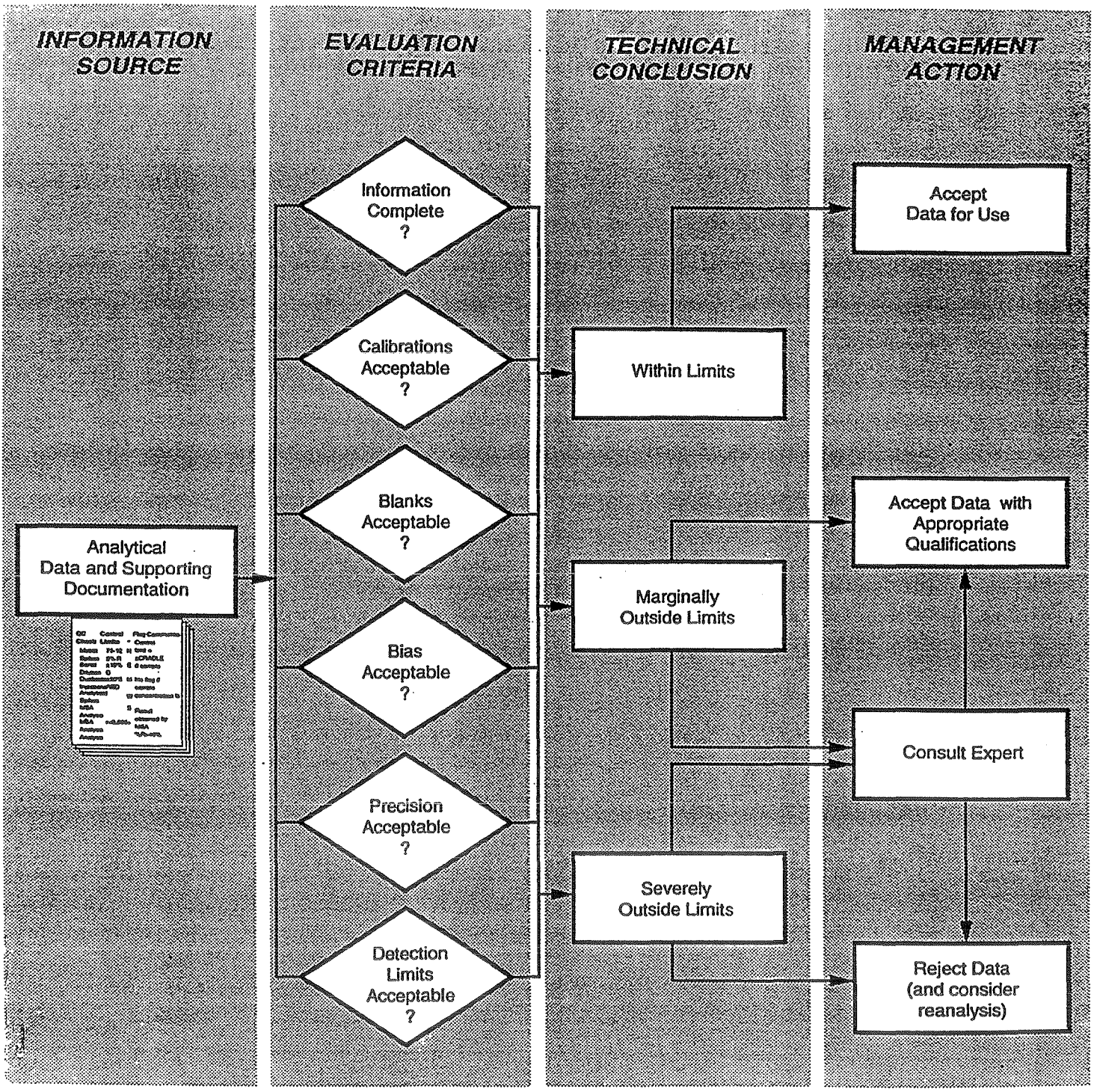


Table 8 Corrective Actions Checklist

SAMPLE PROGRAM IDENTIFICATION: _____

SAMPLING DATES: _____

MATERIAL TO BE SAMPLED: _____

MEASUREMENT PARAMETER: _____

ACCEPTABLE DATA RANGE: _____

_____

CORRECTIVE ACTIONS INITIATED BY: _____

TITLE: _____

DATE: _____

PROBLEM AREAS REQUIRING CORRECTIVE ACTION: _____

_____

_____

MEASURES TO CORRECT PROBLEMS: _____

_____

_____

MEANS OF DETECTING PROBLEMS (FIELD OBSERVATIONS, SYSTEMS AUDIT, ETC.):

_____

_____

_____

APPROVAL FOR CORRECTIVE ACTIONS: _____

TITLE: _____

SIGNATURE: _____

DATE: _____

8.2.2 Corrective Action for Laboratory Analysis

All laboratories are required to comply with the Standard Operating Procedures (SOPs) or other documented methodology given in Tables 2-6. The Laboratory Project Manager will be responsible for ensuring that the laboratory initiates the appropriate corrective actions required for conformance with the QAPP. All laboratory personnel are responsible for reporting problems that may compromise the quality of the data. The QA Coordinator will be notified immediately if any quality control sample exceeds the project specified control limits (Tables 2-6). The Laboratory Project Manager will document the corrective action by memorandum to the QA Coordinator within 5 days of the initial notification. The analyst will identify and correct the anomaly before continuing with the sample analysis. A narrative describing the anomaly noted, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, re-extraction) will be submitted with the data package in the form of a cover letter.

8.3 Laboratory and Field Performance Audits

Laboratory and field performance audits consist of onsite reviews of field and laboratory quality assurance systems and equipment for sampling, calibration, and measurement. All laboratories are required to have written procedures addressing internal QA/QC; these procedures have been submitted to the QA Coordinator and are acceptable. All personnel engaged in sampling and analysis tasks must have appropriate training. The contract laboratories will not be audited except for Syncrude's analytical laboratory for naphthenic acid analyses. The other analytical laboratories will not be audited for this project due to their recent accreditation by CAEAL which involves a thorough audit process.

A field audit will be conducted to review field operations including: SOPs or other documented field methodology, equipment maintenance and calibration records, chemical application and sampling techniques, and record keeping (e.g., chain-of-custody forms). The highest priority will be given to review field work which involves the collection of samples for chemical and physical analyses.

The results of the audit will be discussed with each field team and with Suncor, followed by a formal audit report. The audit report will list action items for correction and will provide a time-line for implementing corrections.

9.0 DISCIPLINE-SPECIFIC ISSUES, TECHNICAL APPROACH AND SCOPE

Varying levels of quality assurance will be required for the teams involved in the Suncor Steepbank Mine EIA. Previous sections have already detailed QA procedures for field sampling and for submitting samples to laboratories and sub-consultants.

The following sections will describe the discipline-specific issues, technical approach and scope of work for each team. Data tracking will be important to ensure that transcription errors are not made when transferring data obtained from field surveys, reports and other historical sources to data files. In addition, each team is responsible for ensuring that a certain percentage (e.g., 10%) of in-house calculations are double-checked.

9.1 Aquatics

9.1.1 Issue Summary

9.1.1.1 Bridge Construction

Potential impacts on Athabasca River water quality associated with construction include siltation, barrier for migrating fish and release of hydrocarbons from the McMurray Formation. These are primarily short term in nature.

Long-term impacts are the same as for any bridge, e.g., loss of habitat at pilings, ice build up and potential flooding, improved access to river and the potential for spills. Of these, spills of toxic materials is the most important. It is improbable that the area adjacent to Suncor contains any significant spawning habitats for fish or any rare/endangered aquatic species.

9.1.1.2 Hydro-Transport

Transport of tailings across the river via pipeline either suspended from a bridge or buried below the river, is an obvious issue. Potential impacts are primarily related to potential breakage and spills. Pipeline construction is regulated, and siltation and other disturbances to the river would have to be minimized.

9.1.1.3 Steepbank River

Arctic grayling spawn in this river and bull trout have been recorded, thus it will be viewed as important habitat, which cannot be adversely affected by the project. Mining near the river creates a number of

potential issues such as increased sediment loads (runoff and fugitive dust), altered hydrology (surface runoff patterns and groundwater-surface water interactions), and increased nutrient and contaminant loads (surface runoff, groundwater, atmospheric deposition). Mining on the north side of the river would require altering the course of the river or the construction of a bridge, with potential issues identified above in "bridge construction."

9.1.1.4 Wastewaters

Reclamation of Lease 86 and development of new mines may result in the need to release additional wastewaters to the Athabasca River, particularly if engineered tailings technology is selected. Discharge of expressed water from engineered tailings is a substantial issue and will require considerable impact investigation. This is potentially the major water quality issue with respect to new mine development and reclamation. Other wastewaters that need to be discharged or disposed of in some other manner include those arising from:

- mine dewatering - saline and toxic, currently diverted to tailings ponds
- camp facilities - sewage, currently discharges to Athabasca River
- mine site runoff - quality not well characterized, currently discharges to river
- plant runoff - likely toxic, diverted to tailings ponds
- extraction process - toxic, stored in tailings pond
- upgrading process - waters, currently discharges to river

The EIA will need to evaluate the cumulative effects of these point source effluents on river water quality plus effects of non-point source loads (groundwater, atmospheric deposition, surface runoff) and upstream loads (from upstream municipal and industrial effluents).

9.1.1.5 Atmospheric Deposition

Atmospheric deposition of contaminants, particularly those resulting in acidification, is an important issue raised during Syncrude's Energy Resources Conservation Board (ERCB) application. Potential effects associated with atmospheric releases will have to be defined.

9.1.1.6 Fisheries

The key issues related to fisheries include:

- the potential for loss of recreational, subsistence or commercial fish production due to direct or indirect toxic effects
- loss of critical habitats that precludes future fish production
- concerns for human health from consumption of fish
- aesthetic concerns in relation to tainting of fish which would limit use of the resource

The choice of critical indicator species and "early warning" parameters is another issue to be addressed prior to any final decision-making regarding baseline data collection. In risk assessment terms, we have to determine the assessment endpoints and the measurement endpoints for fish populations in the area. These endpoints should be defined as precisely as possible. For example, the assessment endpoint could be recruitment of walleye in the study area. The measurement endpoint could be the number of young-of-the-year walleye in the study area, with declines of > 50% being of concern.

9.1.1.7 Mine Reclamation

Wet vs Dry Landscape

Selection of a reclamation landscape technique will obviously affect issues and potential impacts on water quality. Primary issues related to wet landscape would likely be related to catastrophic release of tailings into the Athabasca River and sustainability of productive and non-toxic conditions in end-cap lake(s). Primary issues related to dry landscape include toxicity of surface runoff and seepage waters, discharge of expressed waters from engineered tailings, erosion of dry landscape units, and bioaccumulation of hydrophobic compounds.

On-Site Impact

Potential for impact will be a function of the final reclamation landscape. If end-cap lakes are constructed, then potential effects on these water bodies will need to be addressed. If dry landscape is predominant, then effects will be primarily associated with wetlands, in particular the potential effects on terrestrial and aquatic biota that might utilize the wetlands.

Off-Site Impacts

The Athabasca River is the major receiving water body for surface and subsurface discharge from Lease 86. As such, focus of offsite effects needs to be directed towards this water body, and particularly to effects on fish and human health.

9.1.2 Technical Approach

9.1.2.1 Fisheries

The primary study area will include the mainstem Athabasca River and Steepbank River within the vicinity of the Suncor Lease. Sampling on the Athabasca River will be conducted from the southernmost boundary of Lease 19 downstream to a few kilometers below the mouth of the Steepbank River, which involves approximately 25 km of the mainstem river. The southernmost boundary of Lease 19 occurs in the vicinity of the inflow of McLean Creek. It is proposed that the upper boundary of the study area on the Athabasca River be moved upstream to include the Willow/Stony Island complex which may provide significant fish habitats.

The study area on the Steepbank River will consist of the lower portion of the river within the proposed mine area. A point located upstream of Lots 1 and 3 is suggested as the upstream study limit, which would include approximately 25 km of river to the river mouth.

The seasonal fisheries inventory investigations will be conducted at selected sampling areas within the overall study area. For non-forage fish species, sampling areas will be selected that are representative of the habitats available in the study area. As well, sampling areas for non-forage species will include those which provide potentially significant or critical habitats such as snye and backwater areas, side channel habitat, and potential spawning, rearing, feeding and overwintering habitats. Available information from previous studies will be utilized in selecting sampling locations. For forage species, sampling will be restricted to selected areas which provide potential habitat for this species assemblage, including peripheral channel edge areas and backwater areas. For the mainstem Athabasca River, specific sampling areas will be designated and sampled each season to help evaluate the seasonal abundances and movements of forage species. Sampling will be conducted with recognition of the significance of this reach of the Athabasca River to the fish populations of Athabasca Lake. Although sampling will be restricted to the Suncor area, sampling activities and timing will be selected to reflect

documented and suspected spring, summer and fall movements of fish species from Lake Athabasca upstream to spawning and feeding areas.

Sampling will be conducted on a seasonal basis and will include the early spring spawning/migration period prior to freshet, mid-summer, the fall spawning/migration period and the overwintering period. Sampling will consist of multiple sampling techniques including boat electrofishing, backpack electrofishing, seining, gill netting, set lines, fry traps, minnow traps, air-lift sampling and kick nets. The main emphasis will be on electrofishing and seining for both forage and non-forage species in order to minimize incidental mortalities due to sampling. Sampling on the mainstem river for large fish species will primarily be conducted with the use of a Smith-Root SR-18 electrofishing boat. In the Steepbank River, the lower sections assessable from the mainstem river will be sampled using an inflatable boat equipped with a portable boat electrofishing unit and an outboard jet-drive, while upper sections which are assessable only by helicopter will be sampled with a backpack electrofishing unit. Sampling for forage fish in both rivers will primarily be conducted by backpack electrofishing and beach seining. Other sampling techniques such as gill nets and set lines will be used to sample habitats in which electrofishing effectiveness is reduced (such as very deep areas), to sample for fish species which are not as susceptible to capture by electrofishing (such as burbot), to sample for forage fish during the winter when other techniques are not feasible. Fry drift-traps will be used in the spring to sample for the presence of post-emergent fry, particularly walleye in the Athabasca River. Further detail on the technical procedures used for the fish inventory are given in Golder SOP number TP-8.1-0 (Appendix VII).

Catch-per-unit-effort (CPUE) data will be calculated for all sampling equipment and events in order to determine relative abundance of the fish species captured in each season.

Captured individuals of all fish species will be identified to species and enumerated. Individuals of large fish species will be measured for fork length and weight and the appropriate non-lethal ageing structure will be collected, as detailed by Mackay et al. (1990). The life history stage (fry, juvenile, adult), sex and state of maturity will be recorded for each fish, when discernible from external examination. Each fish will also be examined for external pathology, and all abnormalities will be recorded according to the existing external and internal autopsy classification system utilized by Golder Associates for biomarker analysis during EEM studies for the Pulp and Paper industry. Incidental mortalities will also be examined internally for definitive sex and state-of-maturity information, stomach contents, internal

pathology, and lethal ageing structures will be collected. For forage fish species, a sub-sample will be measured for fork length and weight and sacrificed to obtain ageing materials.

Fish population data for non-forage fish will be presented as follows; length-frequency analysis, length-weight regression analysis, length and weight at age analysis, condition factor calculations and frequency of external abnormalities. Data for forage fish species will consist of length and weight at age analysis.

During both the spring and fall spawning seasons, the Athabasca and Steepbank Rivers will be examined for spawning activity and the location of spawning areas for all large fish species, with emphasis on walleye in the mainstem river and bull trout, Arctic grayling, northern pike and longnose and white sucker in the Steepbank River. For determining the location of spawning areas in the mainstem river, concentrations of adult fish in spawning condition (ripe/spent) will be used to identify potential sites. Air-lift sampling and kick net sampling will be used to recover eggs from the substrate in order to confirm suspected spawning areas. For the Steepbank River, the portion of the river in the Suncor area will be visually examined for spawning activities with spawning sites confirmed by visual observation or egg recovery by kick sampling.

The main habitat mapping activities will be conducted in the fall during low flow conditions according to Golder SOP number TP-8.5-0 (Appendix VII). The entire lengths of the Athabasca and Steepbank Rivers within the primary study area will be mapped according to a habitat classification scheme which describes each habitat area by bank type, channel type, habitat type (e.g., pool, riffle, run, backwater, etc.) and class (quality). This scheme is compatible with the requirements of the EEM guidelines but will provide additional details which relate habitat conditions to potential fish use. Complete habitat mapping of the two rivers in the primary study area will define the availability of each of the habitat types present. The habitat maps will also include the locations of all sampling activities in order to relate fish use to habitat characteristics.

Information on physical habitats at the new bridge crossing location will be required as soon as possible to facilitate early and unobstructed review and permitting from Navigable Waters and the Department of Fisheries and Oceans. Therefore, one of the first study tasks will be to map the habitats in the Athabasca River within the area of the proposed bridge crossing. This will be conducted after ice-out and before the freshet. Emphasis will be placed on the identification of any apparent sensitive or critical habitat within the crossing corridor, that may be avoided in the final siting of the bridge crossing.

Assuming no sensitive or critical habitats are affected in the Athabasca River, no difficulties are anticipated in obtaining the necessary Federal and Provincial approvals for the bridge.

Measurements of physical habitat features will be conducted in representative habitat types. Measurements on the Steepbank River will consist of depth and velocity profiles, cover availability and general substrate characteristics. On the Athabasca River, measurements may be limited to depth profiles (as determined by sonar tracings) and general substrate conditions.

All significant habitat-use areas (i.e., spawning, nursery, rearing, feeding and overwintering) will be mapped with respect to location, extent and habitat classification. Measurements of physical habitat features will also be conducted at each of these locations in order to better describe these habitats and to address data deficiencies concerning depth and velocity distributions in this section of the Athabasca River.

Geographic Positioning System (GPS) techniques will be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations.

Prior to the onset of the field program, two sentinel species (VECs) will be selected for each of the rivers for fish health analysis. The species selected will not necessarily be the same for the Athabasca and Steepbank rivers. For each river, one of the two species will be a spring spawning fish and the other a fall spawner. For each sentinel species, biomarker data will be collected for 40 individuals, including 20 of each sex. Collections will be conducted during the appropriate spawning period in order to obtain fish with developed gonads for determining Gonadal Somatic Indices as well as fecundity counts and egg diameters.

Data collected during biomarker analysis will include; external and internal pathology, liver weights, gonad weights, fecundity counts, egg diameter measurements, collection of liver samples for MFO and retinol analyses, and collection of blood plasma samples for determining lactate and circulating sex steroid levels. As blood samples will be collected from pre-spawning fish, the samples will be analyzed for two sex steroids, testosterone and estradiol. Strict adherence to proper sampling protocols will be maintained while collecting, processing and storing biomarker samples to ensure the integrity of these sensitive samples. This protocol includes: proper capture and handling techniques; blood removal, sacrifice, and liver removal within the proper time frame; the use of hexane and acetone-washed

dissection tools, and; storage of samples collected for laboratory analysis in hexane/acetone-washed foil and liquid nitrogen (MFO) or dry ice (plasma) (see Golder SOP number TP-8.1-0, Appendix VII).

Additional information collected from fish sacrificed for biomarker data will include stomach contents, life stage, sex, state-of-maturity and lethal ageing structures. Flesh samples (fillets) will be collected from a sub-sample of the sacrificed fish (suggest 20/species). These samples will be wrapped in hexane/acetone washed foil, preserved on dry ice and stored frozen for possible later contaminant analysis.

9.1.2.2 Benthos

The benthos monitoring component of the EIA will closely follow Environment Canada's "Guidelines for Monitoring Benthos in Freshwater Environments" (1993), as this document provides a logical framework to follow for benthos monitoring, from defining the objectives of the study through to reporting and follow-up action. Consistently following such a framework is important for standardizing a monitoring program, particularly for long-term efforts. EVS and Dr. Paine (PLA) prepared this document through technical workshops with Environment Canada staff and other experts.

In addition to communication with Suncor and the appropriate regulatory bodies, EVS and its associates will ensure any benthic monitoring and data analysis is completed in cooperation with the Northern River Basins Study whenever possible to ensure the data and knowledge available from this agency is used to the fullest potential.

The first activity to be completed as part of the baseline assessment for benthic community assessment will be to review available benthos data, using the EIA scoping study as the primary source of references. Available benthos data will provide a starting point from which action plans for the baseline assessment can be developed.

A baseline assessment monitoring program will be designed according to needs identified from current available benthos data. The field work will be completed in the fall of 1995, and it will include the collection of samples from the Athabasca River and the Steepbank River for community assessment, and the collection of benthic biomass for bioaccumulation analysis on the Athabasca River. To assess community structure, 4 articial substrate (AS) will be placed at 12 sites in the Athabasca River. The AS

will be of the "barbecue chicken basket" variety assembled as per ASTM protocols. The colonization period of the AS will be approximately 6-8 weeks. A shorter colonization period may have to be considered depending on weather and river flow conditions. All YAS will be retrieved, but only three will be randomly selected and submitted for analysis; the others will be archived. As each AS is retrieved, the natural sediment will be grab-sampled using a pole-mounted Eckman. Three grab samples corresponding to the three AS sites randomly selected will be composited and submitted for analysis. The remaining third of each grab sample not composited will be archived. At all 3 sites on the Steepbank River, 5 samples of the natural sediment will be collected using the sampler most appropriate to the substrate and analyzed for community structure (no AS).

Benthic biomass for bioaccumulation analysis will be collected from 4 sites in the Athabasca River using a kick net. All samples will be screened on-site and the benthos preserved a s appropriate and shipped in appropriate containers with correct labelling and chain-of-custody forms. As this study is part of the larger risk assessment work, the results of the chemical analysis will be reported but not interpreted.

Potential impacts to the benthic community from the mine development will be assessed using statistical analyses and qualitative assessments. The statistical analyses conducted on the benthos data should reflect the objective and design of the monitoring program itself, and selecting the appropriate analysis should be conducted as part of the program design (Environment Canada, 1993). Power analysis is an effective method for developing and evaluating study designs, and may be used as part of this program to determine the number of samples required (see Osenberg et al., 1994).

Analysis of benthic community data involves standard calculations such as species abundance and richness in support of the impact hypothesis; a variety of statistical approaches may be used. Combinations of univariate (e.g., ANOVA, ANCOVA, regression analysis) and multivariate statistics (e.g., Principal Component Analysis and Detrended Correspondence Analysis) will be considered for investigating spatial and temporal trends in the community data.

Sediment quality or other abiotic data (chemistry, physical, bathymetric, currents, etc.) and/or biotic data (fisheries) will likely be monitored at the same sites concurrently with the benthic data during the baseline assessment program. Multivariate statistical techniques are available to link community structure to environmental variables. For example, the use of Canonical Correspondence Analysis (CANOCO Program) and Redundancy Analysis (CANOCO Program) will be investigated. Composite

indices such as diversity, Hilsenhoff's Biotic Index and others may be calculated for data presentation purposes.

9.1.2.3 Water Quality

The spring field program will proceed during the low-flow period before freshet. River water, sediment and porewater samples will be collected upstream from and adjacent to Lots 1 and 3 in the Athabasca River and in the Steepbank River near the mouth.

In light of the absence of previous data regarding sediment and porewater chemistry in the Steepbank River, a more detailed survey will be conducted for this system. Site selection will be guided by the preliminary findings of the fisheries and benthos investigations, and will be aimed to concentrate on potential spawning and feeding areas. Sediment and porewater samples will be collected using an Ekman dredge and minipiezometers, respectively.

River water will be analyzed for conventional water quality variables (pH, conductivity alkalinity, dissolved oxygen, suspended solids, total dissolved solids, major ions, nutrients, metals), periphyton and selected contaminants (target PAHs and PASHs, naphthenic acids). All sediment and porewater samples will be screened for contaminants using the bacterial bioluminescence assay, MicroTox®, and selected samples analyzed for target PAHs, PASHs, and naphthenic acids. Particle size and total organic carbon will be done on all sediment samples., and concentrations of metals and selected contaminants.

The exact design of the fall field program will depend upon preliminary interpretation of the data generated by the spring water quality and fisheries investigations. The fall data will be examined to evaluate its completeness, to identify data gaps, and to locate ecologically sensitive areas and potential "hot spots" with higher than expected contaminant levels in environmental media. The fall program will then be developed to fill in data gaps, confirm anomalous results, and to provide detailed data in selected areas.

Although limited river water and sediment sampling will be conducted, the fall sampling program will rely heavily on the use of minipiezometers which are ideal for acquiring detailed spatially integrated chemical data. Sampling will be stratified, focusing on ecologically sensitive areas such as spawning areas where biological effects are most likely. It is anticipated that since spawning is very limited in the

mainstem of the Athabasca River, the fall water quality survey will focus primarily on the Steepbank River. Chemical analyses will be as outlined for the spring survey, with the possible expansion of target analyze lists based on the spring results.

9.1.2.4 Quality Assurance and Quality Control (QA/QC)

Ten percent of the analytical budget will be reserved for QA/QC. The aquatics QA/QC program will include thorough sample documentation through the use of GPS to record spatial data, detailed field notes, chain-of-custody forms and photographic records. Sampling will be conducted by appropriately trained personnel using standard techniques and approved containers provided by the analytical laboratories. Chemical analyses will be validated using transport blanks and blind duplicate samples which will be analyzed for target chemicals and toxicity. A detailed Quality Assurance Plan will be included in the workplan and approved by the QA/QC officer prior to each field program.

9.1.3 Detailed Work Scope

The aquatics workplan was extensively developed for the EIA Scoping Study. Optimization of this workplan depends upon how much reliance can be put on existing data versus collection of new data. Those decisions will be made after meeting with regulators and reviewing the most recent NRBS data. For the Spring and Summer 1995 aquatic sampling program, Golder Associates have prepared specific work instructions (SWIs) and technical procedures (see Appendix VII). The SWIs have been approved by both the Project Manager and QA Coordinator. Additional SWIs and technical procedures will be prepared, as needed, for other seasonal aquatic sampling.

Task 5210 Project Initiation

Objectives: Establish aquatic baseline conditions for the study area through a review of existing information and development of focused, cost-effective field programs to confirm the existing data base and fill data gaps.

Tasks:

- Complete final review of existing fisheries, benthos, and water quality information
- Present the current fisheries workplan to provincial and federal regulators, and interested non-government organizations, and obtain feedback
- Revise the fisheries workplan as required
- Produce a summary of existing fisheries resource use
- Select the sentinel fish species (VECs)
- Make recommendations regarding further fish tainting work
- Develop a detailed workplan for the spring field program (and outlines for the summer, fall and winter field programs) to provide information on fish populations, habitat availability and use, fish health, benthic invertebrates, and sediment and water quality in the mainstem Athabasca River adjacent to the leases and in the Steepbank River within the lease

Deliverables:

- Letter report with recommendations regarding funding for NRBS fish tissue analysis
- Fisheries workplan submitted to AEP and DFO for review. Formal response from both AEP and DFO will be requested. This needs to be done as soon as possible to allow time for review, particularly as it pertains to construction of the bridge
- A detailed workplan and budget outlining all aquatics work for the spring field program (based on review of all historical data plus revisions, as required, to take into account AEP and DFO responses)

BASELINE DATA COLLECTION

Task 5220 NRBS Analyses

Objectives: Determine whether fish tissue samples already collected by NRBS would provide additional information useful for Suncor EIA.

Tasks:

- Review NRBS information and fish collection to make recommendations regarding funding for analysis of fish tissue samples already collected by NRBS

Deliverables:

- Letter report with recommendations regarding funding for NRBS fish tissue analysis

Task 5230 Spring Aquatics Sampling Program

Objectives: Establish aquatic baseline conditions for the study area through a focused, cost-effective field program to (1) delineate fish habitat, health and populations, (2) archive fish tissue samples for possible contaminant analysis, (3) characterize benthic invertebrate communities, and (4) quantify baseline sediment and surface water quality conditions. This information will also be used to optimize the summer, fall and winter sampling programs.

Tasks:

- Map spawning areas, and Athabasca River at proposed bridge crossing location
- Collect fish population and age-structure data
- Obtain biomarker data for sentinel species
- Archive tissue samples from sentinel species
- Sample benthic invertebrates and complete taxonomical and chemical analyses of benthic samples
- Collect water quality data including conventional parameters, PAHs, PASHs, naphthenic acids, and toxicity for river water, sediment and porewater
- If appropriate, conduct an inventory assessment of Ruth Lake

Deliverables:

- All data verified and input into database
- Maps of spawning areas and Athabasca River at proposed bridge crossing

- A concise summary of seasonal habitat availability, seasonal habitat use, and the health of fish populations in the Steepbank River on Lease 97, as well as in the mainstem Athabasca River in the vicinity of Lease 19. Population status and fish health and movements will also be documented for migratory species that are seasonal inhabitants or migrate through the Athabasca River adjacent to Lease 19
- A concise summary of benthic invertebrate communities and tissue contaminant levels within the study area
- A concise summary of baseline water quality conditions in the study area
- Summary of loadings of conventional pollutants, PAHs, PASHs and naphthenic acids from existing sources and non-point sources in the study area and upstream
- A detailed workplan outlining the summer field program

Task 5240 Summer Aquatics Sampling Program

Objectives: Establish aquatic baseline conditions for the study area through a focused, cost-effective field program to delineate fish rearing habitat, summer feeding habitat and summer fish populations. This information will also be used to optimize the fall and winter sampling programs.

Tasks:

- Document rearing and feeding areas
- Collect fish population and age-structure data
- Collect water quality data
- Obtain biomarker data for sentinel species
- Archive tissue samples from sentinel species
- Install artificial substrates for sampling benthos

Deliverables:

- All data verified and input into database
- GIS maps of rearing, feeding and summer use areas

- A concise summary of seasonal habitat availability and seasonal habitat use in the Steepbank River on Lease 97, as well as in the mainstem Athabasca River in the vicinity of the Lease 19
- A detailed workplan outlining the fall program (based on findings of spring and summer sampling programs)

Task 5250 Fall Aquatics Sampling Program

Objectives: Establish aquatic baseline conditions for the study area through a focused, cost-effective field program to (1) delineate fish habitat, health and populations, (2) archive fish tissue samples for possible contaminant analysis, (3) characterize benthic invertebrate communities, and (4) quantify baseline sediment and surface water quality conditions. This information will also be used to optimize the winter sampling programs.

Tasks:

- Map spawning areas
- Collect fish population and age-structure data
- Obtain biomarker data for sentinel fish species
- Archive tissue samples from sentinel fish species
- Sample benthic invertebrates and complete taxonomical and chemical analyses of benthic samples
- Collect water quality data including conventional parameters, PAHs, PASHs, naphthenic acids, and toxicity for river water, sediment and porewater

Deliverables:

- All data verified and input into database
- GIS maps of spawning areas
- A concise summary of seasonal habitat availability, seasonal habitat use, and the health of fish populations in the Steepbank River on Lease 97, as well as in the mainstem Athabasca River in the vicinity of Lease 19. Population status and fish health and movements will also

be documented for migratory species that are seasonal inhabitants or migrate through the Athabasca River adjacent to Lease 19

- A concise summary of benthic invertebrate communities and tissue contaminant levels within the study area
- A concise summary of baseline water quality conditions in the study area
- Summary of loadings of conventional pollutants, PAHs, PASHs and naphthenic acids from existing sources and non-point sources in the study area and upstream
- A detailed workplan outlining the winter field program (Based on findings of spring, summer and fall sampling program)

Task 5260 Winter Aquatics Sampling Program

Objectives: Complete seasonal abundance data and identify overwintering areas.

Tasks:

- Map overwintering habitat
- Note presence and abundance of overwintering species

Deliverables:

- All data verified and input into database
- GIS maps of overwintering areas
- A concise summary of seasonal habitat availability and seasonal habitat use in the Steepbank River on Lease 97, as well as in the mainstem Athabasca River in the vicinity of Lease 19

Task 5270 Aquatics Impact Assessment/Mitigation

Objectives: Quantify and qualify potential impacts to the aquatic ecosystem (fish and benthic invertebrates). Identify measures to ameliorate any negative impacts. Identify mitigation opportunities such that there is no net loss of productive fish habitat associated with the project. Recommend monitoring studies to assess the condition of the resource over the long term.

Tasks:

- Initial priority is to assess effect of bridge construction on Athabasca River fishery
- Determine aerial extent and quality of any microhabitats that would be affected by the new mine. It is likely that the only impact on microhabitat would be the bridge crossing
- Determine if habitat enhancement is required to meet the objective of no net loss of productive fish habitat
- Determine the potential impacts to fish health and populations from potential effects on macrohabitats in the Steepbank and Athabasca Rivers, using statistical analysis
- Assess the potential impacts to the benthic community from the mine development, using statistical analyses
- Evaluate the existing extent of fish, benthic invertebrate, sediment and porewater contamination. Use modeling techniques like the Reclamation Landscape Model (RLM) and the Oil Sands Reclamation Performance Assessment Framework (RPAF) to project human and ecological risk associated with process drainage and seepage water releases to the Athabasca River. This will be a cumulative assessment that accounts for background and upstream constituent loadings
- Recommend measures that should be taken to mitigate potential impacts
- Recommend designs for further baseline, pre-operational and post-operational long-term monitoring

Deliverables:

- Report summarizing potential impacts, health and ecological risk to the Athabasca River, recommendations for mitigation measures and identification of residual impacts assuming incorporation of mitigatory measures
- Recommendations and rationale for long-term monitoring programs

9.2 Hydrology and Hydrogeology

9.2.1 Issue Summary

Alteration of Drainage Patterns and Effect on Steepbank River

Mining in Areas 1 and 2 will affect surface runoff patterns and discharge of groundwater to the Steepbank River. This may result in changes in flow conditions in the river, which may adversely affect river biota.

Discharge of Mine Drainage Water

A modified surface drainage pattern will result from mining new leases. The volumes (both spatially and temporally) of this water and quality of the water will need to be estimated so that potential effects on adjacent surface water bodies can be assessed.

Effects on Wetlands and Other Water Bodies

Wetlands and small ponds and streams will be directly and indirectly affected by mining activities. Some of these water bodies will be eliminated as a result of mine development. Other water bodies located in the lower portions of the drainage basins may either dry up as a result of diversion of influent water or the hydrology of those systems may be altered as a result of discharge of mine drainage water. This would affect aquatic and terrestrial wildlife associated with the water bodies.

9.2.2 Technical Approach

The hydrology and hydrogeology issues can be divided into three basic stages as listed below:

Stage 1) What are the pre-mining conditions?

Stage 2) What changes will happen during mining?

Stage 3) What changes will happen after mining?

At each stage of the mine plan the Steepbank EIA must address two principal issues:

A) What is the water quality (on site and off site)?
B) What is the water flow (direction and quantity)?

Stage 1 will establish the baseline conditions for the hydrogeology and hydrology components of the EIA.

Stage 2 requires a conceptual mine plan from the Steepbank Mine Feasibility Study before this work can commence. This plan is expected in May 1995. The effects on the baseline parameters established in Stage 1 can then be assessed and appropriate mitigative measures evaluated. Work in this stage is an iterative process requiring close liaison with the Feasibility and EIA teams.

Stage 3 also requires input from mine feasibility as well as so that the impacts of projected closure options can be assessed.

A brief technical scope for the hydrology and hydrogeology subprojects which incorporates the management and activity concepts outlined previously is presented in the following sections.

Hydrogeology

Four principal geologic units require investigation and hydrogeologic characterization:

1. Devonian Limestone
2. Basal McMurray Formation
3. Intra Ore deposits
4. Overburden deposits

A brief discussion on the work to be completed under each task is presented below:

Stage 1

Collect Existing Data

The majority of maps, airphotos, regional and local hydrogeological information will be provided from existing reports and sources at Suncor. Site specific data collection is required.

- Orientation Reconnaissance
- Geologic exposure and seepage mapping along the Athabasca and Steepbank Rivers

Both these task will be completed in February, 1995.

Review Existing Data

As data is collected and made available it will be reviewed by the project team. This review will be assessed with the objective of minimizing the costs of the field, sampling and analysis programs.

Determine Monitoring and Sampling Plans

Two geophysics field programs are planned. The first program will be a Ground Penetrating Radar program along the east bank of Athabasca River. This program is being conducted in conjunction with the Mine feasibility bridge excavation program and will attempt to establish the depth to the Devonian surface.

The second geophysics program will consist of a electromagnetic survey of the new lease areas. This survey will be used to provide asses the nature of the shallow geological materials including surficial channels and buried aquifers.

Two drilling/instrumentation programs and five sampling programs are to be conducted. The first instrumentation program is being conducted concurrently with the spring 1995 coring program to minimize drilling costs. The second instrumentation program will be conducted in early summer and is intended to address any identified data deficiencies.

The details of these programs will be finalized under this work task.

Install Monitoring and Sampling Points

Two installation field programs will be conducted. The first program commenced in January 1995 in conjunction with the Coring Program. This program consists of the installation of 14 monitoring wells and 26 pneumatic piezometers at 27 locations within the new lease area.

The second installation program is tentatively scheduled for early summer. Details of this program will be finalized when data requirements are finalized.

Data Collection

Data collection and sampling, including water levels, pressures and water chemistry is scheduled to be conducted five times in the next year. January and February, May, July/August, October and January/February 1996.

This data series, in conjunction with the existing database from lease 86 will provide sufficient data for evaluation of the EIA requirements and allow identification and amelioration of any data deficiencies identified.

Evaluate Data

Data evaluation will continue throughout the program as required. Data evaluation and model development would be conducted concurrently with the data collection so that on going results and appropriate data reports can be provided to the project team as they become available. In particular, data on dewatering issues such as basal aquifer pressures and water quality must be available early in the program so that the mine feasibility study can be completed by December, 1995.

For planning and scheduling purposes, three principal data evaluation milestones have been established as follows:

POST FEBRUARY 1995 SAMPLING EVENT

This data evaluation will include the first complete set of data from the new leases. Specific objectives of this evaluation are to:

- Develop the initial hydrogeology database for the new lease program
- Develop a conceptual model and understanding of the flow paths and water quality issues at the new leases
- Assess the performance of the instrumentation in each hydrogeologic target unit in terms of meeting the objectives of the EIA
- Provide preliminary hydrogeologic inputs to the EIA and Feasibility Study project teams.

POST MAY 1995 SAMPLING EVENT

This evaluation will include updating the hydrogeologic database with the results of the most recent sampling event and identification of important parameter relationships to the hydrology of the area. The data will be prepared as inputs to Stage 2 - Mining Impact Assessment which is expected to commence in May or early June.

POST FEBRUARY 1996 SAMPLING EVENT

This evaluation will update the previous event and incorporate the final mine feasibility results which is due in December 1995 as well as relevant data from the other aspects of the EIA project.

Prepare Stage 1 Technical Report

This work will finalize the pre-mining assessment of the hydrology and hydrogeology for the EIA.

Stage 2

Mining Impacts on Hydrogeology

The precise scope of this stage depends on the input from the Mine Feasibility Project. It is expected to commence in May 1995 and be completed by May 1996. Actual dates will vary depending on the Mine feasibility schedule which is not yet finalized.

Stage 3

Mine Closure Impacts on Hydrogeology

The precise scope of this stage also depends on the input from the Mine Feasibility Project. It is expected to be commence in the fall of 1995 and be complete in May 1996.

Hydrology

Specific hydrology components that will be addressed include the following:

Stage 1

Collect Existing Data

Collect and review all existing hydrological data in the area:

- Existing stream flow records
- Existing climatological data
- Conduct a field reconnaissance

Review Existing Data

Review data and update design storm and IDF data for model inputs:

- Develop runoff models for the natural catchments
- Gauge selected streams to calibrate models
- Sample selected streams to provide water quality data including assessment of suspended load and bedload in discharge from the natural catchments

- Establish storm and annual hydrographs for selected lease streams including winter base flow conditions (in any)
- Provide a Stage 1 technical report

Stage 2

- Receive conceptual mine plan
- Estimate surface water dewatering requirements
- Develop conceptual designs and cost estimates for drainage alternatives including: stream diversions, channel and ditch designs, control structures and erosion control measures
- Evaluate the effects of the measures in terms of the pre-mining conditions
- Provide a Stage 2 technical report

Stage 3

- Receive Conceptual Mine Closure Plan
- Assess potential changes to the surface water runoff models due to closure plan
- Develop conceptual designs and cost estimates of long term drainage alternatives including: stream diversions, channel and ditch designs, control structures and erosion control measures
- Evaluate the effects of the measures in terms of the pre-mining conditions
- Provide a Stage 3 technical report

9.2.3 Detailed Work Scope

Tasks 5300 and 5400 Hydrology and Hydrogeology

For this study, hydrogeology will be addressed under one subproject and hydrology as a second subproject due to the differences in technical expertise required. However, in terms of the basic scope of work required, each subproject will require the same basic task descriptions as follows:

Tasks 5320 and 5420 Baseline Conditions

- Collect existing data
- Review existing data
- Determine monitoring and sampling plan
- Install monitoring and sampling points
- Data collection
- Evaluate baseline data results
- Prepare Stage 1 technical report

Tasks 5330 and 5430 Mining Impact Assessment

- Receive conceptual mine plan from feasibility group
- Incorporate physical changes (e.g., pit excavation, waste stockpiles) to the baseline model
- Assess impacts of changes to the baseline model
- Identify narrow scope areas for detailed assessment (e.g., new maintenance area, fueling areas)
- Develop conceptual amelioration recommendations for narrow scope areas
- Submit Stage 2 assessment report to Feasibility Study
- Evaluate any revisions to mine plan concept
- Prepare Stage 2 technical report

Tasks 5340 and 5440 Post Mining Impact Assessment

- Receive mine closure plan from feasibility group
- Incorporate physical changes (e.g., pit fill and capping, waste stockpile leveling) to the baseline model
- Assess impacts of changes to the baseline model
- Identify narrow scope areas for detailed assessment (e.g., facilities removal, fueling/maintenance area reclamation)
- Develop conceptual amelioration recommendations for narrow scope areas

- Submit Stage 3 assessment report to Feasibility Study
- Evaluate any revisions to mine plan concept
- Prepare Stage 3 technical report

Deliverables:

- A series of data reports to the EIA project team as field work, laboratory results and data analyses are completed
- Final reports for each stage of the work

9.3 Air

9.3.1 Issue Summary

Local Impacts

Local impacts include the area surrounding the Suncor operations to a distance of about ten kilometers. The primary issues are:

- *VOC and THC Fugitive Emissions*: includes the large area source emissions from the tailings ponds areas as well as H_2S fugitive emissions from the coke piles. The impacts are likely to be very localized.
- *Heavy Metals and Particulates* are issues which will have to be addressed in the EIA. The impacts from particulates will vary depending on the distribution of particulate sizes and densities. Larger and heavier particulates (those greater than ten microns) are likely to deposit within tens of meters to several hundreds of meters. The effects here may be related to impacts on water quality and vegetation issues in the deposition zones. Small particles (those less than ten microns) are likely to remain suspended for very long distances, or indefinitely. The impacts here are likely to be human health respiratory or wildlife related.

- *Fugitive Dust* from the tailings ponds areas are a growing concern. In addition, the fugitive dust from the coke area is issue due to their proximity to the Athabasca river.
- *Stack Emissions*, including SO_2, NO_x, and VO_x emissions, and operational flaring are also of concern. Whereas there are current initiatives reducing these emissions, the historic impact of these emissions should be dealt with, and the projected cumulative impact must be addressed.

Regional Impacts

Regional impacts include the area surrounding the Suncor operations in the order of tens to hundreds of kilometers. Regional impacts can include the cumulative impacts of the surrounding industries in terms of emissions inventories, acidifying potential and regional health effects. Included in this regional impact assessment will be results of the biomonitoring and the lichen impact surveys. In co-operation with the Regional Air Quality Coordinating Committee (RAQCC), regional emission impacts on human health will also be studied.

Greenhouse Gases

Greenhouse gases must be considered in terms of industry standards and is a long range transport issue. The existing emission inventory and projected conditions associated with the expansion will be evaluated. The contribution of the Suncor operations to global warming should be addressed in the EIA.

9.3.2 Technical Approach

The purpose of this section is to briefly outline our approach for the air quality impact assessment. The existing powerhouse and incinerator emissions will be characterized by reviewing the stack survey and CSEM data. While 15-minute data are available for the past year, we believe that the daily average data are sufficient for the purposes of providing an indication of past performance. The information will be depicted in a time series format consistent with the air quality information undertaken for Suncor in 1992 and Syncrude in 1992. We will require data from Suncor for the years 1991 to 1994 for the update. Similar daily data will be required for the flare stacks.

Secondary stacks will have to be identified and documented. This documentation will be based on a review of plant drawings and the vent gas analysis survey undertaken for Suncor by BOVAR Engineered Products. The data will be reviewed for completeness by our combustion engineer.

The existing emissions will be compared to those expected due to Suncor's SO_2 reduction program. A summary of the current and future emissions will be provided in graphical and tabular format.

Fugitive emission sources will be identified for the current and proposed operation. The aerial extent and type of source will be noted. In the absence of information from Suncor, the emissions will be estimated by using standard U.S. EPA emission factors (U.S. EPA, 1985).

The main off-site emission sources are those associated with Syncrude and the major Syncrude source is the powerhouse stack. While we have estimated emissions from other sources (e.g., highways and communities), we believe it is best to focus on this major off-site source.

We also will require plot plans of the current and proposed plant layouts with building dimensions. The building dimension data will be processed using the U.S. EPA program "BPIP" so the building information can be incorporated into the dispersion model calculations. Specifically terrain data have been digitized for the area centered on Suncor. The terrain elevations are available for the ISCON5, RTDM and ADEPT2 dispersion models. These data need to be updated to any reflect changes in landforms or regional boundaries.

For the reasons stated in the Workplan, we believe a simplified general climate discussion focusing on ambient temperature and precipitation should be sufficient. If required, a more comprehensive climate can be provided. The appropriate Environment Canada reports on climate change applicable to the prairie provinces will be consulted and comments will be made regarding the expectation for the area given the extended life of the plant. The caveats associated with the models will be identified.

The recently completed BOVAR-CONCORD meteorology report will be used as the basis for the diffusion climate section. Specifically, the information and appropriate sections will be transferred to the EIA to provide the required diffusion climate summary. Comments will be made to compare the results from the enhanced Suncor program with previous assessments. Convective mixing heights will be estimated using climatological values for the area and mechanically mixing heights will be based on wind speeds. This is consistent with previous assessments undertaken for this area.

The ISCST2 and RTDM models use PG stability class. The solar radiation/wind speed method and the standard deviation methods ($\sigma\theta$ and $\sigma\phi$) will be used to estimate stability classes. These methods have

been applied to the area for both Suncor (Concord Environmental Corporation 1992a) and Syncrude (Concord Environmental Corporation 1992b). The data will then be formatted to serve sequential time series models such as ISCST2 and RTDM and climatological models such as ADEPT2.

Air quality exceedance data from Suncor's ambient stations for the period 1986 to 1991 were summarized in the Concord (1992a) report. This information will be updated to reflect the data from 1992 to 1994. The data will be summarized to determine trends according to time of year, time of day, wind speed and wind direction as per the Concord (1992a) report.

The static exposure station data for both Suncor and Syncrude will be integrated and the results will be displayed as contours superimposed on a map of the area. The Syncrude EIA used total sulphate and hydrogen sulphide data from both networks for 1986 to 1991. This map will be updated to include 1992 to 1994 data.

Alberta Environmental Protection (AEP) collects precipitation chemistry in Fort McMurray. The most recent years (up to 1994) will be used to characterize baseline precipitation in the area. The background acidifying protection (AP) and effective acidity (EA) values will be calculated based on the precipitation chemistry values.

With regard to dispersion modeling, the new AEP guidelines (AEP 1994) indicate that both "screening" and "refined" modeling approaches have to be applied for environmental assessments. For the screening assessment, BOVAR-CONCORD proposes to use SCREEN2 to evaluate each source on an individual basis. For the refined assessment, BOVAR-CONCORD proposes to adopt ISCST2 for the shorter secondary stacks that are likely to be influenced by building downwash and either ISCON5 or RTDM for the taller primary stacks. The ISCON5 model falls under the AEP definition as an "alternate model". The BOVAR-CONCORD 1992 report should provide the necessary confirmation that this model is acceptable. This, however, will have to be confirmed with AEP.

It is our understanding that Suncor, as part of their SEC project, proposes to use the current air quality and meteorological database collected in 1994 to evaluate dispersion, and the performance of dispersion models as it relates to the SEC system. It is preferable that the model selected and evaluated as part of the SEC system be used as the basis for the EIA. This will enhance the credibility of the model

predictions. AEP requires that models be evaluated on an "ensemble" basis and not a point-by-point basis. An ensemble approach was adopted in our 1992 Suncor report.

Speciality models may be required for selected emissions. For example, the FDM (Fugitive Dust) Model as well as ISCST2 can be used to assess ambient concentrations for wind borne dust emissions.

The prediction of deposition has historically been undertaken using the ADEPT2 model that is no longer supported by AEP. Unfortunately, there is no other model that predicts wet and dry deposition on a local to regional scale basis. The assumptions incorporated into this model have been subject to close scrutiny by intervenors at recent hearings. While the application of the model is relatively straight-forward, additional level-of-effort is likely to be required to address issues prior to any public hearings. The U.S. EPA is in the process of developing a deposition model. BOVAR-CONCORD routinely accesses the U.S. EPA Bulletin Board to determine the status of this model.

Once selected, the models will be used to predict one-hour, one-day and annual average SO_2, NO_2 and particulate concentrations from the existing and proposed emission scenarios. The modeling will address the main stacks, the flare stacks and the secondary stacks. The SO_2 evaluation will be undertaken for two scenarios: Suncor only and combined Syncrude and Suncor emissions. The model predictions will be compared to the ambient air quality objectives to determine "acceptability". The model predictions will be superimposed on regional maps of the area.

The ADEPT2 or equivalent model will be used to predict annual average sulphur equivalent deposition for the existing and proposed emission scenarios. The predicted values will incorporate background deposition and be used to predict AP and EA values that can be compared to preliminary target loadings. The results will be superimposed on regional maps of the area.

The odor assessment work undertaken by Suncor will be reviewed and summarized. When quantification is possible, dispersion modeling will be used to predict the possibility of odor occurrences. This prediction assumes a known source has been identified and the odor threshold of the compound is known.

Air quality changes associated with fugitive dust emissions can be undertaken using the ISCST2 model (or alternatively using the U.S. EPA FDM model). Fugitive dust issues have been identified as being localized and an area of potential interest is the deposition to the Athabasca River.

As outlined in the Workplan, we will summarize the steps taken by Suncor to minimize fuel use and as such reduce CO_2 emissions. We will also estimate the total CO_2 emissions from Suncor's operation based on fuel use. At this stage, we feel the Steepbank Mine EIA should not pursue the greenhouse gas issue beyond this point. The lack of scientific consensus on the greenhouse gas issue as it relates to global warming and climate change makes it difficult to provide a meaningful discussion that will contribute to the EIA process. This type of discussion is best held on a provincial or national level rather than on an individual facility level.

9.3.3 Detailed Work Scope

The workplan tasks presented in this section focus on the data base preparation, assessment and preparation of the air quality component of the EIA. The tasks associated with the required biomonitoring program are outlined in the next section.

Task 5520 Source Characterization

- Identify, characterize and quantify Suncor's point source emissions for the existing and proposed operating scenarios. Point sources include the existing and proposed powerhouse stacks, the flare stacks and the process heater stacks.
- Characterize and quantify fugitive emission sources such as volatilization from the tailings pond, mine area and coke piles.
- Identify, characterize and quantify emissions from off-site sources (e.g., Syncrude) to allow cumulative effects to be assessed.
- Obtain update of existing and proposed plant plot plans, building dimensions and changes to local topographic features (e.g., dykes).

Topography

Update digitized terrain for use in dispersion models. While the scoping document suggested using terrain data from regional habitat modeling, this may not be a realistic approach. Firstly, terrain formats are very specific to the selected dispersion model and secondly, the study area for the air quality assessments is generally much larger than that associated with the regional habitat mapping. Special consideration should address changes in nearby land-forms due to mining and/or tailings operations.

Task 5530 Meteorology

- Prepare a general climate description based on available local and airport data. The level-of-effort for general climate is usually greater for a grass roots development to demonstrate an understanding of potential climate effects on the operation. As Suncor has been operating in the area for a few decades, it can be assumed that Suncor design staff have an understanding of climate extremes that may adversely affect construction and operation.
- Comment on changes in climate that could take place over the life-term of the plant and the impact this may have on the plant operation. General climate models usually focus on average climate changes and not on extreme events. As it is the extreme events that can affect operations and since climate models disagree as to even the average changes, BOVAR-CONCORD will put a low level-of-effort into making the comments specified in the Request for Tender will be minimal.
- The meteorological data collected at the Mannix and Lower Camp towers provide an excellent data base by which the diffusion potential of the area can be determined. The meteorological data base can provide an overall description of air flow and turbulence in the area.
- Enhance the data base for use by the selected dispersion models. This task involves two components: reformatting of data and the estimation of PG stability categories. As with previous assessments undertaken for the area, more than one scheme will be adopted to provide a sensitivity assessment.

Task 5540 Dispersion Modeling

- Existing air quality will be determined by reviewing and summarizing the air quality data collected by the ambient air quality trailers and the static exposure network operated by Suncor. Precipitation chemistry will be based on Fort McMurray data collected by AEP.
- Dispersion model selection and evaluation. The availability of concurrent source, meteorology and air quality data will allow the selected dispersion model performance to be evaluated. In the absence of any evaluation, the model application will be subject to scrutiny. Candidate models include ISCON5 which was tuned to Suncor trailers and RTDM which forms part of the current SEC system. For the shorter process heater stacks,

the ISCST2 model is the preferred model since it can address the required building downwash effects.

- Although the new AEP dispersion model guidelines do not provide recommendations for which model to use for deposition, they do require deposition predictions. The ADEPT2 model has been applied to the area and is the likely model for this EIA. The U.S. EPA is in the process of developing a deposition model but it is not clear if the tested model will be available for this assessment.
- Prediction of air quality changes with respect to hourly, daily and annual average ambient concentrations. The focus will be on those results from point sources.
- Prediction of changes in deposition of sulphur compounds relating to wet and dry removal processes. Converting the predicted values to the acidifying potential and effective acidity concepts introduced by Western and Northern Canada LRTAP and AEP.
- Assessment of fugitive hydrocarbon and sulphur compound emissions and odor potential. Summarize the results of the odor control and assessment work done to date.
- Predictions of fugitive dust emissions on local air quality.
- Comment on greenhouse gas emissions and summarize the steps taken by Suncor to increase energy efficiency and thereby reduce energy consumption. Compare these steps to the recently formulated Alberta industry/government position with respect to CO_2 emissions.

Task 5550 Impact Assessment/Reporting

- Report preparation including the preparation of graphs, figures, tables and text.
- Summarization and determination of impact assessment and communication to other environmental disciplines.

Task 5560 Biomonitoring Program (0ptional)

The Scoping Study requested a regional biomonitoring study focusing on lichens. Specifically, the Scoping Study requires that a lichen biomonitoring program be undertaken in 1995 to complement previous studies conducted in 1987 and 1991. For this component, we have made the assumption that the end deliverable is a stand-alone report for the 1995 survey and that the results will be integrated into the environmental impact assessment.

The objective of a lichen biomonitoring program can be defined as follows:

- Document the current trace element concentrations in lichens and mosses at Suncor biomonitoring study sites in 1995
- To make qualitative observations of lichen morphology to assess the relative vitality of lichen indicator species at each site
- Compare the 1995 results with the 1987 and 1991 results

In June 1987, seventy-six (76) sites were sampled within a 40 km radius of the Suncor oil sands plant. This included samples collected at forty (40) static air monitoring stations maintained by Suncor, and thirty-six (36) soil sampling sites established as part of their forest monitoring program. The cover and vitality of lichens growing on trees and on the ground was also assessed. Samples were analyzed by ICP to determine the concentrations of metals such as Al, B, Cu, Fe, Ni, Pb, S, Th, Ti, V and Zn.

In 1991, the biomonitoring survey was repeated. Samples were collected at the same sites as those sampled in 1987. The samples were analyzed for the content of same elements using the same methodology. The results were compared with those of 1987 in order to identify areas where element concentrations had changed during intervening time period.

In any biomonitoring program is it important that consistency be maintained in the methodology employed. To eliminate as much variability as possible, it is especially important to maximize consistency in the following areas:

- Sampling methodology
- Personnel doing the sample collection
- Personnel assessing the condition of the bioreceptors
- Elemental analysis methodology
- Laboratory conducting the analyses

9.4 Soils, Vegetation and Terrain

9.4.1 Issue Summary

For development of the new leases the following issues related to soils, vegetation and terrain must be dealt with:

Loss of vegetation habitat in the disturbed areas. This can include:

- Direct habitat loss
- Indirect habitat loss/degradation due to inundation and dehydration
- Loss or degradation of vegetation due to increased fire
- Loss or degradation of vegetation due to air emissions
- Loss of rare plants
- Loss or degradation of topsoil
- Soil compaction
- Soil contamination resulting from air emissions and facility operations
- Soil erosion
- Removal of wetlands

The extent of habitat loss by habitat type must be documented in the EIA.

Achieving return of equivalent biological capability during reclamation is required as a reclamation guideline by Alberta Environmental Protection.

Limited availability of reclamation soils may be a problem depending on soil handling and storage procedures and the ultimate reclamation requirement for organic soil layer horizons.

Rare and endangered species may be present in the areas to be disturbed and should be documented.

Wetland habitat impacts will occur as the areas are mined. Equivalent replacement during reclamation will have to be considered.

Mining of the Athabasca River escarpment will affect the aesthetic profile of the east bank of the Athabasca River.

9.4.2 Technical Approach

The collection of baseline biophysical data for the proposed new mine area is fundamental to our understanding of the nature and condition of resources which could potentially be impacted as a result of the New Mine development. Conventionally, the approach used to conduct such studies involves the use of existing literature, aerial photography, fieldwork, data analysis and reporting. In recent years, environmental impact assessment has begun to address more complex spatial and temporal issues such as biodiversity, plus regional and cumulative impacts on both a spatial and temporal nature.

Based on the issue scoping study, our approach will focus on the development of a fully integrated, biophysical data base for the study area using GIS and satellite Landsat Thematic Mapper (TM) technology, complimented by aerial photography, existing data sources (especially map data) and a directed field program. Existing data sources are recognized as valuable resource material which must be utilized in an effective manner. This hierarchical study approach is particularly well suited to biophysical resource description and evaluation. An Ecological Land Classification (ELC) of the study area will be compiled from both existing map data sources and from site specific field programs.

The use of satellite imagery allows us to address both local (mine area) and regional (extended study area) issues and in particular, allows us to address cumulative impacts in a graphic format which is readily updated. Projections of likely development scenarios and potential impacts on biophysical resources can be evaluated in both qualitative and quantitative form. This combination of Landsat TM imagery and GIS technology would provide Suncor with an extremely flexible management tool, and it provides an effective visual display that is readily understood by the public. Further, the use of Landsat TM imagery will allow Suncor to expand the regional study area, and to model for cumulative impact assessment over much larger spatial and temporal boundaries.

Field data collection will be conducted by teams of biophysical scientists. Botanists and soil- terrain scientists will collect site specific information at locations previously identified from remotely sensed data sources. Sampling locations will therefore be pre-stratified according to statistical procedures to maximize the efficiency of the field program. This guided approach to field sampling provides a much

stronger basis for classification accuracy by minimizing human bias in the site selection process, and it has the added advantage of providing an quantitative assessment of the classification accuracy.

In addition to the conventional site descriptive information on landform, soil, forestry and vegetation conditions, data sheets will also be completed on wildlife habitat variables (HEP). Furthermore, systematic observations will be made at each site on species diversity, fire history and degree of existing disturbance or impacts.

A summary of the methodology for each work task associated with the biophysical resource section is provided in the following section.

Initial Vegetation Classification and Mapping

The basis of the biophysical resource assessment program is the preparation of an interactive ELC, for both the local and regional study areas.

A detailed review of the existing literature will initiate the mapping activity and will include a collection and evaluation of all data relating to vegetation, soils, surficial geology, bedrock geology and landforms within the study area. Existing resources presently include: the Suncor Oil sands Group Report (Concord 1991); the Environmental Impact Assessment Issue Scoping Report for Lease 31 and Redwater Upgrader (OSLO 1991); physiographic information (Turchenek and Lindsay 1982); Bedrock geology (Green 1972; Carrigy 1973); oil sands geology (Flach 1984; Keith et al. 1988); surficial geology (Bayrock 1971; Bayrock and Reimchen 1974; Lindsay et al. 1957; and McPherson and Kathol 1977); significant natural terrain features (Westworth 1990); soils (Turchenek and Lindsay 1982; Graecam Enterprises 1992; Knapik et al. 1984; and, Twardy 1978); and vegetation (Rowe 1961; Stringer 1976; Strong and Leggat 1992; Concord 1992; OSLO 1992; Ellis 1991; Thompson et al. 1978; Packer and Bradley 1984; Hardy Associates (1978) Ltd. 1980). This information base will provide an initial understanding as to the existing conditions from which the expected number and nature of vegetation types in the study area can be estimated.

This will be supplemented with airphoto interpretation using 1:20 000 color infrared airphotos to further establish the approximate number of vegetation/landform types in the study area. In addition, a potential rare plant list, and their habitat preferences will be compiled, and information on use of plants by aboriginal peoples will be integrated from socio-economic data sources.

Digital remotely sensed satellite imagery provides the most cost effective means of quantitatively and qualitatively measuring the earth's surficial attributes over large areas. In the context of impact assessments and land reclamation, the analysis of ground-verified satellite data provides critical baseline spatial information on the distribution, and pattern of vegetation species and community types, human land use and disturbances as well as other categories of land cover. These data may then be utilized in more sophisticated multivariate spatial models including potential wildlife habitat mapping, air quality effects on vegetation, and surface erosion modeling among others. Furthermore, the orbital frequency that a satellite passes over the same area allows for a very efficient means of monitoring environmental spatial changes on the landscape over time.

To prepare the maps the Landsat TM data must be extracted from a CD-ROM and imported into an image processing computer environment. These data can then be rectified to 1:20 000 digital elevation models (DEM) in the Universal Transverse Mercator (UTM) projection. Study area boundaries must be delimited and the image segmented to encompass this region in addition to an acceptable buffer of adjacent lands.

The TM image will then be pre-classified for land cover using maximum likelihood, principle components analysis (PCA), or sequential maximum a -posteriori methods. Broad delimitations should represent the main overstory vegetation types if possible, as well as wetland, riparian, and upland units. Developed, denuded or other human effected areas will also be classified where possible. Coarse habitat preference maps will be generated based on selected wildlife species or communities identified as being critical in the wildlife scoping process. The unsupervised classification will then be further divided into topographic subclasses from the DEM, using a GIS.

Additional relevant biophysical information includes soils, surficial geology and bedrock geology information. Existing maps of these layers for the study area will be compiled, where there is sufficient detail to add to study area classification (Turchenek and Lindsay 1982; Green 1972; Green et al. 1970; Bayrock and Reimchem 1974; McPherson and Kathol 1977; Westworth 1990; Stringer 1976; and Ellis 1991). These maps may be digitized as separate layers and geo-referenced to correspond with the TM imagery. If considered useful, each layer may be combined with the TM polygons, to provide a rationale for additional polygon breakdown based on soils, geology, broad vegetation units and/or parent material. This overlay technique allows us to look at relationships between biophysical variables and greatly assists in the development and description of ELC map units.

The resulting polygons and vegetation types will be cross-referenced with airphoto interpretation in order to assess the accuracy and detail of this process. Additional polygons may be added at this time based on airphoto interpretation. In addition, ambiguous or vague polygons and boundaries can be identified for clarification in the field. A list of the vegetation types and their likely dominant canopy species will be compiled, using the results of the mapping, airphoto interpretation and literature review tasks.

As part of the final field study design, the locations of field sites for both vegetation and wildlife sampling will be identified based on a GIS analysis of the digital coverages resulting from the Landsat TM data pre-classifications. Site locations should be systematically and randomly located within class boundaries in order to more effectively and efficiently direct field data acquisition.

Initial Updating of the Phase 3 Forestry Maps to AVI Standards

The main objective for updating the Phase 3 Forestry Maps to AVI Standards, is to achieve a detailed and accurate map of the forestry resources within the study area, from which an accurate and detailed assessment of losses to the forestry resource, due to project impacts, can be measured. For this task:

- All Phase 3 Forestry maps for the study area will also be assembled and reviewed
- These maps will be updated to AVI standards based on airphoto interpretation from 1:20,000 scale colour infrared airphotos. Forest units will be delineated according to species composition, density class, height class and other criteria required for AVI levels of detail
- Appropriate sampling points will be selected from those identified based on computer random selection. Additional sites will be located as necessary, in accordance with access and the field sampling program

Airphoto and Landsat Interpretation for Mapping of Soil Units

In order to identify preliminary soil units within Lease 97/Lot 1 and Lot 3 of the study area, airphoto interpretation is required at a 1:10 000 scale. This will build on the existing literature and soil maps for the region. Mapping will be co-ordinated with the mapping units achieved through Landsat TM imagery classification, and the preliminary ELC generated for the entire study area. Our approach to completing the C&R is again based on maximizing the use of remote sensing information sources in order to pre-classify major soil map units prior to field sampling. Existing topographic maps, landform, soils, and forest cover maps will be digitized as part of the ELC work. Conventional aerial photography will also be used to identify soil map units covering Lease 97, Lot 1 and Lot 3. A hierarchical, GIS approach to

data management and presentation allows us to enlarge that portion of the study area required for more detailed (1:10 000) scale map presentation of soil resources. The map base would therefore consist of the satellite imagery, pre-classified to identify major map units, complimented by conventional air photographic analysis.

Field Surveys and Data Collection - Vegetation and Forestry

The Field Survey component of this project for ELC vegetation assessment, rare plant surveys, forestry data collection and ELC soils data, will be implemented in early to mid summer; in order to sample vegetation at an optimal time for most species identification. A team approach will be taken such that two teams of three will be required to collect the following data components: ELC vegetation description data; Soils data collection for ELC descriptions; Forestry data collection; and, HEP variables.

The field component of this project will require approximately 10 sampling sites for each vegetation/ELC type identified during the pre-field mapping stage. An initial assessment of the number of units to be expected includes the following possible vegetation /ELC types within the study area:

Riparian Zone

- Unvegetated sand/gravel/mud flats
- Herb/grass-dominated lower terraces
- Shrub-dominated lower terraces
- Deciduous (balsam poplar dominated) riparian forest on alluvial sediments (middle and upper river terraces)
- Coniferous (white spruce dominated) riparian forests
- Back water channels, oxbows and wetlands

Wetlands

- Sphagnum bogs
- Black spruce bogs
- String bogs

- Tamarck fens
- Herbaceous fens
- Open water ponds

Upland Forests

- Deciduous forest
- Mixed wood forest
- Jack pine-dominated forest
- White spruce-dominated forest
- White spruce-aspen forest
- Mixed coniferous forest
- Upland shrub communities

In addition to these potential map units, others such as special landform-vegetation complexes, including sand-dunes, bedrock outcroppings, springs, tarsand/vegetation associations, also need to be investigated. Therefore, it is estimated that there will be 15 to 20 mappable vegetation/landform types within the study area.

Vegetation sampling should be organized to collect data for vegetation type description and analysis, as well as for HEP analysis and Forest inventory data. Tasks associated with the fieldwork component of the project will include the following:

- Within each site, one 10 m x 10 m quadrant will be sampled for vegetation cover and composition, forestry data, site conditions and HEP parameters
- At each quadrant, information will be collected to record species composition, strata, percent cover and species vigour. All plant species within the 10 m x 10 m plots will be recorded as to percent cover per strata. The following strata will apply:

  A1 - canopy tree species > 5 m tall
  A2 - understory tree species > 5 m tall
  B1 - tall shrubs 2 - 5 m tall
  B2 - low shrubs <1- 2 m tall

C1 - tall herbs 0.5 - 1 m tall

C2 - low herbs < 0.5 m tall

G - grasses and grass-like species

D - ground cover bryophytes and lichens

E - epiphytes

In addition, each species will receive a vigor rating, using a 4 point scale.

In addition to the standard parameters measured for vegetation description and classification, HEP parameters will also be collected (in consultation with the Wildlife team) in order to model habitat suitability for selected wildlife species. HEP is a method which can be used to document the quality and quantity of available habitat for selected wildlife species. It is estimated that in addition to standard vegetation variables, there will be an additional 20 to 30 variables measured to adequately allow for Habitat Evaluation Procedures. Some of the indices to be collected include:

- Tree stem densities of d.b.h. classes (ocular estimates)
- Shrub stem densities at specified heights
- Percent visibility through various strata
- Number standing and fallen snags
- Percent available browse per species (ocular estimates)
- Shrub distribution type (even, patchy, dense etc.)
- Tree branch spacing

HEP variables may be collected from nested quadrants within the 10 m x 10 m quadrant.

Forestry Data Collection

Variables required for forestry mapping to AVI standards can be collected from within the same quadrant used for HEP and site characterization. Necessary information includes the following:

- Tree density
- Forest height class (to an accuracy of 3 m)
- Forest canopy composition and cover (species specific)

- D.B.H.(diameter at breast height) for dominant and sub-dominate tree species
- Age class of dominant and subdominant tree species

It is apparent that there may be some overlap between the variables collected for ELC characterization, HEP analysis and Forestry data needs. Data collection will be organized so as to eliminate any overlap in the data being collected from each site.

Field Surveys for Soil Data Collection

Two levels of detailed are required for collecting necessary soils data for this project. A general survey of the entire study area will be conducted so as to sample the soil characteristics of the map unit types (ELC types) which occur within the study area. In addition, a more detailed soil survey, to Level 2 criteria, will be conducted in Lease 97 and Lots 1 and 3, in order to meet C&R criteria.

ELC soil profile characterization will be done within the greater study area, soils resources would be mapped at a 1:20 000 scale. This will require representative profile characterization for each of pre-determined map units. Generally at each map unit type should be inspected for soils characteristics at 3 separate inspection points. Each map unit type should also undergo some lab analysis. Soil profile characterization will follow that proposed for Lease 97, Lot 1 and Lot 3. This will include profile descriptions for each horizon including depth, thickness and sequence, colour, texture, structure, consistence, effervescence, stoniness, field pH, mottling and roots. In addition, terrain information will be collected from each inspection site including, slope class, aspect, landform, surface stoniness, surface and internal drainage, extent of erosion, land use and
vegetation class.

The C&R Level Soil Sampling on Lease 97 and Lots 1 and 3 are specific in terms of soil survey procedures and inspection intensity (Alberta Agriculture 1993). The area of interest covers approximately 9.5 sections and require a total of about 400 inspections (at approximately 40 inspections per section).

Soil survey information to be collected at each C&R inspection site, according to the Canadian System of Soil Classification (1987), includes the following:

Soil Survey Intensity (1:10 000) Level 2 - 40 inspections per section

- Profile Characterization for each horizon (topsoil, subsoil and parent material) thickness and sequence:

  - Colour
  - Texture
  - Structure
  - Consistence
  - Effervescence
  - Stoniness
  - Field pH
  - Mottling
  - Roots

- Terrain information includes:

  - Slope class
  - Aspect
  - Landform
  - Surface stoniness
  - Surface and internal drainage
  - Extent of erosion
  - Land use
  - Vegetation class
  - Land use and vegetative

Approximately 50 soil samples from the A and B horizons will be collected and analyzed for organic matter, pH, EC and other characteristics. This data will be entered as part of the site information for each quadrant and mapping unit.

The following lab analysis will be conducted:

- pH
- Saturation percentage
- Electrical conductivity
- Soluble cations
- Sodium adsorption ratio
- Particle size distribution
- Total nitrogen
- Total organic carbon
- Cation exchange capacity
- Exchangeable cations
- Gypsum
- Calcium carbonate equivalent

At a lower level of intensity, these analyses will also be conducted for the remainder of the study area, outside of Lease 97/Lot 1 and Lot 3. This will aide in ELC characterization and mapping, as well as the development of mitigation and reclamation planning. Approximately 1 sample for each ELC type is recommended, resulting in a total of 15 to 20 samples, for the study area.

Data Analysis, Map Finalization and Baseline Report Preparation - Vegetation and Forestry

The following objectives are identified for the analysis of the field data:

1. Revise the TM imagery map to incorporate new and altered polygons
2. Describe the vegetation characteristics, including consistencies and variation within the identified vegetation types, utilizing both descriptive and analytical techniques
3. Describe the forestry resources within the study area, based on the up-dated Phase 3 Forestry maps
4. Describe the soil consistencies and variation within the vegetation types, using both descriptive and analytical methods
5. Implement an Accuracy Assessment of the TM classification based on field data
6. Produce a finalized map of vegetation - ELC types in the study area, with map unit descriptions

The initial vegetation, land use, timber and land cover classification maps will be updated based on the collected field data. The resulting digital maps will provide a baseline spatial distribution of a number of environmentally significant variables including:

- Dominant canopy vegetation
- Dominant understory vegetation (where visible)
- Human developed and disturbed areas
- Areas of vegetation stress
- Water resources
- Critical wildlife habitat
- Soil map units

All of the collected field data for vegetation, HEP and Soils will be entered into dBASE, for data storage and data analysis. It is estimated that each site will have at least 50 fields including vegetation species data, HEP variables and Soils data.

Biophysical Impact Assessment and Mitigation

The following impacts on vegetation related to the New Mine Development will be assessed:

- Loss of surface area of each vegetation type due to mine development
- Loss of vegetation types due to inundation or dehydration resulting from alteration of drainages
- Loss or degradation of vegetation resulting from increased fire
- Loss or degradation of vegetation due to air emissions
- Loss of economic resource related to vegetation loss/degradation

A VEC (Valued Ecosystem Components) selection for vegetation species and communities will be conducted, building on the literature review and on the mapping units. A four step process will likely be adopted including: The selection of evaluation criteria, the identification of candidate VEC vegetation species and communities within the study area, the assignment of importance values to vegetation types based on the evaluation criteria, and the selection of the key indicator vegetation species or communities based on the overall evaluation.

The evaluation criteria for VECs selection typically involves an assessment of the following characteristics for each candidate species and vegetation community: abundance, rarity, ecological importance (sensitivity to physical disturbance), sensitivity to pollutants, economic importance, recreational importance, suitability for reclamation, information availability, diversity and rare plant potential.

The impact assessment for vegetation will include calculation of habitat loss for each of the ELC units, and interpretation of these losses relative to the impact on VECs.

Soils and Terrain Impact Assessment

A calculation as to the potential loss of soil resources will be derived using GIS, and the proposed development plan. Loss of soil units will be calculated, and converted to the expected loss of soil capability types.

Loss of Forestry Resources

Using the updated Phase 3 Forestry Maps (to AVI standards) overlaid with the proposed development plan, the loss of specific forestry resources will be calculated, using GIS technology. This will form the basis of the forest salvage plan, based on species-specific volumes of merchantable timber to be removed during project construction.

Assessment of Impacts to Vegetation due to Air Emissions

The final air emission model outputs will be overlaid with the ELC map in order to generate the potential areas of impact due to air emissions. The assessment will be based on species tolerances to the emission chemicals, chemical concentrations across the regional study area, and the extent of cover of those species being modeled. This will rely heavily upon the existing air impact studies that have been completed in the region over the last few years.

Soils and Vegetation Mitigation and Reclamation Planning

Reclamation assessment for the EIA will be landscape-based and will utilize site-specific biophysical information on terrain, soils and vegetation.

A key factor will be the investigation of self-sustainability of revegetation efforts. The intent would be to develop reclamation management plans specific to end land use objectives for the new mine. The data

base would incorporate ELC mapping and description at a regional level, while specific soils information would be assessed from the C&R survey (1:10 000). Ancillary data, incorporating such resources as surficial geology, forest cover and soils capability for forestry, as well as wildlife habitat (based on HEP analysis) would also form part of the data assessment program.

Part of the reclamation plan for soil resources will build on the data analysis on soil capability and concerns, generated by Can-Ag. Reclamation alternatives will include capability of various reclaimed profiles for different applications, planning of soil handling techniques to optimize quality and minimize handling costs, and soil reconstruction/augmentation plans to enhance capability.

9.4.3 Detailed Work Scope

Task 5610 Project Initiation

Task 5620 Ecological Land Classification (ELC) Mapping

Objectives: Establish existing biophysical conditions for the Baseline Study Area, and the EIA Project Area (Figure 1). In addition, describe general biophysical conditions for the Regional Study Area (Figure 2).

Tasks:

- Collect and review existing biophysical literature for the study area, including all map and relevant file data
- Acquire and process satellite imagery for the study area and compile existing aerial photography
  - Define boundaries and presentation map scales for the Baseline, EIA Project Area and Regional Study Areas
  - Evaluate complimentary use of existing aerial photography (photo mosaics ?)
  - Complete satellite data processing, initial classification of vegetation types and ELC types

- Estimate the number of vegetation and ELC types expected in the Baseline Study Area and define biophysical VECs necessary
  - Use initial typing information, complimented by ancillary data. Types and subtypes should be delineated for both the Baseline Regional Study Area (a hierarchical classification scheme)
  - Incorporate input form literature and stakeholders on VECs
  - Identify specific VECs for detailed mapping and field investigation
- Produce initial ELC and vegetation types of the Baseline Study Area using remotely-sensed imagery, in both digital and hard copy format
  - Integration of existing and new data sources to produce both ELC and vegetation maps for the Baseline and Regional Study Area
- Digitize hydrography, soils, surficial and bedrock geology layers. Overlay and geo-reference these layers with vegetation types
  - Utilize ancillary data sources acquired in Subtask 1 to develop the biophysical database
  - Use overlay techniques to describe interrelationships between biophysical elements of the tarsand environment
- Cross-reference vegetation types and boundaries in the digital file with remote-sensing interpretation and establish preliminary vegetation and ELC community names
  - Prepare hierarchical classification to be applicable to the Baseline and Regional Study Areas
  - Incorporate requirements of wildlife habitat mapping
- Based on literature sources, identify potential rare and native use plants in the study area and assess the potential of each vegetation type to support them (H, M, L)
  - Identify potential areas on field maps for subsequent field investigation
- Select initial field sampling sites
  - Stratify sampling according to number and areal extent of map units - focus on EIA Project Area.
  - Review with wildlife group

Deliverables: A draft report describing the methods and results of the biophysical mapping component and a description of the mapping units initially created, including:

- Summary of the literature in terms of the biophysical environment including vegetation, soils, surficial geology, bedrock geology and hydrology
- Initial vegetation and ELC description of the Baseline Study Area including a hard copy and a digital file
- A description of the ELC types expected in the Baseline Study Area, based on the pre-field classification, including an estimate of vegetation dominants, physical site characteristics, and percent cover and area (ha) of each map unit within the study area
- An assessment of the potential rare and endangered plant species and important ethno-botanical species in the Baseline Study Area and the potential of each habitat type to support such species
- A stratified field sampling program

Task 5630 Forestry Mapping

Objective: Update Phase 3 Forestry Maps to AVI standards for the EIA Project Area. Select field sampling sites for ground-truthing in concert with the ELC site selection process.

Tasks:

- Using 1:20,000 airphotos and satellite imagery data, update forest cover type map units on the Phase 3 Forestry Maps
- Select field sampling sites based on the updated mapping scheme, in order to acquire detailed forest inventory information for new and altered forest cover units

Deliverables: Update Phase 3 Forestry Maps for the EIA Project Area.

Note - An option to use 1 to 100,000 scale forestry mapping, completed for ALPAC is being evaluated. This would provide complete coverage for the entire Regional Study Area.

Task 5640 Vegetation Sampling

Objectives: Collect vegetation and site data to finalize ELC mapping within the Baseline Study Area.

Tasks:

- Conduct a detailed systematic vegetation inventory of ELC units
- Conduct a rare plant survey focusing on areas of high potential
- Identify plant species of importance to the aboriginal community, and investigate historical gathering locations within the Baseline Study Area (coordinate with Historic Resources Task)
- During the collection of biophysical parameters, the soil and vegetation technicians will also record those parameters necessary for Habitat Evaluation Procedure (HEP). They will also collect forestry information necessary to upgrade the Phase 3 Forestry Maps to AVI standards for the EIA Project Area
- Following completion of the field program, the initial ELC maps produced in Task 1 will be assessed for their accuracy, updated and finalized

Deliverables:

- An interactive, biophysical database (dBASE) documenting site, soil, terrain, vegetation and HEP variables associated with each ELC type for the Baseline Study Area. A more detailed ELC map (at a greater level of resolution) will be produced for the EIA Project Area
- Field verified ELC map with detailed ELC descriptions, analysis and evaluation
- Documentation of species important to the aboriginal community and known locations
- Documented rare plant species and locations, and an assessment of the rare plant potential of each ELC unit
- ELC map in both hard copy and digital format

Task 5650 Soil Sampling

Objectives: Conduct a soil survey which meets C&R specifications for Lease 97 and Lots 1 and 3. Field Truth ELC Map Units throughout the Baseline Study Area.

Tasks:

- Conduct a soil survey of Lease 97 and Lots 1 and 3 at an intensity of approximately 40 samples per section. This should be focused on the ore bodies within the study area
- Conduct a soil survey throughout the remainder of the Baseline Study Area in order to acquire adequate data for accurate soils mapping and future soils reclamation/ reconstruction needs
- At selected sampling locations, conduct a detailed (test pit) profile characterization of soil properties including topsoil and subsoil depths. These control sites should be complimented by a series of inspection points
- Submit soil samples for laboratory analysis as required

Deliverables:

- A stand alone C&R level soil report including detailed soil map (1:20,000 scale) and soil map unit descriptions for Lease 97 and Lots 1 and 3
- An appendix of soil profile data, including soil physical and chemical properties
- For the rest of the study area include a detailed soils database for the mapped soil units. This information will form a component of the final ELC map units and accompanying descriptions

Task 5660 Impact Assessment and Reporting

Objectives: To quantify and asses the loss/changes to terrestrial biophysical resources including: landforms, soil capability, plant cover vigour, vegetation community structure, composition and diversity associated with mining and development activities for the Steepbank Mine. To estimate impacts on biophysical resources in non-mined areas.

Tasks:

- Quantify the direct loss of each vegetation-landform unit (ELC's) due to mining developments and assess its significance
- Quantify the loss of biophysical Valued Ecosystem Components (VECs) and assess its significance
- Quantify the loss of each ELC type and VECs to be affected from other direct development-related activities and assess its significance
- Evaluate the potential impact on each ELC type and VECs within the Regional Study Area, due to air emissions
- Quantify the loss of merchantable timber within the EIA Project Area (species specific), based on the updated Phase 3 Forestry Maps
- Identify the nature extent of residual impacts to the biophysical resource
- Identify potential cumulative impacts and regional impacts on biophysical resources within the Regional Study Area

Deliverables:

- An independent assessment of the nature, degree and extent of direct impacts on the biophysical resources of the study area
- An evaluation of the potential impacts to VECs, due to both direct and indirect disturbances
- An assessment of the impacts to forestry resources
- An assessment of the impacts to soil resources
- An evaluation of cumulative and regional impacts using remote sensing technologies and existing data sources
- An evaluation of the residual impacts to biophysical resources

Task 5670 Mitigation

Objectives: to identify potential mitigation measures to reduce or minimize biophysical impacts as a result of mining operations.

Tasks:

- Compile a series of mitigation options, in conjunction with Suncor personnel, to limit the extent of impact or to avoid sensitive areas
- Provide site-specific timber and soil resource information for subsequent preparation of a Conservation and Reclamation Plan for Lease 97, Lots 1 and 3
- Provide a database of biophysical information (including soil physical and chemical data) which can be used in subsequent reclamation research and planning

Deliverables:

- A summary report on mitigative strategies to minimize impacts on biophysical resources

9.5 Wildlife

9.5.1 Issue Summary

Wildlife issues related to the proposed new mine development can be logically divided into those concerning (1) the construction and operation phase and (2) the reclamation phase. Within the construction and operation phase, issues can be further subdivided into those concerning direct mortality, indirect mortality and biodiversity.

Construction and Operation Phase

Increased access can lead to increased hunting, poaching and trapping. It is generally recognized that new access into previously inaccessible areas can disrupt wildlife populations through increased legal and illegal hunting and trapping.

Removal of problem wildlife (bears, beavers). Bears can be attracted to garbage at camps and at landfills. This can lead to bear - human interactions which often leads to either the death or translocation of the offending animals. Translocation of bears often is ineffectual, as the bears either return or experience mortality en route. Beavers often become a problem when they block culverts and flood lands. These 'nuisance beavers' often have to be removed.

Increased vehicle - wildlife collisions. Increased traffic levels both on and off the new leases could result in increased vehicle - wildlife collisions. Wildlife most susceptible to this would include ungulates, porcupines and owls.

Facilities - wildlife collisions (e.g., avifauna). Birds are susceptible to mortality through flying into power lines, emission stacks and other structures.

Forest fires. Forest fires caused by construction activities could kill animals on and off the development site. Moreover, these forest fires could result in large-scale changes to the current vegetational communities in the area.

Changes in predator populations. Predator populations can change in size and/or distribution as a result of the development. This could result in impacts to prey populations. For example, ploughed roads in winter are often used as travel corridors by wolves and coyotes, giving then to access to previously inaccessible areas.

Tailings ponds. Animals could be affected through ingesting or being coated in new tailing pond liquids. This is especially a concern for waterfowl, shorebirds and other water birds. For example, waterfowl and shorebirds could use the tailings pond during migration.

Habitat loss. The development of the new lease areas will result in the removal of vegetation communities, thereby changing the availability and quality of terrestrial wildlife habitat in the region. Consequently, there will be a direct loss of wildlife habitat. Animals that are displaced to adjacent, undisturbed areas may find these areas already occupied and mortalities may result through interaction with resident animals or through lack of food resources. Habitat losses can be permanent (e.g., construction of a permanent highway) or temporary (e.g., areas mined for tar sands will eventually be reclaimed).

Habitat alteration (e.g., air emissions, impeded drainage, etc.). The quality of a habitat also can be changed such that it can support fewer (or greater) numbers of animals. Habitats can be changed through the impacts of air emissions, aquatic pollutants, changes in drainage patterns, creation of power line or road right-of-ways, etc. Habitat fragmentation could occur creating relict habitats that are unsuitable for sustaining species.

Indirect habitat loss through displacement caused by disturbance (e.g., noise, visual stimuli). The effectiveness of a habitat can be decreased through auditory, olfactory and visual disturbance even though the physical characteristics of the habitat may remain unchanged. The end result is that, although the habitat is physically suitable, wildlife do not use it due to its proximity to these disturbances.

Harassment. Harassment can be defined as any activity that precipitates excitement in an animal, and causes it to prepare itself physiologically for flight (Geist 1975). This can result in increased levels of stress and energy expenditure, disruption of feeding and/or mating behaviour, etc., which in turn can lead to increased mortality and/or lower reproductive rates.

Barriers to movements (particularly blockage of movement corridors); habitat fragmentation. Expansion into the new lease areas might create movement barriers to certain wildlife species such as lynx, black bear, wolf, white-tailed deer or moose. If the expansion does create a barrier(s) to movement, it could result in: (1) decreased gene flow between segments of a population; (2) preclusion of movement to critical habitat such as summer range, winter range, denning areas, etc.; or (3) localized extinctions due to restricted movement. Any of these conditions would result in reduced populations within the region. Barriers to movements can take the form of roads, ploughed snow berms and buildings; the mining operations also could act as an impediment to movement.

Changes to landforms. Landforms can influence animal habitat directly (e.g., use of eskers or valleys as travel routes) or indirectly (e.g., landforms play a large part in what vegetation communities develop on a site). Modifying those landforms through grading, mining, etc. could have detrimental impacts to wildlife habitat. Mining of the Athabasca River escarpment could impact wildlife movement along the river.

Reclamation Phase

Problems with re-establishing habitat to achieve 'no net loss'. Microtine rodents (e.g., meadow voles) have been a problem on some reclaimed sites as they girdle the seedlings planted. Raptor nesting sites have been placed at locations within Suncor's lease 86 to increase the local population of raptors and hence decrease the local populations of microtine rodents.

Reclamation of disturbed sites should not only attempt to achieve revegetation, it should eventually come close to duplicating the habitats that existed prior to the disturbance taking place. Thus, the planting of

agronomic species should only be regarded as a first step in the reclamation process. Pre-disturbance conditions must be quantified in sufficient detail such that the success of reclamation can be evaluated. Habitat Suitability Index models (USFWS 1980) are one means of quantifying habitat values for species pre and post disturbance.

Allow for or promote speedy recolonization of reclaimed areas by animals, such that pre-disturbance levels of biodiversity are achieved. A reclaimed area may be suitable habitat for a species but still serve no purpose if the species has been extirpated from a sufficiently large area that it cannot recolonize the habitat. Careful planning of the location and phasing of the mining operations to retain wildlife corridors and refugia is required to allow for successful recolonization of the reclaimed habitat.

Close or reduce access. Access control in reclaimed areas is often essential to reduce levels of hunting, poaching and trapping.

9.5.2 Technical Approach

Preliminary Ecosystem Classification and Mapping

As a basis for stratifying sample effort in the study area and for assessing potential impacts associated with the proposed oil sands development, there is a definite need to classify and map the ecological resources of the study area at an operationally-practical scale. Previous mapping projects have classified vegetation and habitat types in the study area at scales of 1:100,000 or smaller. Although previous mapping projects such as the vegetation classification of the AOSERP study area and a wildlife habitat classification of a 55,000 km^2 area of northeastern Alberta recently completed by D.A. Westworth & Associates Ltd. will provide a useful starting point for initially stratifying the study areas for the February winter field work, more detailed mapping (e.g., 1:20,000) is required. A more detailed ecosystem classification map will be based on the availability of suitable aerial photographs and/or enlarged Landsat imagery. The interpretation of the aerial photographs and Landsat imagery will be assisted by reference to existing surficial geology, soils, and vegetation/forest cover maps. The ecosystem classification map will provide information on landforms, surficial materials, and vegetation, which will form the basis for classifying the Suncor study area into current wildlife habitat suitability units for the species considered to be Valued Ecosystem Components. Areas representative of the range of ecotypes found within the Suncor study area will be selected for detailed sampling in the field. In

addition, areas with high potential for sensitive features (e.g., raptor nesting sites or major moose wintering areas) will be identified.

Finalize Baseline Data Collection Program

Specific protocols for collecting data at the local (e.g., Suncor's leases) and regional scales will be developed. Data will be collected for a number of purposes:

- To verify the preliminary ecosystem classification
- To provide ecological attribute data for the various units of the ecological land classification (e.g., species composition of vegetation, characteristic wildlife species)
- To provide a baseline for the monitoring of change

The types of data sets required for each purpose are different and careful thought is necessary to identify the specific data requirements for each. Data coding sheets will be designed to ensure consistency of data collection and to facilitate subsequent computerized handling of the data (e.g., input to GIS database, statistical analysis).

Execute Baseline Inventory Program

To a large extent, the timing of the baseline inventory program is scheduled to coincide with the phenology of important biological events (e.g., important late winter areas for moose) and as a result, most of the field work will be conducted during five main periods in 1995:

- Early winter (e.g., November) track surveys of ungulates, carnivores, and terrestrial furbearers and a winter bird survey
- Spring (May) for ungulate and hare browse and pellet group surveys, waterfowl staging surveys and raptor surveys
- Late spring (late May-early June) and early summer (July) for breeding bird, breeding herpetofauna, terrestrial insects, small mammal surveys
- Fall waterfowl staging and beaver aerial surveys
- Late winter (February) track surveys of ungulates, carnivores, and terrestrial furbearers and a winter bird survey

Because the late winter track surveys are dependent on suitable snow conditions, work on this component of the baseline inventory program will be started on a priority basis.

The methodologies discussed below represent current scientific sampling protocols, will withstand peer review and are completely defensible. Many of these methodologies were used by D.A. Westworth & Associates Ltd. in several recently completed environmental impact assessments that have undergone provincial and federal regulatory reviews. The various activities associated with the proposed field program are briefly described below.

Winter Track Surveys

Although trapping is an important land use activity in northeastern Alberta, the status of most of the resident furbearing mammals is poorly understood. Little information exists regarding the species present in the area, or their relative abundance and distribution. Winter track counts are the most effective method for censuring furbearers, and if conducted under carefully controlled sampling protocols, can provide a good method of monitoring changes in populations over time. Winter track counts in the Suncor study area would involve transect surveys conducted along predetermined survey lines stratified by habitat type.

Track count surveys will be conducted in mid- and late winter 1995 to determine the abundance of ungulates, carnivores and terrestrial furbearers in major habitat types in the project area. Stratified track count transects will be established in representative habitat types across the study area. Observers traveling on foot (snowshoes or cross-country skis) or snowmobile will record the number of sets of tracks of each species that intersect the transect, along with pertinent data on habitat and snow conditions. All track counts will be standardized by backdating to the most recent snowfall sufficiently deep to cover animal tracks and calculating track frequencies in terms of the number of tracks/km/track-day.

Ungulate Aerial Surveys

Aerial surveys will be conducted in early and late winter 1995 to determine abundance and distribution of moose and other ungulates in the project area. The aerial surveys will employ a standard methodology, which includes the use of sightablility correction factors (Gasaway et al. 1989). Because of the effect search effort has on ungulate sightability, particularly in coniferous dominated areas, sightability correction factors are used to correct population estimates for moose and deer, providing a

degree of precision that is not obtained during simple transect aerial surveys. The method involves randomly selecting a number of small search areas (e.g., 4-8 km^2) within the study area and re-surveying these areas at a more intensive manner. Gasaway et al. (1989) recommend an intensive search effort that is approximately 2.5 time the standard survey effort. This type of aerial survey is the current scientifically-accepted method for censuring ungulates, providing 95% confidence interval around the population estimate. This methodology has been successfully used by D.A. Westworth & Associates Ltd. in assessing ungulate population trends in relation to Esso's Cold Lake Heavy Oil Project in northeastern Alberta (Brusnyk et al. 1990). Surveys will be conducted by helicopter using two observers and an observer/navigator. Surveys will be flown at an altitude of 100 to 120 m and an airspeed of 100-120 km/hr along flight lines spaced at 0.4 km intervals. In addition, information on river otter distribution (as indicated by tracks) and other direct sightings of wildlife (e.g. wolves) will also be recorded opportunistically during the aerial surveys.

Winter Bird Survey

While most of the bird species that breed within the Suncor study area are migratory, a number of species, such as the great horned owl, snowy owl and black-capped chickadees, are likely present in the study area year round. Although present in smaller numbers, these species represent a unique faunal group, with specific habitat requirements that should be considered in the proposed study design. Information on this group of birds is lacking and as a result, a winter bird survey to determine the species composition and abundance of winter bird communities in different habitat types should be undertaken. For logistical efficiency and budgetary considerations, this survey can be conducted in conjunction with the winter track counts.

Browse Surveys and Pellet Group Counts

While aerial surveys will provide information on the early and late winter distribution and abundance of ungulates within the Suncor study area, they do not serve as an accurate measure of carrying capacity and habitat use. Browse surveys and pellet groups counts are used as a method of quantitatively measuring forage availability and habitat use by ungulates as well as snowshoe hares and in conjunction with other types of information such as habitat type, and land use pattern, provides an index of habitat suitability. Habitat suitability is a criterion used in assessing the potential impacts of various types of resource developments on local ungulate populations.

Based on the preliminary ecosystem map, browse and pellet group transects will be established in representative habitat types within the Suncor study area. A minimum of 25 10 m^2 circular browse plots and 25 50 m^2 pellet group plots will be placed at 25 m intervals along each transect. Any stem between 0.4 m and 2.5 m in height and less than 3.0 cm in diameter at breast height will be considered as available browse. A twig of available browse in each plot will also be undertaken and the species, number of browsed (ungulate vs. hare) and unbrowsed twigs (greater than 2.5 cm long) will be recorded. Browse production (stems/ha) and utilization (browsed twigs/ha) will be calculated for ungulates and snowshoe hares.

Avifauna Surveys

Avifauna surveys will include both aerial and ground-based survey techniques. Lakes and watercourses (rivers and streams) will be surveyed for breeding waterfowl and colonial nesting birds in late May or early June using a helicopter. The waterfowl surveys will be designed to include the peak spring and fall migration periods. The peak migration periods will be determined in close consultation with Canadian Wildlife Service and Ducks Unlimited biologists. In addition, breeding pair survey will also be conducted in spring to determine breeding success. A helicopter survey of shorelines of lakes and watercourses in the study area will also be undertaken in spring, just prior to leafing of deciduous trees, to identify active nesting locations of ospreys, bald eagles and other raptors.

Ground surveys of breeding birds in various habitat types in the study area will entail use of the variable circular plot method described by Szaro and Balda (1982). Bird species will be identified by song or by sight in a 15 minute count period and within a 60 m radius of the plot centre. Horizontal distances from the plot centre are then estimated for each bird observed or heard and densities, reported as the number of males observed/ha will then be calculated. To ensure that a complete species list of the Suncor study area is created, all birds observed or heard between sample plots as well as those outside of the 60 m radius will also be recorded. The results of the breeding bird surveys will provide a data base on species composition and relative abundance of breeding birds in major habitat types within the Suncor study area.

Herpetofauna Survey

The distribution and abundance of amphibians and reptiles are not well understood in Alberta. Recent droughts have changed distributions dramatically and in most cases, current data do not exist for the area. Spring surveys will be conducted within representative areas containing potential breeding habitat.

Frogs and toads attract potential breeding partners with territorial songs which are characteristic of each species. These breeding songs can be used to inventory frogs and toads which are normally difficult to census. Potential breeding habitats will be identified by air-photo interpretation and inventoried in spring during the peak breeding season using similar methods described by Roberts et al. (1979) in an inventory of amphibians and reptiles in the AOSERP study area. One of the study team members conducted these inventories and is familiar with the sampling methodology and vocalization of amphibians in the vicinity of the proposed Suncor study area.

Beaver Aerial Survey

An aerial survey will be conducted in October 1995 to determine the locations and densities of beaver colonies within the project area. The survey will be conducted by helicopter using two observers and a navigator/recorder. All streams, wetlands and the shorelines of lakes will be systematically searched for beaver lodges and food caches. Locations of muskrat houses and other incidental observations will also be recorded. The presence of a food cache will be used as the criterion for distinguishing active colonies from inactive colonies.

Rare and Endangered Species

Any rare or endangered species that may potentially occur in the study area (e.g. wolverine, woodland caribou) will be determined by a review of current status lists maintained by Alberta Environmental Protection (AFLW 1991) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1994). Locations or sightings of any rare or endangered species will also be solicited from knowledgeable individuals such as federal/provincial biologists, trappers, and local naturalist and fish and game clubs and will be recorded opportunistically during field surveys conducted by the study team.

Final Synthesis of Data

This phase involves the consolidation of all office and field data collected during the course of the information retrieval and field data collection components of the study into the final form that will be used to support the impact assessment and mitigation planning phase. The data synthesis phase involves the following tasks:

- Determination of current habitat suitability
- Geographic information system mapping and modeling
- Description of existing environment

Determination of Current Habitat Suitability

Habitat Evaluation Procedures (HEP) will be used to quantify habitat losses for VECs expected to result from the construction and operation of the proposed new mine site and associated facilities. These procedures were developed by the U.S. Fish and Wildlife Service (USFWS 1980) as a method to quantify changes in wildlife habitat carrying capacity resulting from resource development. HEP models are appropriate for two types of wildlife habitat comparisons (USFWS 1980), which can be combined to quantify the impact of habitat alteration on wildlife carrying capacity. HEP can be used to compare the carrying capacity of different areas at a single point in time and/or the carrying capacity of the same area at different times. In the context of the proposed Suncor mine site, HEP will be used to compare carrying capacity of different habitat types for each of the VECs at a single point in time (e.g., 1995).

The application of HEP for any wildlife species involves a combination of ecosystem/habitat mapping and the field measurement of important life requisite variables to be used in the evaluation. The selection of appropriate variables depends on an understanding of the ecology and habitat requirements of the species under consideration. Because the requirements and preferences of a wildlife species may vary by geographic location, field studies are required to determine the importance of various habitat features to local wildlife populations. Once the important habitat variables have been identified, they are quantified through measurements in the field. These data are used to develop Habitat Suitability Index (HSI) models, which provide a numerical evaluation of the carrying capacity of each habitat type. HSIs may range from 0 (habitat of no value) to 1 (optimum habitat). Multiplying the area of each habitat type by the corresponding HSI value and then summing the values of all habitat types in the project area, provides a measure of habitat supply expressed as Habitat Units (Hus).

Description of Existing Environment

A comprehensive description of the existing environment within the proposed Suncor study area will then be prepared based on the information review and baseline environmental components of the study. All information obtained from the literature review and field surveys will be summarized and compared to determine the current status of wildlife populations in the project area. Key results of this data synthesis may include but will not be limited to:

- Community composition for ungulates, terrestrial and semi-aquatic furbearers, waterfowl, terrestrial birds, herpetofauna, and terrestrial insects
- Relative abundance of individual species

- Distribution of individual species within the project area
- Identification of important habitats and/or concentration areas for these species
- A review and analysis of existing trap line returns

It is also expected that the following map-based products will be produced:

- A final ecosystem classification map showing landform and vegetation features
- An overlay showing the locations of sensitive wildlife features such as raptor nests, ungulate winter concentration areas, and any locations of rare or endangered wildlife species
- Overlays showing current habitat suitability ratings for moose, deer, furbearers, etc.
- Locations of sample transects and special features such as important wildlife concentration areas, movement corridors, or other special or sensitive landscape features
- Distribution maps for each species of interest within the project area

Environmental Impact Assessment

The environmental impact assessment phase of the study is designed to ensure that all potential impacts of the proposed new mine are identified and assessed in accordance with the requirements of Alberta's Environmental Protection and Enhancement Act. The following approach to assessing environmental impacts has been successfully used by D.A. Westworth & Associates Ltd. in a number of project EIAs the firm has participated in or conducted in the past. The EIA framework, however, will be finalized in close consultation with the Golder Associates and Suncor representatives at a later date. The impact assessment phase involves the following tasks which are described briefly below:

- Assess Impacts
- Identify Mitigative Measures
- Identify Residual Impacts

9.5.3 Detailed Work Scope

Task 5710 Project Initiation/Planning

Objectives: Finalize scope of study and study boundaries, integration of the wildlife component into the EIA, and ongoing liaison with Suncor Inc. and Golder Associates.

Tasks:

- Project initiation and site orientation
- Meeting to finalize study scope and boundaries
- Meeting with Golder Associates to review proposed work program and scope of EIA
- Development of revised work program in accordance with format outlined by Golder Associates
- Implementation of reporting and cost control procedures as required by Golder Associates
- Implementation of e-mail system to interface with Golder Associates and other sub-consultants
- On-going meeting with EIA Project Manager

Task 5720 Preliminary Investigations

Subtask 5721 Information Review and Compilation

Objectives: To compile and review existing information relevant to the project.

Tasks:

- Review available published and unpublished reports, maps, and inventory information available from government agencies, universities and private sector sources
- Review trapping statistics for trap lines in the study area
- Review existing impact data and impact mitigation programs with respect to oil sands development

Deliverables: Preparation of a review of historical information relevant to wildlife in and around the Steepbank Mine project area.

Subtask 5722 Identification of VECs

Objectives: To identify valued ecosystem components (VECs) relevant to the project.

Tasks:

- Compile a list of rare and threatened wildlife species in the vicinity of the project area
- Participate in a public consultation process to identify species or issues of local or public concern
- Liaison with federal and provincial officials and other stakeholder groups
- Finalize list of VECs

Deliverables: Component report indicating the rationale used in the selection process along with the final list of VECs.

Task 5730 Winter Surveys

Subtask 5731 **Late Winter Aerial Survey**

Objectives: To document late winter distribution and habitat use patterns of ungulates in the project area.

Tasks:

- Prepare survey mapping existing air photo coverage for the project area
- Conduct helicopter survey using standardized aerial survey methodology
- Develop sightability correction estimates
- Calculate population estimates
- Prepare maps showing late winter distribution of ungulates

Deliverables: Component report describing distribution and late winter abundance of ungulates in relation to habitat type and lease areas.

Subtask 5732 Early Winter Aerial Survey

Objectives: To document early winter distribution and habitat use patterns of ungulates in the project area.

Tasks:

- Prepare survey map using existing air photo coverage for the project area
- Conduct helicopter survey using standardized aerial survey methodology
- Develop sightability correction estimates
- Calculate population estimates
- Prepare maps showing late winter distribution of ungulates

Deliverables: Component report describing distribution and early winter abundance of ungulates in elation to habitat type and lease areas.

Subtask 5733 Winter Counts

Objectives: To document use of the Steepbank study area by furbearers and ungulates by habitat type.

Tasks:

- Establish track count transects in representative habitat types throughout the study area
- Conduct repeated surveys of track transects to determine the abundance of ungulates, carnivores and terrestrial furbearers in major habitat types
- Record pertinent data on snow conditions and habitat characteristics in each habitat type
- Standardization and analysis of data to determine track frequencies in terms of the number of tracks/km/track-day within each habitat type

Deliverables: Component report on late winter habitat use by ungulates, carnivores and terrestrial furbearers.

Subtask 5734 Winter Bird Counts

Objectives: Determine the species and relative abundance of winter bird communities within the Steepbank Mine study area.

Tasks:

- Conduct systematic surveys for birds along transects established in representative habitat types within the study area
- Calculate densities and/or relative abundance of winter bird species for each habitat type

Deliverables: Component report describing species composition, diversity and abundance of winter bird communities within the Steepbank Mine study area.

Subtask 5735 Trapping Study

Objectives: To obtain detailed information traditional land use as it relates to trapping.

Tasks:

- Compile trapping information for registered trap lines in the Steepbank Mine study area
- Contact trappers and accompany them on their trap lines during the winter trapping season
- Record information on trapping methods, locations of cabins, trails, cubbys and traditional trapping locations as well as information on locations of important hunting areas, and berry picking areas

Deliverables: Component report that documents the methodology and results of the study including maps showing trap lines and locations of cubbys and trap sets. An assessment of the relative impact of proposed mine areas on trapping areas will also be made.

Task 5740 Spring Surveys

Subtask 5741 Browse Survey/Pellet Group Count

Objectives: To provide accurate measures of ungulate carrying capacity and habitat suitability for use in habitat suitability modeling.

Tasks:

- Conduct a browse survey and pellet group count along transects established in representative habitat types in the Steepbank Mine study area
- Summarize and analyze field data to determine levels of browse projection and use by ungulates and hares
- Summarize and analyze field date to determine patterns of habitat use by ungulates and hares

Deliverables: Component report describing sampling and analytical methods along with an assessment of carrying capacity and habitat suitability for ungulates and hares.

Subtask 5742 Breeding Bird Survey

Objectives: To determine the species composition, species diversity and relative abundance of breeding birds within the Steepbank Mine study area.

Tasks:

- Conduct systematic surveys for birds along transects established in representative habitat types within the study area
- Calculate densities and/or relative abundance of breeding birds for each habitat type

Deliverables: Component report describing species composition, diversity and abundance of breeding waterfowl, colonial nesting birds and raptors along the Athabasca and Steepbank rivers and other watercourse and /or water bodies within the Steepbank Mine study area.

Subtask 5743 Waterfowl Survey

Objectives: To determine the relative abundance and distribution and raptors, colonial nesters, and breeding waterfowl, within the Steepbank Mine study area.

Tasks:

- A systematic search along major watercourses and water bodies within the study area during peak spring migration will be undertaken by two experienced observers in a Bell 206B helicopter
- Plot active nesting locations for raptors and colonial nesters
- Summarize and analyze data to assess breeding success

Deliverables: Component report outlining methods and results of the survey, particularly as it relates to location of important habitat area in the vicinity of the Steepbank Mine leases.

Subtask 5744 Herpetofauna Survey

Objectives: To determine the relative abundance and distribution of amphibians and reptiles within the Steepbank Mine study area.

Tasks:

- Identify potential breeding habitat by examining available aerial photography and select representative sampling area
- Conduct surveys within each sampling area along systematically placed transects and recording all visual sightings and vocalizations
- Record habitat conditions including type of water body and vegetation
- Summarize and analyze field data to determine relative abundance and distribution of amphibians and reptiles

Deliverables: Component report describing sampling methodology and relative abundance and distribution of herpetofauna in the study area.

Task 5750 Summer/Fall Surveys

Subtask 5751 Waterfowl Survey

Objectives: To determine the relative abundance and distribution of migratory waterfowl within the Steepbank Mine study area.

Tasks:

- A systematic search along major watercourses and water bodies within the study area during peak spring migration will be undertaken by two experience observers in a Bell 206B helicopter
- Summarize and analyze data to assess breeding success

Deliverables: Component report outlining methods and results of the survey, particularly as it relates to location of important fall staging habitats in the vicinity of the Steepbank Mine leases.

Subtask 5752 Beaver Aerial Survey

Objectives: To document the relative abundance and distribution of beaver and muskrat within the Steepbank Mine study area.

Tasks:

- Conduct a helicopter survey of all water bodies and watercourses within the study area for active beaver lodges and muskrat caches
- All locations to be accurately plotted on NTS maps of the study area
- Calculate densities for beaver and muskrat on all watercourses and water bodies within the study area

Deliverables: Component report documenting the relative abundance and distribution of beaver and muskrat within the Steepbank study area.

Task 5760 Data Analysis

Subtask 5761 HSI Modeling

Objectives: To quantify habitat losses for VECs expected to result from the construction and operation of the proposed Steepbank Mine and associated facilities for use in the EIA.

Tasks:

- Review existing information and models for VECs
- Identify and collect field data on important life requisites for VECs
- Calculate aerial extent of each major habitat type within the study area
- Summarize relevant field data and develop appropriate HSI models for each VECs
- Incorporate real extent of habitat types into each HSI models and calculate habitat units
- Based on a detailed review of proposed facilities construction and operation plans, calculate habitat losses and gains for each VECs

Deliverables: Component report describing the methods and results of HSI modeling for the Steepbank Mine study area including a review of the ecological requirements, important life requisites and model equations for each VECs. A sensitivity analysis of the models will also be undertaken where possible.

Subtask 5762 Habitat Suitability Mapping

Objectives: To map habitat suitability within the Steepbank Mine study area based on the results of the HSI modeling for each VECs.

Tasks:

- Develop a habitat suitability rating system for the study area
- Based on existing vegetation and habitat maps, identify important and/or sensitive habitats within the study area

Deliverables: Component report/maps depicting wildlife habitat suitability in the context of the proposed Steepbank Mine and associated facilities including current habitat suitability overlays for each VECs.

Task 5770 Impact Assessment

Objectives: To assess the full range of potential impacts the proposed Steepbank Mine may have on the wildlife resources in the region.

Tasks:

- Meet with the EIA Project Manager to discuss and finalize impact significance definitions
- Finalize format of impact assessment process with EIA Project Manager
- Assess potential construction and operations-related impacts on VECs with respect to significance, duration and real extent
- Develop impact sensitivity rating maps depicting areas of high, moderate and low potential for impacts
- Compile and synthesize historical information on resource development and wildlife resources in the region around the proposed Steepbank Mine
- Assess cumulative effects of the proposed mine project in light of other resource development projects in the region

Deliverables: Component report describing the EIA process and result of the assessment including sections on direct and indirect impacts facilities construction (including mine site, linear corridors, and associated infrastructure) and operation, summary of overall impacts and a cumulative effects assessment.

Task 5780 Mitigation/Monitoring

Objectives:

- To develop a mitigation plan that incorporates practical and operationally -feasible measures that reduce or eliminate project impacts
- To identify residual impacts following the implementation of the recommended mitigation pan into the proposed Steepbank Mine project
- To recommend an environmental monitoring program designed to ensure regulatory compliance, verify impact prediction, and to refine the mitigation program

Tasks:

- Work with EIA study team to design and implement effective mitigation and monitoring programs
- Review mitigation measures applicable to open pit oils ands development
- Develop mitigation and reclamation strategies for restoring productive habitats on disturbed landscapes
- Identify requirements for environmental effects monitoring

Deliverables: Component report documenting the recommended mitigation and environmental monitoring program.

9.6 Socio-Economics

9.6.1 Issue Summary

Socio-economic issues which are likely to be raised through the Steepbank Mine Development project include the following:

Local Employment and Training

Employment of local residents typically provides a major benefit, and helps to offset negative impacts which may result from the development of a project. Suncor is currently employing a large number of

Fort McMurray residents. If the mine expansion project generates additional employment, there will be pressure to hire and train local residents to the greatest extent possible.

Local Procurement

As with local employment, the purchase of goods and services can provide significant local benefits, and assist to offset any negative impacts.

Displacement of Trapping and Hunting

Hunting and trapping currently comprise key land uses for the area of the new mine. The manner in which Suncor addresses this issue will be important in helping to determine the response from local trappers and hunters.

Expected Population Changes Resulting From the Suncor Project

Fort McMurray is well-positioned to accept new population. To assist the City and local services to adequately plan services for future populations within the region, they will require information on Suncor's project and staffing plans. A key component of this issue will include an examination of the regional population both with and without the Suncor mine expansion.

Resulting Demands Upon Local Services and Infrastructure

Population changes may result in changes in demands for local services and infrastructure. Information from Suncor on staffing will assist agencies in planning and delivering services and infrastructure.

Regional and Provincial Economic Benefits

A key component of the impact assessment will be a discussion of the benefits which will accrue to the region and to Alberta by maintaining the Suncor operation compared to winding the project down. Issues to be discussed will include local employee payroll, local purchases of goods and services and government taxes and royalties.

Implications of the Project for Human Health (Emissions Related Issues)

Air emissions will be addressed in other sections of the impact assessment, however, given the level of concern within the Alberta public about the impact of air emissions on health, this issue will need to be addressed in the impact assessment.

Impact of the Project Upon the Fort McKay Band

Included will be issues related to land claims, employment and training.

9.6.2 Technical Approach

Project initiation will provide validation and modification of the proposed workplan presented here through discussions with the client, government and stakeholders and will result in a definition of the Valued Social Components which will provide the focus for the socio-economic sections of the EIA.

The assumption in the proposed workplan is that the project data requirements will be identified during the project initiation task, and will be provided within four months of the request date by the Suncor Project Manager. Valued Social Components are defined as the study components which require examination because they have been identified as containing key issues of concern to regulatory agencies, stakeholders and Suncor. For example, examination of the regional economy as part of the EIA is based upon the assumption that regulatory agencies and stakeholders will be concerned about the potential impact of the project at the economic level.

Data Collection

Employment data for both development and operations phases will be gathered from Suncor to be used as the basis for projecting changes in regional employment and population. This employment data will be required in the form of quarterly data disaggregated by employment group. Project procurement data will also be gathered from Suncor and used as the basis for the regional, provincial and national economic impact assessment. The Statistics Canada Inter-Regional Input Output Model requires data on a disaggregated basis by commodity area and this data is normally provided by project engineering staff for both development and operations on a quarterly basis. Tax and royalty data will provide an additional input for the Statistics Canada model and will be gathered from Suncor project engineering and financial staff.

Four economic profiles will be developed as the basis for the assessment of the project upon the regional, provincial and national economies. Employment and skills profiles will be developed through analysis of Statistics Canada 1991 Census Data. These profiles will provide the basis for the analysis of project related impacts from the Suncor Mine Expansion. A Regional Sectoral Profile will be developed through Statistics Canada data and discussions with the Fort McMurray municipal and business organizations.

This profile will provide the basis for the assessment of Suncor's current role in the regional economy and potential impacts from the Mine Expansion Project. A Municipal Fiscal Profile will be developed for the Fort McMurray Region based upon information from the City of Fort McMurray, the Municipality of Wood Buffalo and the Alberta Government. Given the recent changes in municipal boundaries and tax sharing, this profile will provide the basis for the analysis of impacts from the project. An Inter-Regional Economic Profile will be developed using the Statistics Canada Inter-Regional Input-Output Model. This model will form the basis of the assessment of economic impacts from the project upon Alberta, Canada and other provinces.

A regional demographic profile will be developed on the basis of information from Statistics Canada 1991 Census Data and information from the City of Fort McMurray. The profile will include information on population by age and sex structures, cultural minorities including aboriginal groups, education levels and family structure. This profile will form the basis of the assessment of changes in population resulting from the Mine Expansion.

Human Services typically include five areas of regional services: education, medical/health, social services, public protection and recreation/leisure. An Education Services Profile will be developed through review of literature and discussions with staff and administrators from schools in the region and from the Regional Education Board. A Medical / Health Services Profile will be developed through review of literature and discussions with the Fort McMurray Regional Health Board and administrative staff at the Hospital and Public Health Unit. A Social Services Profile will be developed through review of literature and discussions with regional social service providers (municipal, provincial and federal). Protection Services Profile will be developed through review of literature and discussions with RCMP and Fire Department representatives. Recreation / Leisure Services Profile will be developed through review of literature and discussions with regional recreation service providers.

Regional infrastructure services generally include transportation, municipal and commercial services. A Regional Transport Services Profile will be developed through review of literature and discussions with regional transportation service providers (Alberta Transportation, Fort McMurray Regional Airport, private service providers, municipal, provincial and federal agencies). A Regional Municipal Services Profile will be developed through review of literature and discussions with regional municipal administrators (City of Fort McMurray, Fort McKay, other appropriate regional communities). A Regional Commercial Services Profile will be developed through review of literature and discussions

with regional business associations, the City of Fort McMurray, other regional organizations and municipalities, private sector services, municipal, provincial and federal agencies.

Social character, political/decision making processes, political jurisdictions and land claims issues address regional issues which while less quantitative than other issues, are typically of significant concern to local populations in assessing the potential impact of a project upon regional communities. Aboriginal Communities and Issues will be identified through review of literature and discussions with representatives from each of the affected communities including residents of Fort McMurray, Fort McKay, and others as appropriate. A specific issue which will need to be addressed is the nature and extent of involvement aboriginal communities wish to have in developing the Suncor EIA. The nature of that involvement will determine the extent of work required to address aboriginal issues related to the Suncor project. The assumption used in this proposal is that aboriginal groups will wish to cooperate with the study researchers, rather than complete portions of the EIA separately. Local Decision and Political Processes will be identified through discussions with local community leaders. Political Jurisdictions issues will be identified through discussions with regional municipalities and community leaders. Issues will likely include the recent creation of the Municipality of Wood Buffalo and the Regional Health Board. Land Claims and Traditional Lands issues will be identified as they may affect the Suncor Mine Expansion.

Social Impact Assessment

The impact assessment component of the socio-economic assessment will identify and assess the types, nature and significance of impacts related to the Suncor Mine Expansion upon communities within the region. Economic impacts will also be examined for the Province, Canada and other provinces as appropriate. The impact assessment process will be based upon the Values Social Components identified in the Project Initiation tasks, the baseline information collected on each of those Components and the project socio-economic information provided by Suncor. Dialogue with service providers and agencies will provide a key input into the assessment and evaluation of project related impacts. Specific methods for each of the study sub-components are discussed below.

The examination of economic impacts will address employment, regional economic, municipal fiscal and inter-provincial assessments. Employment Impacts will be assessed based upon comparison of information on regional employment and workforce characteristics with the Suncor Mine Expansion requirements and discussions with local employment agencies. The analysis will include assessment of

labour force by occupation/trade, source/residency of labour force in comparison to regional supply/demand and recruitment/contracting policies, concurrent requirements from other regional projects (e.g., Syncrude).

Regional Economic Impacts will be determined based upon comparison of information on the regional economy and economic capability with the Suncor Mine Expansion requirements and discussions with local municipalities and business associations. The assessment will include projection of direct, indirect and induced employment and economic effects, using either and economic base model or income-expenditure technique.

Municipal Fiscal Impacts will be determined through discussions with regional municipalities, provincial agencies and through the use of Municipal Fiscal Impact Models developed by Nichols Applied Management. The assessment will include the direct and indirect effects of the project upon municipality's (Wood Buffalo/Fort McMurray) financial situation, including effects on local revenues/expenditures/tax levels. These derived in part from estimates of population effects and induced impacts on municipal operating revenues and costs, and infrastructure requirements, and from an examination of the direct municipal impacts related to the project itself (e.g. municipal services required, assessment generated, etc.). In addition, the fiscal effects/implications of project vis-à-vis native communities, particularly Fort McKay will be examined.

Inter-Regional Economic Impacts will be determined through discussions with regional municipalities, provincial agencies and through the use of the Statistics Canada Inter-Regional Input-Output Model. Costs for access to the Statistics Canada Model are included within the component budget.

Demographic models developed by Nichols Applied Management will be employed to determine the effect of population changes resulting from the Suncor project. The demographic model will use employment and local procurement data from the economic impact assessment to determine potential regional population changes. Cumulative impacts from other regional projects will be incorporated to determine the overall impact of know developments on the population of the area. Demographic projections will be prepared for population, by age and sex, by household for the regional municipalities including Fort McMurray and Fort McKay. These demographic projections will provide a basis for the determination of changes in demands for regional human services and infrastructure.

Dialogue with regional human service representatives will provide a basis for the determination of project related demands and impacts upon these services. Lack of this dialogue has been, historically, the basis for much of the criticism socio-economic impact assessments have attracted.

Assessment of impacts to Education Services will be based upon population projections prepared for the project and discussions with regional administrative and line staff. Medical / Health Services impact assessments will be based upon population projections prepared for the project and discussions with local and regional administrative and line staff. Social Services impact assessments will be based upon population projections prepared for the project and discussions with local and regional administrative and line staff.

Protection Services will be based upon population projections prepared for the project and discussions with regional RCMP and fire department administrative and line staff. Assessment of impacts upon Recreation / Leisure Services will be based upon population projections prepared for the project and discussions with regional administrative and line staff.

The assessment of project related impacts upon regional infrastructure will include discussions of transport, municipal and commercial services. The assessment of impacts to Regional Transport Services will be based upon population projections prepared for the project, information provided by Suncor on transportation service requirements for the project and discussions with regional administrative and line staff. The Regional Municipal Services impact assessment will be based upon population projections prepared for the project and discussions with regional and local government administrative staff regarding current constraints and capabilities and project requirements. The assessment of impacts upon Regional Commercial Services will be based upon population projections prepared for the project, information provided by Suncor on commercial requirements for the project and discussions with regional municipal administrative staff and business representatives.

The assessment of project related impacts upon regional social characteristics will include discussions on aboriginal issues, local decision-making, local political jurisdictions and land claims issues. Impacts upon Aboriginal Communities and Issues related to the Suncor Mine Expansion will be assessed through discussions with regional aboriginal community representatives. Specific issues likely to be identified include the nature and extent of economic benefits (employment, training, contracting), access by aboriginal people to the development area, compensation for lost access and resources and cultural

impacts associated with mine expansion to the west of the Athabasca River. The assessment of impacts upon Local Decision and Political Processes will involve discussions with local community leaders in determining the potential impact of the Suncor Project upon these processes.

Assessment of project related impacts upon Political Jurisdictions / Land Claims will involve discussions with local municipalities and community leaders. Of particular interest to this component of the EIA will be the implications to Suncor of the creation of the Municipality of Wood Buffalo, the Regional Health Board and the financial and other implications of those jurisdictional changes upon Suncor.

Mitigation Measures

The development of mitigative measures will address ways in which critical negative impacts of the project can be reduced and positive project impacts can be enhanced. The development of mitigative measures will require close communication with Suncor and key stakeholder groups.

For economic impacts, potential mitigation measures are likely to include Suncor policies promoting local hiring, contracting and purchasing in order to promote regional economic benefits. Mitigation of demographic impacts typically involves recruitment policies which promote local hiring and training to both minimize the numbers of in-migrants, and employ existing unemployed residents. In addition, the demographic projections prepared for the Suncor project can be used effectively by regional service providers to plan and provide services in a timely manner.

Mitigation measures for human service impacts typically involve the provision of key services by proponents at the project site, thereby reducing the demands upon regional services which are typically resourced to address the needs of the regional population. Such services often include emergency medical, training and recreation services. As with human services, mitigation measures for infrastructure typically involve the provision of key services and infrastructure by proponents at the project site, thereby reducing the demands upon regional services which are typically resourced to address the needs of the regional population. Such services often include accommodation, food and transportation services.

Mitigative measures for impacts upon social characteristics are typically project and site specific. For the Suncor project, possible mitigative measures for aboriginal issues and land claims may involve agreements including sharing of economic benefits (employment, training, compensation) and

involvement in project studies and monitoring. Mitigative measures for other study components will be developed during discussions with stakeholders.

During the impact assessment process, critical impacts will be flagged for development of specific mitigative measures. VEC definitions will provide a focus for the development of mitigative measures.

9.6.3 Detailed Work Scope

Task 5810 Project Initiation

Objectives: Project initiation will provide validation / modification of the proposed workplan through discussions with the client, government and stakeholders and will result in a definition of the Valued Social Components which will provide the focus for the socio-economic sections of the EIA. This work area will also initiate the collection of information on those aspects of the project required to complete the impact assessment. The assumption in the proposed workplan is that the project data requirements will be identified during the project initiation task, and will be provided within four months of the request date by the Suncor Project or Task Manager.

Tasks:

- Meetings with Suncor, AEP, ERCB, and other appropriate regulatory bodies
- Meetings with Stakeholders, assumed to be in the form of a workshop organized by Suncor;
- Identify Valued Social Components
- Gather employment data for both development and operations phases
- Gather project procurement data from Suncor
- Gather tax and royalty data from Suncor project engineering and financial staff

Deliverables:

- Revised socio-economic component workplan
- Identification of Valued Social Components
- Project socio-economic data gathered as a basis for socio-economic impact assessment

Task 5820 Baseline Data Collection

Objectives: Baseline data collection will be gathered as the basis for the impact assessment components of the socio-economic assessment. The baseline information will form the basis of the without Suncor scenario used for comparison to the with Suncor scenario being proposed as the Suncor Mine Expansion Project. Data collection for each of the expected Valued Social Components are discussed in the following tasks.

Tasks:

- For Economics, develop employment and skills profiles, regional sectoral, municipal fiscal, inter-regional economic, and regional demographic profiles
- For Human Services, develop education services profiles, medical/health services, social service, protection services and recreation/leisure services Profiles
- For Infrastructure, develop regional transport services profiles, municipal services, and regional commercial services profiles
- For Social Characteristics, identify aboriginal communities and issues, local decision and political processes, land claims and traditional lands issues, and define political jurisdiction issues

Deliverables: Information profiles for all of the different data categories itemized above.

Task 5830 Impact Assessment

Objectives: The objective of the impact assessment component of the socio-economic assessment is to identify and assess the types, nature and significance of impacts related to the Suncor Mine Expansion upon communities within the region. Economic impacts will also be examined for the Province, Canada and other provinces as appropriate. The impact assessment process will be based upon the Valued Social Components identified in the Project Initiation tasks, the baseline information collected on each of those Components and the project socio-economic information provided by Suncor. Dialogue with service providers and agencies will provide a key input into the assessment and evaluation of project related impacts.

Tasks:

Economic Impacts

- Assess Employment Impacts
- Determine Regional Economic Impacts
- Determine Municipal Fiscal Impacts
- Identify Inter-Regional Economic Impacts

Demographic Impacts

- Use Demographic models to determine the effect of population changes resulting from the Suncor project.

Human Service Impacts

- Assess impacts to Education Services
- Assess impacts to Medical / Health Services
- Assess impacts to Social Services
- Assess impacts to Protection Services
- Assess impacts upon Recreation / Leisure Services

Infrastructure Impacts

- Assess impacts to Regional Transport Services
- Assess impacts to Regional Municipal Services
- Assess impacts upon Regional Commercial Services

Impacts Upon Social Characteristics

- Identify Impacts upon Aboriginal Communities and Issues
- Assess impacts upon Local Decision and Political Processes
- Assess project related impacts upon Political Jurisdictions / Land Claims

Deliverables: The impact assessment process will provide socio-economic components for the EIA, and will validate and refine the Valued Social Components identified during the Project Initiation tasks. Impacts will be assessed according to significance criteria identified through discussions with regulators and stakeholders. Critical impacts will be flagged for development of specific mitigative measures. Completed VEC component reports will include the following:

- Employment Impacts
- Regional Economic Impacts
- Municipal Fiscal Impacts
- Inter-Regional Economic Impacts
- Demographic Impacts
- Education Services Impacts
- Medical / Health Services Impacts
- Social Services Impacts
- Protection Services Impacts
- Recreation / Leisure Services Impacts
- Regional Transport Services Impacts
- Regional Municipal Services Impacts
- Regional Commercial Services Impacts
- Impacts Upon Aboriginal Communities & Issues
- Impacts Upon Local Decision / Political Processes
- Impacts Upon Political Jurisdictions / Land Claims

Task 5840 Development of Mitigation Measures

Objectives: To address critical issues in a way which reduces the negative impact of the project and enhances the positive project impacts. The development of mitigative measures will require close communication with Suncor and key stakeholder groups. The following are potential areas where mitigation may be appropriate:

- Economic Impacts
- Demographic Impacts
- Human Service Impacts

- Infrastructure Impacts
- Impacts Upon Social Characteristics

Deliverables: Critical impacts will be flagged for development of specific mitigative measures. VEC definitions will provide a focus for the development of mitigative measures. Mitigative measure component reports will be prepared as necessary.

9.7 Historical Resources

9.7.1 Issue Summary

The historical resources impact assessment is a legislated investigation process regulated by the Archaeological Survey, Alberta Community Development. In view of this, it is important to involve the regulators in all phases of the project, particularly for large ones such as this. Adequate time must be planned to enable their review.

In accordance with current regulations, archaeological investigations need only be conducted in areas where the ground surface will be disturbed. Hence, it is important to have a clear understanding of the impact zones in order to limit the investigations. This will avoid costly examination of areas which will not be disturbed. The fact that subsurface prospecting, a standard component of archaeological investigations, disturbs the ground is another reason for limiting the investigations to the areas to be impacted.

It is highly likely that archaeological sites will be found as a result of the impact assessment. While many of the sites will have been adequately dealt with by recording them, others will be deemed more significant and will require mitigation. This could be accomplished by various means including avoidance, surface collection, excavation, mapping, completing oral histories and so on. Beyond the fact that archaeological mitigation is labour intensive, in this geographic area there would likely be a one year time lag between when the site was recorded and when the mitigation was initiated.

Most archaeological sites that are recorded are mitigatable. Exceptions include sacred sites and highly unique sites. Such sites have been recorded in the area. Should sites such as this be found,

Suncor would want ample time for considering design changes to avoid the sites, as well as to deal with interested stakeholders and the Archaeological Survey.

Recently, First Nations people have been intervening at regulatory hearings. Their concerns relate to the consultation process that is completed by archaeologists in other jurisdictions, such as British Columbia, as part of the historical resources impact assessment process. They are concerned that traditional land use has not been considered by the archaeologists. While the Historical Resources Act only requires proponents to protect those physical remains of man's past that are to be affected by the project, increasingly, the judiciary panels are sympathetic to this issue and are asking proponents for concessions in this manner. It is likely that the Historical Resources Act will change in the future such that archaeologists are required, on behalf of the proponent, to consider traditional land use, proximity to sacred areas and cultural material ownership issues in a manner cognizant with local band protocol. While this is an evolutionary process and any changes to the act are unlikely in the immediate future, Suncor would be well advised to avoid problems at the hearings phase and deal with this issue at the time of the impact assessment.

9.7.2 Technical Approach

Our field approach is fairly traditional, as it must be to satisfy the legislation governing our archaeological activities.

Extensive Site Assessment Procedures

Archaeologists must assess every site that is found as a consequence of archaeological inventory. While archaeology is a very regulated discipline, there is considerable leeway in both the assessment of the sites and in the interpretation of the results. Our approach has always been to apply considerable rigor at this stage. This not only means extensive shovel testing in the field but applying considerable effort to the questions of what a given site may mean to both the public and scientific communities. With the burgeoning interest from local communities and First Nations people, it is important to the success of the application process to identify locally meaningful sites at this stage.

Avoidance is our preferred mitigative alternative. Many significant archaeological sites can be avoided by adequate planning. Archaeological sites can be very localized, particularly in the boreal forest. Frequently, sites are so small that minor design changes can not only protect the sites, but save the client

considerable amounts of money as archaeological mitigation is very labour intensive and hence expensive.

9.7.3 Detailed Work Scope

Task 5910 to 5950 Project Initiation, Baseline Data Collection and Impact Assessment/Mitigation

Objectives: Locate historical resources, assess the historical significance and provide recommendations for subsequent phases of investigation. In accordance with regulations and guidelines applicable in Alberta, historical resources as referred to herein includes any work of nature or of man that is primarily of value for its paleontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest including, but not limited to a paleontological, archaeological, prehistoric, historic or natural site, structure of object.

Tasks:

- The first priority will be to refine the sensitivity rating for the Study Area which has been developed using 1:50 000 topographic maps. Further refinement should be attempted using background data such as more detailed topographic maps, pedological and muskeg distribution maps and aerial photography. Based on an analysis of the methods employed and results of previous studies in the region, it will be important to identify and examine well-drained areas such as knobs, ridges, escarpments, shorelines, benches, terraces and banks. It has been repeatedly demonstrated that either there are no archaeological sites in the muskeg areas, or that archaeologists are unable to find them if they are there.
- Subsequent to refining the sensitivity rating, it will be necessary to meet with the Northern Region archaeologist at Alberta Community Development to explain the rationale for the stratification into areas of high, medium and low potential for historical resources. His concerns will be incorporated into the research redesign.
- The Tyrrell Museum of Palaeontology will be contacted to ascertain whether they have concerns. If they do, it will be necessary to contract a palaeontologist.
- A permit will be required to allow for the field work to be completed during the summer months.
- While not required by law, it would be inadvisable to complete the study without input from the native groups regarding areas of traditional land use. To economize in this area and

avoid duplication of effort, the public consultation team will make the initial inquiries to the Fort McKay Band to identify key people and arrange the logistics prior to involving the archaeologists. This phase of the project will take some lead time; the people cannot be expected to be immediately available. Fort McKay representatives will be consulted by the archaeologists and hired to join the field crew to show us areas they have traditionally used.

- An overflight to refine the areas of sensitivity and to further refine the priority rating is advisable. In addition, some sites will be discernible from a helicopter flying at low altitude.
- Foot traverses will be completed over areas which exhibit moderate to high potential for historical resources. These will be accomplished by shovel tests to locate buried sites.
- Sites will be recorded and assessed in accordance with current legislation.
- Artifacts will be catalogued and analyzed.
- Based on Golder's experience at recent hearings, it would be advisable to have an archaeologist ground truth any areas not initially covered in the impact assessment which any of the other study teams ascertain that people have been using for gathering plants, hunting, holding ceremonies, etc. While this need not be done in 1995, it should be done before hearings to ascertain whether physical remains are associated.

Deliverables: A refined map at 1:50 000 or 1:20 000 scale which illustrates the sensitivity of the area for historical resources as perceived by Golder Associates, the Archaeological Survey and local people, including Fort McKay residents. Site forms detailing all pertinent site information for those sites located within the confines of the study area. A stand alone report completed in accordance with Historical Resources Act which fulfils permit requirements for a historical resources impact assessment. A summary of the historical resources impact assessment for the environmental impact assessment document.

10.0 DATABASE MANAGEMENT

This section presents the guidelines for the data management of chemical and aquatic organism enumeration results and the handling of spatial data for the Steepbank Mine EIA. Topics discussed include the division of data management tasks between the EIA team members, the data flow process, and the database structures to be used.

10.1 Division of Data Management Tasks And Data Flow

EVS Consultants will be responsible for managing the data associated with analytical results and all associated sample collection information, including sample location, sample number, and the date of collection. These data include those related to tissue (fish and vegetation), water, sediment and soil samples. EVS will also compile the results of benthic invertebrate, zooplankton, and phytoplankton enumerations. Golder will be responsible for non-chemical data that relate to the disciplines of vegetation, wildlife, soils and landforms, socio-economics, and archaeology and traditional land use., as well as hydrology and other physical measures. Golder will also be responsible for the handling of spatial data within their Geographical Information System (GIS). BOVAR-CONCORD Environmental (BOVAR-CONCORD) will be responsible for all air related data. All three companies will use identical station identification file structures. The three station files will combine into a single station file and all other created tables of measures will relate to this parent to create a cohesive data management system.

Data from the database will be made available to all EIA team members in Xbase (.dbf) format after QA/QC review has been completed by the QA Coordinator. The data will be disseminated by electronic mail or the use of an electronic bulletin board. In addition to the Xbase format, study Team Leaders of individual EIA study components may also request the data in spreadsheet format. To conserve space on the electronic bulletin board, these spreadsheets will not be posted for the use of all EIA study team members. Team Leaders of studies will be responsible for having their results analyzed by the team unless an agreement is made between the project manager(s), the Team Leader, and the data manager for additional analysis by the Data Management Team.

The flow of data among the study component principal investigators, EIA team members, and the Data Management Team is represented in Figure 4. Each EIA study team will use the appropriate station identifiers (IDs) as shown in Table 9. The second character of the station ID may be used by subgroups in the study team as decided in consultation with the Team Leader (e.g., AW001 - AW999 for water samples collected by the aquatic team and AB001-AB999 for benthic samples collected by the aquatic team). The Data Management Team will be provided with the final workplan for each study group by the study team leader. The workplan will identify the anticipated stations with the appropriate station IDs, locations of the stations in universal transverse mercator (UTM) grid coordinates, a description of the station type, (transect, quadrant, point station, etc.), how the station will be located in the field (e.g., global position system unit), and the degree of accuracy associated with the station positioning measure. The variable measures to be collected at the stations will be clearly identified. If samples will be shipped to a laboratory for analysis, the laboratory name should be stated as well as the analyses to be conducted, units of measure, and other key descriptors. This information will be used by the Data Management Team to refine the database structures prior to receiving the study data and to allow discussion with the laboratory regarding the format of electronic deliverables.

Sample identifiers (IDs) can be assigned in the field or by the study Team Leader. Sample IDs will be four digits starting with 0001 at each station and will be incremented by 1 for each new sample at a station. If desired, the first character of the sample ID may indicate the matrix sampled (e.g., F001 for a fish sample; B001 for a benthic sample). If sampling will occur at two different time periods, the sample ID will continue with the next sample number in sequence at the second sampling period (e.g., 0001-0005 collected in the first sample period and 0006-0010 collected in the second sample period). This will require accurate recording in the field of sample collection and numbering.

Samples to be shipped to a laboratory will be submitted with a chain-of-custody form. Photocopies of the chain-of-custody forms and an electronic spreadsheet will be submitted to the Data Manager by the study Team Leader within 3 weeks of sample collection. The spreadsheet will be formatted with each sample presented as a row of data. Data necessary for the completion of the appropriate sample data file will be provided. All matrix types will include station ID, location, sample ID, replicate number, sampling date and time, and matrix collected. Other categories of sample information will depend on the matrix collected. For example, a study of fish tissues might include the following additional information: genus and species name for the collected sample; the number of organisms in a sample if a composite was created; and relevant sex, weight, and length measurements. Other field measures collected should also be supplied. For example, water quality studies may include water temperature, pH, and dissolved oxygen.

Table 9 Station Identifiers to be Used by the EIA Study Team

EIA Study Team	Station Identifiers To Be Used
Wildlife	WX001 - WX999
Aquatics	AX001 - AX999
Hydrology/Hydrogeology	YX001 - YX999
Air Quality	QX001 - QX999
Soils/Vegetation/Terrain	SX001 - SX999
Historical	HX001 - HX999
Reclamation	RX001 - RX999

Upon completion of the sample analyses, the laboratory will supply one complete data report to the study Team Leader. The laboratory will also supply one summary data report and the electronic deliverable to the Data Manager. The study Team Leader will initiate the QA/QC checklist and send the complete data package to the QA Coordinator.

While the QA Coordinator oversees the review of data quality, the data management team will begin the translation of the data set into the defined data structures. Documentation will be kept during the data management task of translation techniques and any deviations or other changes made to the data. When the QA review is complete, the QA Coordinator will report the findings to the study Team Leader and the Data Manager.

The Data Manager will ensure that the findings of QA review have been incorporated into the database and will conduct a QA review of the data according to the methods set out in the QAPP. The Data Manager will then release the resulting data sets in Xbase format to the EIA team via electronic mail or the use of an electronic bulletin board. The study Team Leader may also request output of the database contents into one of two spreadsheet formats. The data may be organized with each sample ID in the left most column(s) of the spreadsheet and the chemical and other measures in adjacent columns, or the data may be organized with the chemical variables in the left-most column with the sample ID at the top of each of the adjacent columns. Spreadsheet data will be in Microsoft Excel format unless otherwise agreed upon by the data manager and the team leader. To conserve space on the mail server, these spreadsheets will not be provided to all EIA team members. To minimize data management costs, additional data analyses requested of the Data Management Team will be authorized only with the agreement of the requesting party, the Project Manager(s), and the Data Manager.

10.2 Data Management System

10.2.1 File Naming Conventions

The sample matrix will form the first two characters of the data table file names (SW - surface water; SD - sediment; GW - groundwater; SO - soil; FS - fish tissue, etc.). Sample identification files will be identified using "SMP" for the third through fifth characters of the file name. All analytical results will have a file name with "CHM" as the third to fifth characters. Similarly, abundance measures will be stored in files that have "ABD" as the third to fifth characters. Results for QA/QC samples will be

stored in a file separate from the sample results tables and will have "Q" as the sixth character of the file name. The seventh and eighth characters will indicate the version of the data with a letter and a number. The letter will occupy the seventh position of the file name and will increment when new data is added. The eighth character will be a number which will increment when the existing data has changed. For non-QA/QC data, an underscore character will hold the place for the sixth character. Example file names are shown below:

MATRIX	SAMPLE FILE	RESULTS	QA/QC RESULTS
Sediment	SDSMP_A1.dbf	SDCHM_A1.dbf	SDCHMQA1.dbf
Surface water	SWSMP_A1.dbf	SWCHM_A1.dbf	SWCHMQA1.dbf
Groundwater	GWSMP_B2.dbf	GWCHM_B2.dbf	GWCHMQB2.dbf
Fish tissue	FSSMP_C1.dbf	FSCHM_C1.dbf	FSCHMQC1.dbf
Benthos	SDSMP_A1.dbf	BNABD_A1.dbf	BNABDQA1.dbf
Phytoplankton	SWSMP_A1.dbf	PHABD_A1.dbf	PHABDQA1.dbf
Zooplankton	SWSMP_A1.dbf	ZOABD_A1.dbf	ZOABDQA1.dbf

10.2.2 Data Table Relations

The planned data management system outlined in the following sections has been effectively used in other similar field study efforts. However, the structures outlined are only the anticipated structures based on what is currently known about the data to be collected. The structures may change once the receipt of data begins.

The database structure is hierarchical in nature (Figures 9 and 10). All data tables will have the ability to relate to the STATION table, which will unify all sample locations. However, this does not mean that all media or data must be collected from all stations. The station identifier (STATIONID) will be unique for every record in the table and each unique STATIONID will have different UTM coordinates, which provide a two-dimensional identification of where samples were collected. The sample tables are the next tier in the structure and will describe the sample characteristics at the time of collection. The sample file provides the third and fourth dimensions of the location (depth and time). The combination of the station identifier (STATIONID), sample identifier (SAMPLEID), and replicate identifier (REP) will be the basis of a unique sample identification. Each matrix collected will have a distinct sample file, but all sample files will link to the station table using the STATIONID. The next tier of files contain the results of sample analyses. All analytical and conventional results will be stored in files with similar

structures separated on the basis of the organism enumerated. The station identifier (STATIONID), sample identifier (SAMPLEID), replicate identifier (REP), and the measured chemical analyte or conventional make up a unique record in the analytical tables. The results of aquatic organism enumerations will be in three files of the same structure. The station identifier (STATIONID), sample identifier (SAMPLEID), replicate identifier (REP), and species code or summary variable will define a unique record in the organism enumeration files.

10.2.3 Data Table Structures

The following discussion focuses on the data structures that will be used to record the results associated with the analytical and aquatic organism enumeration components of the study. To minimize data table sizes and to ensure consistency in the identification of variables, data dictionaries will be used. At this time, two dictionaries are planned. One will store the analytical and conventional variables and will be called CHEMDICT.dbf. The other will store species codes, qualifier codes, and other necessary coded characteristics and will be named CODE.dbf. Appendices VI and IX of this document contain samples of the contents of these files. Current data dictionaries will form the basis of the dictionaries to be developed for this project. Information provided by the study teams and laboratories will be added to the data dictionaries by the Data Management Team as the project progresses. Study Team Leaders, who are aware of the parameters that they will be measuring, may submit a list of parameters and the associated units of measure to the data management team prior to sampling. This information may be submitted in printed form for short lists, or in spreadsheet form for long lists.

These structures will be created by the Data Management Team and may be modified by the Data Management Team based on discussions with the study Team Leaders and the Data Manager. Data provided by the study teams in electronic spreadsheet format and electronic data supplied by the laboratories will be translated by the Data Management Team using database programs to the format required by the described structures.

A station file will be used to store information relevant to the location of sample collection and will form the necessary link to the GIS. Each record in the station file will have a unique station identifier (STATIONID). Table 10 shows the details of this file's structure. The structures described in Table 10 and subsequent tables refer to the contents of these files in the units column. The source file is shown in capital letters and the lower case name indicates the category of code to be used.

Figure 8 Suncor EIA Data Management System for Chemical Data and Aquatic Organism Enumerations (EVS Managed)

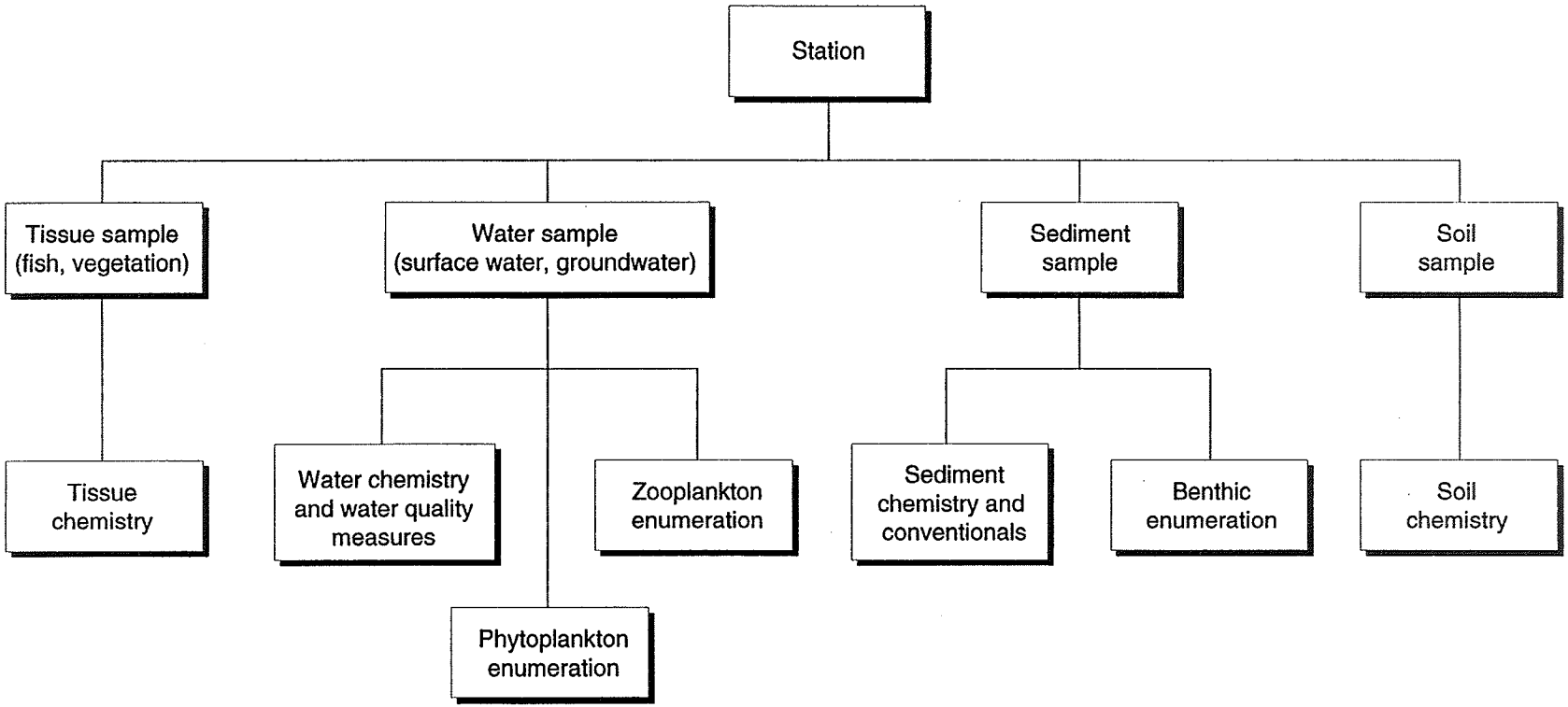


Figure 9 *Suncor EIA Data Management System for Non-Chemical Data (Golder Managed)*

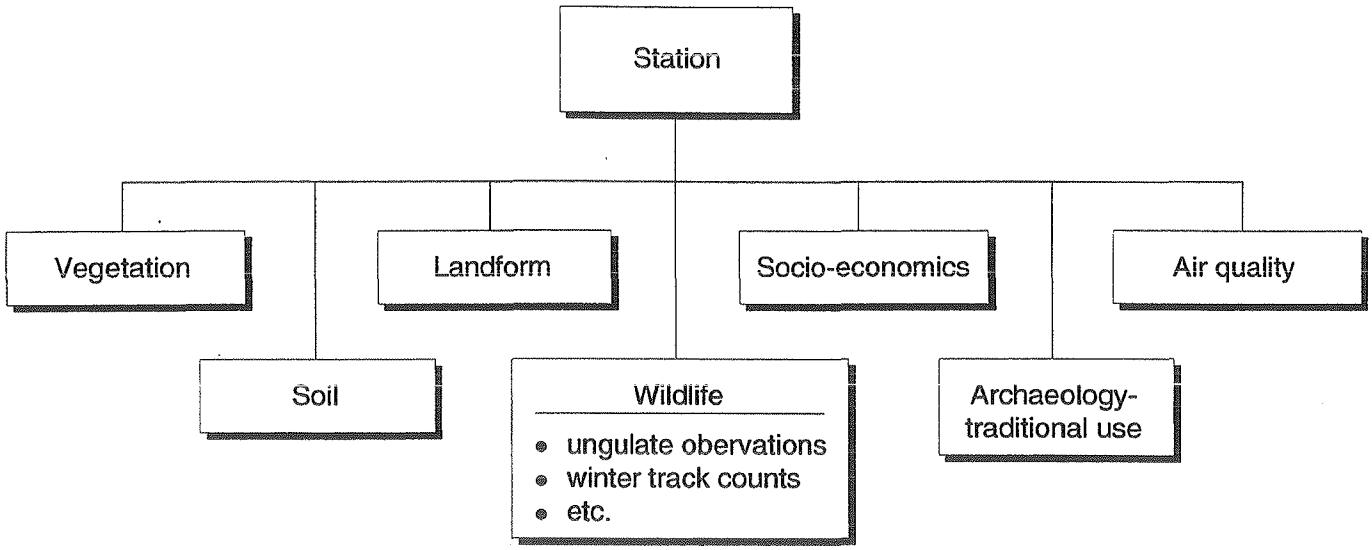


Table 10 Anticipated Structure of the Station File

Field Name	Data Type	Width	Decimals	Units	Description
STATIONID	Character	5			Unique station identifier
TYPE	Character	10		CODE: stn_type	Differentiates between quadrant, transect or distinct point stations
FIRST_X	Character	6			Easting at NE station corner
FIRST_Y	Character	7			Northing at NE station corner
SECOND_X	Character	6			Easting at SW station corner (not required for distinct point stations)
SECOND_Y	Character	7			Northing at SW station corner (not required for distinct point stations)
RADIUS	Numeric	4	1	meters	Used for defining the radius of circular stations
SIGNFIGURE	Numeric	1			Precision of measure
SECTOR	Character	3			Sector in which the station is located
DESCRIPT	Character	25			Station description

The structure for sample files will be based on the matrix collected and the relevant field observations associated with sample collection. Relevant information for QA/QC samples will also be stored in the appropriate sample file. A unique record in the table will consist of STATIONID, SAMPLEID, and REP. Assigned laboratory identifiers and laboratory batch codes will also be used to ensure that the data can be compared to data sheets provided by the laboratory and to allow batches of samples analyzed at the same time to be identified in case of QA/QC problems. The sediment sample file will contain information for sediments collected for both chemical analyses and benthic enumerations. The structure of the soil and sediment sample files will be the same (Table 11). The structure of the surface water and groundwater sample files will be the same (Table 12). Details of samples collected for the purpose of zooplankton and phytoplankton enumeration will be stored in the surface water sample file. Table 13 shows the structure for tissue samples collected.

All chemical/conventional results files will have the same structure; however, the results will be divided into separate files based on the matrix measured. Results for QA/QC samples (field and laboratory blanks, laboratory matrix spikes, laboratory matrix spike duplicates, etc.) will be stored in a file separate from the results of field samples and will have the same structure. The structure for this file is shown in Table 14.

Benthic organism, phytoplankton, and zooplankton enumeration results will also be stored in three tables of similar structure. The raw abundance data and summaries by major taxonomic groupings will be stored within these three files. The structure for the enumeration results of these aquatic organisms is shown in Table 15.

10.3 Historic Data

Historic data may be available which may assist in the evaluation of data collected during the EIA. This data may be submitted to the Data Management Team in a spreadsheet or database format and, where possible and deemed appropriate by the submitter, Project Manager, and Data Manager, the data will be translated to the above described structures. The data will be kept in files separate from the EIA data. The file names for these historic data will be similar to those described in Section 10.2.1. However, the seventh character of the file name will be X to identify it as containing historic data and the eighth character of the file name will indicate the version number as new data is added or existing data is changed. Within the historic files, the station ID will be used to indicate the sampling event in which the data were collected. Further details on the derivation of the station IDs will be made available at the time of the release of the data to the study teams.

Table 11 Anticipated Structure of the Sediment and Soil Sample Files

Field Name	Data Type	Width	Decimals	Units	Description
STATIONID	Character	5			Station identifier
SAMPLEID	Character	4			Sample identifier
REP	Character	2		F1-F9 for replicates prepared for the lab L1-L9 for reanalyses done by the lab	Replicate identifier
SAMPDATE	Character	8		yymmdd	
T_DEPTH	Numeric	3		centimeters	Upper sediment depth measure
B_DEPTH	Numeric	3		centimeters	Lower sediment depth measure
LABID	Character	8			Lab sample identifier
LAB_BATCH	Character	6			Lab batch identifier
QASAMPLE	Logical	1			QA/QC sample identification

Table 12 Anticipated Structure of the Surface Water and Groundwater Sample Files

Field Name	Data Type	Width	Decimals	Units	Description
STATIONID	Character	5			Station identifier
SAMPLEID	Character	4			Sample identifier
REP	Character	2		F1-F9 for replicates prepared for the lab L1-L9 for reanalyses done by the lab	Replicate identifier
SAMPDATE	Character	8		yymmdd	
DEPTH	Numeric	3		centimeters	Depth from surface of collection
LABID	Character	8			Lab sample identifier
LAB_BATCH	Character	6			Lab batch identifier
QASAMPLE	Logical	1			QA/QC sample identification

Table 13 Anticipated Structure of the Tissue Sample File

Field Name	Data Type	Width	Decimals	Units	Description
STATIONID	Character	5			Station identifier
SAMPLEID	Character	4			Sample identifier
REP	Character	2		F1-F9 for replicates prepared for the lab L1-L9 for reanalyses done by the lab	Replicate identifier
SAMPDATE	Character	8		yymmdd	
SPECIES	Character	10		CODE: species	Identified species of the sample
NO_IN_COMP	Numeric	2			Number of organisms in composite sample
SEX	Character	1		M or F	Identified sex of sample for non-composite samples
WEIGHT	Numeric	6	2	grams	Weight of single individual or average weight of composite
LENGTH	Numeric	6	2	centimeters	Length of single individual or average length of composite
LABID	Character	8			Lab sample identifier
LAB_BATCH	Character	6			Lab batch identifier
QASAMPLE	Logical	1			QA/QC sample identification

Table 14 Anticipated Structure of the Analytical/Conventional Results and the Analytical QA/QC Results File

Field Name	Data Type	Width	Decimals	Units	Description
STATIONID	Character	5			Unique station identifier
SAMPLEID	Character	4			Sample identifier
REP	Character	2		F1-F9 for replicates prepared for the lab L1-L9 for reanalyses done by the lab	Replicate identifier
CHEMCODE	Character	10		CHEMDICT : chemcode	Uses codes from the variable dictionary
RESULT	Numeric	12	5		
QUALIFIER	Character	5			Assigned qualifier
UNITS	Character	5			
MEASBASIS	Character	2			Indication of wet weight or dry weight measure
SIGDIGITS	Numeric	1			Number of significant digits
QAQC_DONE	Logical	1			Identifier indicating the results have been through QA/QC review

Table 15 Anticipated Structure of the Benthic, Phytoplankton and Zooplankton Results File

Field Name	Data Type	Width	Decimals	Units	Description
STATIONID	Character	5			Unique station identifier
SAMPLEID	Character	4			Sample identifier
REP	Character	2		F1-F9 for replicates prepared for the lab L1-L9 for reanalyses done by the lab	Replicate identifier
VARIABLE	Character	10		CODE: species or benthicsum	Uses codes from the variable dictionary
RESULT	Numeric	4			
QUALIFIER	Character	5			Assigned qualifier
COMMBASIS	Character	2			Community basis
AREABASIS	Character	1			Number of significant digits
QAQC_DONE	Logical	1			Identifier indicating the results have been through QA/QC review

10.4 Spatial Data

Management of spatial information will largely follow the protocol for the management of analytical information described in the previous sections. Protocol specific to the management of mapped information follows.

10.4.1 Base Maps

Digital base maps at a scale of 1:20,000 and using the UTM projection currently exist for the study area. These are available from the digital mapping branch of the province and include information on hydrography, topography and transportation. These maps will be used as the basis for all spatial databases (e.g., sampling sites, vegetation maps, soil maps, etc.) that are created in support of the EIA. This will ensure that spatial analyses such as map overlays can be conducted with a minimum of error during the analytical portion of the EIA.

10.4.2 Point Data

Point data will be described by station files. All station files must have their geographic locations recorded by UTM coordinates: x (easting) and y (northing), as described in Section 10.4.1. For the study area, these are represented by 6 and 7 digit numbers, respectively. For example, the northernmost corner of Fee Lot #3 is x: 477126; y: 6314468.

Point sample databases must also have fields for date of data acquisition, observer(s), and positional accuracy. Use of GPS technology is recommended to ensure positional accuracy.

Point data that are the result of single observations (e.g., moose observations during an aerial survey) need not be assigned station IDs. However, each point must have: 1) x and y UTM coordinates, 2) a unique reference number, and 3) all other pertinent information (e.g., for moose observations: date, time, number of moose, sex and age class of moose, vegetation characteristics where the moose were observed) in its attribute database.

Vector and Polygon Data

All contractors will be required to submit digital map files that they create as part of their work in pc ARCINFO format, or in an intermediary format that pc ARCINFO accepts. GIS data must be vector and not raster based. Common intermediary formats that are acceptable include DXF and DLG. Files

may be compressed using PKZIP. All digital linework must be free of error. For example, all polygons must be closed and labelled, line overhangs must be eliminated and map edges must be edge-tied.

There are many potential sources of error in a digital map, including the age of the data, the map scale, its accuracy, etc. All too often, GIS users and the public tend to overlook such error once the map is in the computer. Therefore, the following must be attached to each digital map and fully described in accompanying text:

- Age of data
- Scale
- Density of observations used in making the map
- Positional accuracy of point observations
- Accuracy assessment results

Statistically valid accuracy assessments must be conducted on newly interpreted maps to allow the user to determine the degree of confidenie they should place on the map. Ground truth observations should also be included as a point database in a separate GIS layer.

Data Dictionaries

Data dictionaries must be provided for both: 1) GIS map files and 2) fields in the attribute databases. File nomenclature for GIS map files will be established in consultation with the data managers. Examples of proposed GIS layers for the EIA are provided in Appendix X.

Flow of GIS Data

Flow of GIS data will be similar to that of analytical data (Figure 4). Draft workplans and database file structures will be submitted to the GIS Coordinator for review and provision of station identifiers (if appropriate). Completed map products will be transferred to Golder Associates in Calgary for error checking and integration with the central EIA GIS database. Attribute data will also be transferred to Golder Calgary, except for databases that contain the results of analytical tests. These latter databases will be routed through EVS in North Vancouver and/or Seattle before being included in the GIS database.

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12.0 GLOSSARY

The terms used in this glossary were obtained mostly from U.S. EPA (1995).

Accuracy	Indicates the closeness of a measured value to a true value; combines bias and precision.
Analyte	The specific component measured in a chemical analysis.
Audit	A planned and documented investigative evaluation of an item or process to determine the adequacy of and compliance with established procedures, instructions, Quality Assurance Project plans, and other applicable documents.
Bias	Consistent tendency of measured value to deviate, either positively or negatively, from a true value. Usually expressed as the percent recovery of a known amount of a chemical added to a sample at the start of a chemical analysis.
Bioaccumulation	The accumulation of contaminants in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, pore water, or dredged material.
Bioassay	A bioassay is a test using a biological system. It involves exposing an organism to a test material and determining a response. There are two major types of bioassays differentiated by response: **toxicity tests** which measure an effect (e.g., acute toxicity, sublethal/chronic toxicity) and **bioaccumulation tests** which measure a phenomenon (e.g., the uptake of contaminants into tissues).

Blanks	QC samples that are processed with the samples but contain only reagents. They are used to obtain the response of an analysis in the absence of a sample, including assessment of contamination from sources external to the sample.
Calibrated Check Standard	Standard, usually mid-analytical range, used to monitor the validity of instrument calibration between periodic full recalibration.
Calibration	The systematic determination of the relationship of the response of the measurement system to the concentration of the analyte of interest. Instrument calibration performed before any samples are analyzed is called the **initial calibration**. Subsequent checks on the instrument calibration performed throughout the analyses of samples are called **continuing calibration**.
Chromatography	The process of selectively separating a mixture into its component compounds. The compounds are measured and presented graphically in the form of a **chromatogram** and digitally as a **quantification report**.
Cleanup	The process of removing certain components from sample extracts, performed to improve instrument sensitivity.
Coefficient of Variation	The standard deviation expressed as a percentage of the mean.
Comparability	Reflects the confidence with which on data set can be compared with others and the expression of results consistent with other organizations reporting similar data. Comparability of analytical procedures also implies using analytical methodologies that produce results comparable in terms of precision, bias, and effective range of calibration.

Completeness	A measure of the amount of valid data *obtained* versus the amount of data originally *intended* to be collected.
Confidence Coefficient	The probability, expressed as a percentage, that a measurement result will reside in the confidence interval (between the confidence limits).
Conference Interval	The set of possible values within which the true value will reside with a stated probability level.
Confidence Limit	Upper or lower boundary values delineating the confidence interval.
Contaminant	A chemical or biological substance in a form that can be incorporated into, onto, or be ingested by and that harms aquatic or terrestrial organisms, consumers of these organisms, or users of the aquatic/terrestrial environment.
Control Limit	A value for data from the analysis of QC checks indicating that a system or a method is not performing normally and that an appropriate corrective action should be taken. When control limits are exceeded, analyses should be halted; samples analyzed since the last QC sample may need reanalysis.
Data Quality Indicators	Surrogate spike recoveries, matrix spike recoveries, analytical values obtained for blanks, standard reference material, and performance evaluation samples for each parameter in each matrix.
Data Quality Objectives (DQOs)	Qualitative and quantitative statements of the overall uncertainty that a decision maker is willing to accept in results or decisions derived from environmental data. DQOs provide the framework for planning environmental data operations consistent with the data user's needs.

Detection Limits	Various limits are defined: in increasing order these are:
Instrument Detection Limit (IDL)	The analyte concentration that produces a response five time greater than the signal/noise ratio of the instrument. This is similar to the "criterion of detection" which is defined as 1.645 times the standard deviation, *s*, of blank analyses.
Lower Limit of Detection (LLD)	Also called "detection limit" (DL) and "limit of detection" (LOD) - the analyte concentration in reagent water that produces an instrument response 2(1.645)*s* above the mean of blank analyses. This criterion sets the (maximum?) probability of both Type I and Type II errors at 5%.
Method Detection Limit (MDL)	The analyte concentration that, when processed through the complete method, produces an instrument response with a 99% probability that it is non-blank.
Limit of Quantitation (LOQ)	The analyte concentration that produces an instrument response sufficiently greater than the response by the blank that it can be measured within specified accuracy limits by competent laboratories in routine operation. Typically it is regarded as the analyte concentration that produces a response ten times greater than the standard deviation, *s*, of the reagent water blank signal.
Duplicate	Least case of replicates (two); in general, while any portion of the analytical protocol can be duplicated, the term duplicate is usually applied to duplicate samples, i.e., two samples taken at the same time from the same location.

Interference	Unwanted elements or compounds in a sample that have properties similar to those of the chemical of interest and that collectively cause unacceptable levels of bias in the results of a measurement or in sensitive measurements. Unless removed by an appropriate cleanup procedure, the interferant is carried along with the chemical of interest through the analytical procedure.
Internal Standard	A pure compound different from, but similar enough to, the analyte, that, when added at a known concentration to the sample extract immediately prior to instrumental analysis, allows corrections due to instrument inefficiencies or vagaries.
Laboratory Control Standard	A standard, optimally certified by an outside authority, used to measure method bias.
Matrix	The sample material (e.g., water, sediment, tissue) in which the chemicals of interest are found. Matrix refers to the physical structure of a sample and how chemicals are bound within this structure.
Matrix Effects	Matrix effects are physical or chemical interactions between the sample material and the chemical of interest that can bias chemical measurements in either a negative or positive direction. Because matrix effects can vary from sample to sample and are often not well understood, they are a major source of variability in chemical analyses.
Matrix Spike Samples	QC check samples created by adding known amounts of chemicals of interest to actual samples, usually prior to extraction or digestion. Analysis of matrix spikes and matrix spike duplicates will provide an indication of bias due to matrix effects and an estimation of the precision of the results.

Performance Audit	Audit of a laboratory's performance by testing a standard reference material. The test results are evaluated by the auditor.
Precision	Gauge of the degree of agreement among replicate analyses of a sample, usually expressed as the standard deviation, variance, or range.
Quality Assessment	Procedure for determining the quality of laboratory or field data using internal and external quality control measures.
Quality Assurance	A system of operation that specifies the measures used to produce data of documented accuracy.
Quality Assurance Project Plan	A detailed, project-specific document specifying guidelines and procedures to assure data quality during data collection, analysis, and reporting.
Quality Control	A set of procedures applied to an analytical or field methodology to demonstrate that the analysis is in control.
Quality Control Checks	Blanks, replicates, and other samples used to assess the overall analytical system and to evaluate the performances of individual analytical instruments or the technicians that operate them.
Random Error	The deviation experienced in any step of an analytical procedure that can be estimated by standard statistical techniques.
Reference Materials	Materials or substances with well-characterized properties that are useful for assessing the accuracy of an analysis and comparing analytical performances among laboratories.

Replicate	Repeated operation of part of an analytical procedure. Two or more (instrumental) analyses for the same analyte in a processed sample are termed replicate extract analyses.
Representativeness	The degree to which sample data depict an existing environmental condition; a measure of the total variability associated with sampling and measuring that includes the two major error components: systematic error (bias) and random error. Sampling representativeness is accomplished through proper selection of sampling locations and sampling techniques, and collection of sufficient number of samples.
Significant Difference	A quantitative determination of the probability that two measurement of the same parameter are different, given the variability of the measurements.
Spectrometry	The use of spectrographic techniques for deriving the physical constants of materials. Four basic forms of spectrometry commonly used are atomic absorption spectrometry (AA), inductively coupled plasma-atomic emission spectrometry (ICP) for metals, and ultraviolet spectrometry (UV) and fluorescence emission or excitation spectrometry for organic compounds.
Spiked Method Blanks	Method blanks to which known amounts of surrogate compounds and analytes have been spiked. Such samples are useful to verify acceptable method performance prior to and during routine analysis of samples containing organic compounds. Also known as check standards in some methods; independently prepared standards used to check for bias and to estimate the precision of measurements.

Standard Operating Procedures	A written document which details an operation, analysis, or action whose mechanisms are thoroughly prescribed and which is commonly accepted as the method for performing certain routine or repetitive tasks.
Standard Reference Materials	Standard reference materials are certified reference materials containing precise concentrations of chemicals, accurately determined by a variety of technically valid procedures.
Surrogate (or Surrogate Standard)	A pure compound different from, but similar enough to, the analyte that, when added at a known concentration to the sample prior to processing, provides a measure of the overall efficiency of the method (recovery). They are used to estimate the recovery of organic compounds in a sample.
Target Detection Limit (TDL)	A performance goal set by consensus between the lowest, technically feasible, detection limit for routine analytical methods and available regulatory criteria or guidelines. The TDL is, therefore, equal to or grater than the lowest amount of a chemical that can be reliably detected based on the variability of the blank response of routine analytical methods. However, the reliability of a chemical measurement generally increases as the concentration increases. Analytical costs may also be lower at higher detection limits.
Tests/Testing	Specific procedures which generate biological, chemical, and/or physical data to be used in evaluations. The data are usually quantitative but may be qualitative (e.g., organism behaviour).
Toxicity Test	A **bioassay** which measures an effect (e.g., acute toxicity, sublethal/chronic toxicity). Not a **bioaccumulation test** (see definition of **bioassay**).

Type I Error	Also called alpha error, is the probability of deciding an analyte is present when it actually is absent.
Type II Error	Also called beta error, is the probability of deciding an analyte is absent when it actually is present.
Warning Limit	A value indicating that data from the analysis of QC checks are subject to qualification before they can be used in a project. When two or more sequential QC results fall outside of the warning limits, a systematic problem is indicated.

APPENDICES

APPENDIX I

PROJECT TEAM ADDRESSES

TABLE I-1

PROJECT TEAM ADDRESSES

Name	Company	Telephone Number	Fax Number	Email Number	Address
Fordham, Christopher	Suncor	(403) 743-6806	(403) 791-8399		P.O. Box 4001, Fort McMurray, AB T9H 3E3
Gulley, John	Suncor	(403) 743-6715	(403) 791-8339		P.O. Box 4001, Fort McMurray, AB T9H 3E3
Kemp, Gordon	Suncor	(403) 743-6930	(403) 791-8339		P.O. Box 4001, Fort McMurray, AB T9H 3E3
Klym, Don	Suncor	(403) 743-6532	(403) 791-8362		P.O. Box 4001, Fort McMurray, AB T9H 3E3
Lowell, Sue	Suncor	(403) 743-6992	(403) 791-8362		P.O. Box 4001, Fort McMurray, AB T9H 3E3

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Name	Company	Telephone Number	Fax Number	Email Number	Address
Sheeran, Don	Suncor	(403) 743-6513	(403) 791-8399		P.O. Box 4001, Fort McMurray, AB T9H 3E3
Tuttle, Stephen	Suncor	(403) 743-6442	(403) 791-8339		P.O. Box 4001, Fort McMurray, AB T9H 3E3
Balcom, Rebecca	Golder Associates	(403) 299-5611	(403) 299-5606	bbalcom@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Brassard, Brenda	Golder Associates	(403) 299-4615	(403) 299-5606	bbrassard@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Fernet, David	Golder Associates	(403) 299-5605	(403) 299-5606	dfernet@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Hamilton, Hal	Golder Associates	(403) 299-5620	(403) 299-5606	hhamilton@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1

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Name	Company	Telephone Number	Fax Number	Email Number	Address
Johannesson, Carey	Golder Associates	(403) 299-5636	(403) 299-5606	cjohannesson@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Kerr, David	Golder Associates	(403) 299-5610	(403) 299-5606	dkerr@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Marken, Sandra	Golder Associates	(403) 299-5619	(403) 299-5606	smarken@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Raine, Michael	Golder Associates	(403) 299-4642	(403) 299-5606	mraine@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Shaw, Randy	Golder Associates	(403) 299-5637	(403) 299-5606	rshaw@golder.com	1011 - 6 Avenue S.W., Calgary, AB T2P 0W1
Davies, Mervyn	Bovar-Concord	403-750-9335	403-237-7634	76174.1273@compuserve.com	#1190, 555 - 4 Ave S.W., Calgary, AB T2P 3E7
Brusnyk, Lawrence	D.A. Westworth & Associates	(403) 488-3780	(403) 482-6210		Groat Estate I, #101, 12420 - 104 Ave, Edmonton, AB T5N 3Z9

TABLE I-1

PAGE 4 OF 4

Name	Company	Telephone Number	Fax Number	Email Number	Address
Westworth, David	D.A. Westworth & Associates	(403) 488-3780	(403) 482-6210		Groat Estate I, #101, 12420 - 104 Ave, Edmonton, AB T5N 3Z9
Nix, Peter	EVS Environment Consultants	(604) 986-4331	(604) 662-8548	evs_consultants@mindlink.bc.ca	195 Pemberton Avenue, North Vancouver, BC V7P 2R4
Crane, Judy	EVS Environment Consultants	(604) 986-4331	(604) 662-8548	evs_consultants@mindlink.bc.ca	195 Pemberton Avenue, North Vancouver, BC V7P 2R4
Severn, Corinne	EVS Environment Consultants	(206) 217-9337	(206) 217-9343	evswa@halcyon.com	403 - 200 West Mercer Street, Seattle, WA 98119
Manly, Ken	Klohn-Crippen	(403) 274-3424	(403) 274-5349	klohn-crippen@cia.com	114, 6815 - 8 Street N.E., Calgary, AB T2E 7H7

APPENDIX II

TARGET DETECTION LIMITS FOR ORGANIC CHEMICALS

LIST OF TARGET PAHS/ALKYLATED PAHS

TARGET PRIORITY POLLUTANT PAHs	DETECTION LIMIT* WATERS µg/L (ppb)	DETECTION LIMIT* SOILS µg/g (ppm)	DETECTION LIMIT* INVERTEBRATES** µg/g (ppm)
Naphthalene	0.02	0.01	0.02
Acenaphthylene	0.02	0.01	0.02
Acenaphthene	0.02	0.01	0.02
Fluorene	0.02	0.01	0.02
Dibenzothiophene	0.02	0.01	0.02
Phenanthrene	0.02	0.01	0.02
Anthracene	0.02	0.01	0.02
Fluoranthene	0.02	0.01	0.02
Pyrene	0.02	0.01	0.02
Benzo(a)Anthracene/Chrysene	0.02	0.01	0.02
Benzo(b&k)fluoranthene	0.02	0.01	0.02
Benzo(a)pyrene	0.02	0.01	0.02
Indeno(c,d-123)pyrene	0.02	0.01	0.02
Dibenzo(a,h)anthracene	0.02	0.01	0.02
Benzo(g,h,i)perylene	0.02	0.01	0.02
TARGET SUBSTITUTED PAHs			
Methyl naphthalenes	0.02	0.01	0.02
C_2 Substituted naphthalenes	0.04	0.02	0.04
C_3 Subst'd naphthalenes	0.04	0.02	0.04
C_4 Subst'd naphthalenes	0.04	0.02	0.04
Biphenyl	0.04	0.02	0.04
Methyl biphenyl	0.04	0.02	0.04
C_2 Substituted biphenyl	0.04	0.02	0.04
Methyl acenaphthene	0.04	0.02	0.04
Methyl fluorene	0.04	0.02	0.04
C_2 Substituted fluorene	0.04	0.02	0.04
Methyl phenanthrene/anthracene	0.04	0.02	0.04
C_2 Substituted phenanthrene/anthracene	0.04	0.02	0.04
C_3 Subst'd phenanthrene/anthracene	0.04	0.02	0.04
C_4 Subst'd phenanthrene/anthracene	0.04	0.02	0.04
1-Methyl-7-isopropyl-phenanthrene (Retene)	0.04	0.02	0.04
Methyl dibenzothiophene	0.04	0.02	0.04
C_2 Substituted dibenzothiophene	0.04	0.02	0.04
C_3 Subst'd dibenzothiophene	0.04	0.02	0.04
C_4 Subst'd dibenzothiophene	0.04	0.02	0.04
Methyl fluoranthene/pyrene	0.04	0.02	0.04
Methyl benzo(a)anthracene/chrysene	0.04	0.02	0.04
C_2 Subst'd benzo(a)anthracene/chrysene	0.04	0.02	0.04
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	0.04	0.02	0.04
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	0.04	0.02	0.04

*Based on sample size and dilution required. Results reported on a dry weight basis for soils. Sample sizes required for the above detection limits: Water - 4L; Soil - 125 g; Invertebrates - 500 g

**FISH SAMPLES:
For fish samples, a GPC cleanup (modified EPA 3640) is required to isolate the target compounds from the lipid material. The detection limits will be similar to the benthic samples, based upon a minimal sample requirement of 100 grams.

LIST OF TARGET PANH COMPOUNDS

TARGET PANH COMPOUNDS	DETECTION LIMIT* WATERS µg/L (ppb)	DETECTION LIMIT* SOILS µg/g (ppm)	DETECTION LIMIT* INVERTEBRATES** µg/g (ppm)
quinoline	0.02	0.01	0.02
7-Methyl quinoline	0.02	0.01	0.02
C_2 Subst'd quinoline	0.02	0.01	0.02
C_3 Subst'd quinoline	0.02	0.01	0.02
Acridine	0.02	0.01	0.02
Methyl acridine	0.02	0.01	0.02
Phenanthridine	0.02	0.01	0.02
Carbazole	0.02	0.01	0.02
Methyl carbazole	0.02	0.01	0.02
C_2 Subst'd carbazole	0.02	0.01	0.02

*Based on sample size and dilution required. Results reported on a dry weight basis for soils. Sample sizes required for the above detection limits: Water - 4L; Soil - 125 g; Invertebrates - 500 g

**FISH SAMPLES:

For fish samples, a GPC cleanup (modified EPA 3640) is required to isolate the target compounds from the lipid material. A validation is required to ensure the PANH compounds can be isolated from the GPC column (ie: non-reactive with the polystyrene bed). If the GPC cleanup is valid for these compounds, the detection limits will be similar to the benthic samples, based upon a minimal sample requirement of 100 grams.

LIST OF NON-CHLORINATED PHENOLICS IN WATER

PHENOLIC COMPOUNDS	DETECTION LIMITS* µg/L (ppb)
Phenol	0.1
o-Cresol	0.1
m-Cresol	0.1
p-Cresol	0.1
2,4-Dimethylphenol	0.1
2-Nitrophenol	0.2
4-Nitrophenol	2.0
2,4-Dinitrophenol	2.0
4,6-Dinitro-2-methyl phenol	2.0

*Based on sample size and dilution required. A 4L water sample size is required.

LIST OF VOLATILE ORGANICS IN WATER

TARGET COMPOUND	DETECTION LIMIT* µg/L (ppb)
Acetone	100
Acrolein	100
Acrylonitrile	100
Benzene	1
Bromodichloromethane	1
Bromoform	1
Bromomethane	10
2-Butanone (MEK)	100
Carbon disulfide	1
Carbon tetrachloride	1
Chlorobenzene	1
Chloroethane	10
2-Chloroethyl vinyl ether	5
Chloroform	1
Chloromethane	10
Dibromochloromethane	1
Dibromomethane	1
1,2-Dichlorobenzene	1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
cis-1,4-Dichloro-2-butene	2
trans-1,4-Dichloro-2-butene	5
Dichlorodifluoromethane	1
1,1-Dichloroethane	1
1,2-Dichloroethane	1
1,1-Dichloroethene	1
trans-1,2-Dichloroethene	1
1,2-Dichloropropane	1
cis-1,3-Dichloropropene	1
trans-1,3-Dichloropropene	1
Ethanol	100
Ethylbenzene	1
Ethylene dibromide	1
Ethyl methacrylate	200
2-Hexanone	200
Iodomethane	1
4-Methyl-2-pentanone (MIBK)	200
Methylene chloride	5
Styrene	1
Tetrachloroethylene	1
1,1,2,2-Tetrachloroethane	5
Toluene	1
1,1,1-Trichloroethane	1
1,1,2-Trichloroethane	1
1,2,3-Trichloropropane	2
Trichloroethene	1
Trichlorofluoromethane	1
Vinyl acetate	100
Vinyl chloride	20
Xylenes	1

*Detection limits are based upon the dilutions necessary for analysis.

APPENDIX III

GENERAL FIELD SAFETY

SAFETY PROCEDURES FOR FIELD WORK

General

All participants in field surveys must attend a 4 hour Suncor-Syncrude Safety Orientation Program. All contractors must also comply with the guidelines outlined in Suncor's Loss Management Reference Booklet, which is attached to all contracts.

At least one member of a field crew should be certified in Wilderness Survival First Aid. All field staff should at least have training in Standard First Aid or Emergency First Aid.

A person with advanced and wilderness first aid training should be designated as the Field Safety Officer.

Safety procedures and equipment must be discussed and agreed upon between all members of a field crew and the Field Safety Officer. Safety procedures and equipment should be reviewed at frequent intervals during the work (e.g., at least weekly initially; monthly later for long-term projects).

Clothing must be appropriate for the terrain or industrial site, and weather.

Staff involved in strenuous field activities should have an annual medical/physical examination by a physician.

All field workers should be aware of the effects of fatigue and extreme temperatures on their ability to function safely and efficiently.

Remote (Wilderness) Sites

For the purposes of these safety requirements, a remote site is one that is more than 30 minutes' travelling time from a telephone.

A minimum of two persons is normally required, unless there is agreement between the Field Safety Officer and an employee who is experienced and properly trained in work in the area that is safe for the experienced employee to go alone. Inexperienced full-time or part-time staff should not be permitted to do fieldwork alone.

An itinerary and schedule must be left with the Team Leaders. A schedule of phone-in times must also be agreed upon. The Team Leaders must know the locations of field workers every day.

Suitable emergency equipment must be taken. This may include, but not be restricted to food, tent, sleeping bag, survival kit, all-weather clothing, compass, maps, GPS units, bear repellent, field first aid kit, and VHF radio/cellular phone.

Advice must be obtained from local Fish and Wildlife Branch Officers in areas where animals may pose a threat.

All personnel must be given a safety orientation regarding entering and exiting helicopters if their work requires helicopter transport.

Pickup or rendezvous times must be agreed upon and strictly adhered to if a person is being dropped off and met later. Contingency plans must be made for the person(s) dropped off in case it is impossible for transportation to arrive on schedule.

For travel on logging or other restricted roads during hours of operation, radio contact should be maintained with the appropriate control centre. As a minimum requirement, clearance and scheduling must be obtained through the company controlling road use.

Other Natural Environmental Sites

All the above requirements apply, except that the need for emergency equipment may be reduced.

APPENDIX IV

HEALTH AND SAFETY PLAN FOR AQUATIC BASELINE STUDY

1.
Project Name Suncor EIA

Task Aquatic Baseline

Requested by Gord McClymont

Proposed Start-Up Date: May 8, 1995 **Project/Task No.** 952-2307

Rev. Level 1.0

Prepared by/Reviewed by Health and Safety Officer

Printed Name Gord McClymont

Signature Gord McClymont Date July 24 1995

Reviewed by Project Health and Safety Coordinator

Printed Name Chris Bjornson

Signature Chris Bjornson Date July 24, 1995

Approved by ~~Project Manager~~ Component Leader RS.

Printed Name ~~Hal Hamilton~~ Randy Shaw

Signature Randy Shaw Date 26 July 1995

Title Senior Limnologist

Note to Project Managers:

A signed and completed copy of the Health and Safety Plan and a signed and completed copy of the safety briefing must be included in the project file.

2. Project Description:

Suncor EIA aquatics baseline inventory - bridge site habitat assessment, biomarking, fish inventory and habitat assessment, installation of artifical substrates and water quality

3. Location:

Suncor: P.O. Box 4001, Fort McMurray, T9H 3E3

4. Facility/Work Site Description:

Athabasca and Steepbank Rivers (and tributaries) in the vicinity of the Suncor mine site and laboratory facilities at the Suncor mine site.

5. Proposed Personnel and Tasks:

~~Project Manager~~ ~~Hal Hamilton~~

Field Team Leader Chris Bjornson

Proposed Field Team	Job Function/Tasks
Chris Bjornson	Field Team Leader and project health and safety coordinator
Richard Schryer	Senior aquatic field technique auditor
Lynda Gummer	Field biological technician
Christine Godwin Sheppard	Field biological technician
Ken Allen	Field biological technician

6. Potential Hazards

X Chemical	X Trips, Slips, Falls
__ Radiological	__ Trenching/Shoring
X Fire/Explosion	X Heavy Equipment/Vehicular Traffic
X Heat Stress	__ Overhead Hazards
X Hypothermia	X Unstable/Uneven Terrrain
X Electrical	X Animal Attacks
__ Machinery/Mechanical Equipment	

Description:

Hazards include vehicle traffic, remote/wilderness hazards (heat stress/hypothermia, animal attacks, accidents), electrical exposure from electrofishing, exposure to liquid nitrogen, formalin and hexane

7. Personal Protective Equipment

Location	Job Function/Task	Protective Equipment
Boat	Electrofishing	waterproof boots and gloves, life jackets, first aid kit

Vehicles	Travel	first aid-kit, fire extinguisher
Tributaries	Habitat Assessment/Fish Inventory/ Water Sampling	field first-aid kit, cellular phone, waterproof boots and gloves for electrofishing, air horn and pepper spray (in case of a bear attack)
Biomarking Tent	Biomarking	safety glasses, and long forceps for use when storing samples in liquid nitrogen dewar, sharps container or used needles and scalpel blades, air horn and pepper spray (in case of a bear attack)
Suncor's Laboratory	Laboratory work	steel toed boots, safety glasses,
Suncor	On Plant Facilities (excluding camp)	steel toed boots, safety glasses, hard hats

Note: Golder requests an exemption from the requirement to wear steel toed boots, hard hats and safety glasses when doing off-site field work.

7. Onsite Organization and Coordination

Component Leader: Randy Shaw RS.
~~Project Manager: Hal Hamilton~~
Field Team Leader: Chris Bjornson
Site Safety Officer: Chris Bjornson

Field Team

Name	Job Function
Chris Bjornson	Field Team Leader and project health and safety coordinator
Richard Schryer	Senior aquatic field technique auditor
Lynda Gummer	Field biological technician
Christine Godwin Sheppard	Field biological technician
Ken Allen	Field biological technician

8. Special Instructions

It is imperative that the field crew check in every three days (minimum) with Kym Holley (wk 403 299-4607,cell phone (403) 660-6948). Also, in event of an emergency, Kym Holley is to be contacted immediately after emergency personnel have been contacted.

Electrofishing and work in remote wilderness areas are two hazards that are specific to this field project. Golder requires that all crew leaders be thoroughly familiar with electrofishing safety standards. All crew leaders must ensure that each crew member is instructed in safety requirements and complies with safety measures. Electrofishing guidelines (attachment 1) are attached. As, well, Golder requires that all crew members be versed in field safety procedures (see attachment 2).

9. Field Procedure Change Authorization

Instruction Number to be Changed

Duration of Authorization Requested
_____ Today only
_____ Duration of Task

Date: _____

Description of Procedures Modification:

Justification:

Person Requesting Change:

_____ _____
Name Time

_____
Title

_____
Signature

Verbal Authorization Received From:

_____
Name

_____
Title

Approved By
(Signature of person named above to be within 48 hours of verbal authorization)

10. Emergency Procedures **This page to be posted at prominent location on site.**

Yes No
___ X On-site Communications Required? Emergency Channel _____

Nearest Telephone Cellular phone (field) and phone at Suncor laboratory (lab)

Fire and Explosion

In the event of a fire or explosion, if the situation can be readily controlled with available resources without jeopardizing the health and safety of yourself, the public, or other site personnel, take immediate action to do so, otherwise:

1. Notify emergency personnel by calling 911
2. If possible, isolate the fire to prevent spreading.
3. Evacuate the area

Chemical Exposure

Site Workers must notify the site health and safety officer immediately in the event of any injury or any of the signs or symptoms of overexposure to hazardous substances identified below:

Substances Present	Symptoms of Acute Exposure	First Aid
Liquid Nitrogen	vapours may cause dizziness or suffocation	move victim to fresh air and call emergency medical care if unconscious
	contact with liquid may cause frostbite	thaw frosted parts with water, treat for shock
Hexane	vapours may cause dizziness	move victim to fresh air and call emergency medical care if unconscious
Formalin	vapours can cause respiratory distress	move victim to fresh air and call emergency medical care if unconscious
	contact with skin may cause irritation	rinse with water for 10 minutes

On site Injury or Illness

In the event of an injury requiring more than minor first aid, or any employee reporting any signs of symptom of exposure to hazardous substances, immediately take the victim to Fort McMurray Hospital located at Fort McMurray, phone (403) 791-6161. In the event of life-threatening or traumatic injury, implement appropriate first-aid and immediately call for emergency medical assistance at Fort McMurray Hospital. The nearest designated trauma center is Fort McMurray Hospital located at Fort McMurray, phone (403) 791-6161.

Designated Personnel Current in First Aid/CPR (Names)

Chris Bjornson, Lynda Gummer, Ken Allen, Tony Calverley

Designated Back-Up Personnel (Names)	Function
Amy Leis	Field biologist
Marie Lagimodiere	Field biologist
Tony Calverley	Field biological technician
Tanis Dirks	Field biological technician
Richard Seraphim	Field biological technician

Emergency Response Authority

Chris Bjornson is the designated site emergency coordinator and has final authority for first response to on-site emergency situations.

Upon arrival of the appropriate emergency response personnel, the site emergency coordinator shall defer all authority but shall remain on the scene if necessary to provide any and all possible assistance. At the earliest possible convenience, the site safety officer or the site emergency coordinator shall contact the emergency contact (who will contact the project coordinator) or the health and safety officer. The emergency contact will be responsible for contacting the project coordinator.

Health and Safety Officer Gord McClymont Phone (w) (403) 299-4610 (h) (403) 240-1180

Emergency Contact Kym Holley Phone (w) (403) 299-4607 (cell phone) (403) 660-6948

Project Coordinator ~~Hal Hamilton~~ Randy Shaw 125 Phone (w) (403) ~~299-5620~~ 249-5637 RS.

11. Safety Briefing On-site

The following personnel were present at pre-job safety briefing conducted at 0815 hrs. on May 9, 1995 at Suncor Site, and have read the above plan and are familiar with its provisions:

Name	Signature
Chris Bjornson	_____
Lynda Gummer	_____
Christine Godwin Sheppard	_____
Ken Allen	_____

The following personnel were present at pre-job safety briefing conducted at hrs. on _____(date) at Suncor Site, and have read the above plan and are familiar with its provisions:

_____ _____

_____ _____

_____ _____

_____ _____

Fully charged ABC Class Fire Extinguisher available on site? YES_____

Fully Stocked First Aid Kit available on site? YES_____

All project personnel advised of location of nearest phone? YES_____

All project personnel advised of location of designated medical facility or facilities? YES _____

Chris Bjornson
Printed Name of Field Team Leader or Site Safety Officer

_____
Signature Date

ATTACHMENT 1

ELECTROFISHING GUIDELINES

CODE OF SAFE PRACTICE

The purpose of these guidelines is to provide a framework for electrofishing crews to safely and efficiently perform work duties. With this in mind the following safety guidelines and operating procedures are recommended. Three factors are important in order to achieve safe, efficient electrofishing:

1. Experienced personnel - all electrofishing crews must have an experienced crew. All other personnel must be provided with a standard one day field course taught by certified crew leaders before commencing project related work. It is recommended that no more than one inexperienced crew member be part of an electrofishing crew.

2. Good equipment - electrofishing equipment must be maintained in good working order and the entire crew must be trained in operation and maintenance. Annual checks must be made by crew leader to verify equipment safety.

3. Good communications - team work is imperative during electrofishing operations. Roles and responsibilities of individual crew members must be defined before operation begins. Safety is the first and most important responsibility of each crew member.

The following are the operating guidelines:

A. Staff Training

1) All permanent and project staff that use electrofishers as a management tool should be familiar with equipment, methods of operation and potential hazards.

2) All accidents or near accidents involving electrofishing must be reported to the Regional Fisheries Biologist, and the Division

Safety Manager by phone followed as soon as possible by written communication.

3) No leaky waders or gloves are to be permitted.

B. Medical Examinations

1) All crew personnel should be physically fit and must report known health problems to their Supervisor.

C. First Aid

1) Two crew members of any electrofishing crew must have a current first aid training and instruction in CPR (Cardio Pulmonary Resuscitation).

D. Personal Equipment

1) All personnel on the electrofishing crew must be equipped with waterproof footwear that is free of leaks. Footwear must be adequate in height to prevent contact with water. Belted chest high waders with slip resistant soles are recommended for most situations. Chest waders provide additional protection from acid burns while backpack electrofishing.

2) All personnel on the electrofishing crew must wear waterproof gloves that are free of leaks.

3) Under most conditions the wearing of polarized lens glasses is recommended to increase in-water visibility (safety) and the effective retrieval of fish (efficiency).

4) At crew leader discretion, crew members will wear a personal flotation device or life jacket and/or a wader belt.

5) All crew members will wear a personal floatation device while electrofishing equipment is in operation.

E. General Operation

1) The person operating the boat or the backpack unit is in charge of the electrofishing controls. Safety is by far this persons most important responsibility.

2) The anode should never touch the cathode or any other equipment.

3) The amperage being put into the water should not normally exceed five (5) amperes. Under some special circumstances with nonpulsed D.C. it may be necessary to exceed this (8-9 amps) to catch fish in deep water or where the bottom is highly conductive.

4) All equipment should be given a thorough inspection before use.

- check main cables for cracks or exposed wires, also
- check operation of safety switches, also
- wires taped with Scotch #88 tape for temporary repair should be replaced at the earliest opportunity.

5) A crew leader must be in charge of the electrofishing operation and working with the crew at all times.

6) Electrofishing must not be conducted if the crew leader feels the equipment is exposed to significant amounts of rain, snow, or spray that could cause an electrical hazard.

7) No one should ever touch the metal part of either electrode in or out of the water when the electrofisher generator is in operation or the battery is connected to the control box on a backpack electrofisher.

8) If any person feels any electric shock, even minor, operation must shut down, equipment checked and procedures reviewed.

F. Boat Electrofishing:

Operation

1) A minimum crew size consists of a crew leader and one assistant.

2) For projects which involve periods of fish collection anticipated to be greater than three days in duration, a crew of at least three individuals is required for the S.R.-18 or Lifetimer boats.

3) The boat operator is responsible for the immediate safety of the crew since he/she is positioned next to the main safety cut off switch and is controlling the boat. Good crew communications and teamwork are critical for safe and efficient electrofishing.

4) Once sufficient experience has been gained by the crew, a rotation of responsibility or roles is desirable to lessen fatigue and increase efficiency.

5) A second boat and crew may be used to process fish to increase the number of fish captured.

6) At least two individuals in the crew must have the ability to disconnect the electrical current at all times. Current control is achieved with foot switches, hand operated panic switches, the generator shut off switch or as a last resort by removing the positive electrode from the water.

Equipment

1) Two Safety switches which break the electrical circuit must be installed on the electrofishing boat. Anode switches are not required.

2) Electrical connections in the boat and to the electrofisher should be of an environmental design and not immersed in water for long periods of time.

3) All exposed wire must be properly insulated.

4) All equipment must be thoroughly inspected annually by a Crew Leader I.

5) Electrode handles must be insulated or constructed of non-conducting materials. The material should be strong enough to assist with a persons balance.

6) All equipment must be on a common ground.

7) Crews should have waterproof bags with: a) first aid kit, b) change of clothes, c) spare waders, and d) matches.

8) A fire extinguisher must be present with any gas motor.

9) A standard procedure or check list must be used.

G. Backpack Electrofishing:

Operation

1) A minimum crew size consists of a crew leader and one assistant.

2) One dip netter should maintain a secure position so that person can provide assistance to other crew members in case of a fall or other mishap.

3) Under most conditions to avoid fatigue the electrofisher should be frequently rotated among the crew.

Equipment

1) Backpack electrofishers must be equipped with a safety switch which cuts power if the unit is dangerously tilted, a dead man switch on the anode and a quick release shoulder harness.

2) All new models must be inspected once by Electrical Protection Branch before use in the province.

3) All units must be inspected annually be a Crew Leader I.

4) A standard procedure or check list must be used.

H. The Electrofishing Section

1) Electrofishing sections must be scouted prior to electrofishing. This should be accompanied by walking the entire section and making observations of deadfall, long jams. ledges, waterfalls or extensive sections of shallow riffle. Scouting may also be accomplished by experienced boaters using canoes or a 12 foot boat with oars or paddles. It must be stressed that in unfamiliar waters a scouting boat should only be used by experienced personnel. Workers should be aware that river conditions are extremely variable at different flows and hazards (log jams) or hardships (shallow riffles) must be evaluated accordingly. Alternate access should be identified.

2) Check the weather, volume of flow, turbidity etc., prior to the field trip to ensure that the crew can achieve the day's objective safely.

ATTACHMENT 2

GOLDER SAFETY PROCEDURES FOR FIELD WORK

General

All participants in field surveys must attend a 4 hour Suncor-Syncrude Safety Orientation Program. All contractors must also comply with the guidelines outlined in Suncor's Loss Management Reference Booklet, which is attached to all contracts.

- At least one member of a field crew should be certified in Standard First-aid and CPR. All staff should at least have training in Standard First Aid.
- Safety procedures and equipment must be discussed and agreed upon between all members of a field crew and the Field Safety Officer. Safety procedures and equipment should be reviewed at frequent intervals during the work (e.g. at least weekly initially; monthly for long-term projects)
- Clothing must be appropriate for terrain or industrial site, and weather.
- Staff involved in strenuous field activities should have an annual medical/physical examination by a physician.
- All field workers should be aware of the effects of fatigue and extreme temperatures on their ability to function safely and efficiently.

Remote (Wilderness) Sites

For the purposes of these safety requirements, a remote site is one that is more than 30 minutes' traveling time from a telephone.

- A minimum of two persons is normally required, unless there is agreement between the Field Safety Officer and an employee who is experiences and properly trained in work in the area and is safe for the experienced employee to go alone. Inexperienced full-time or part-time staff should not be permitted to do fieldwork alone.
- An itinerary and schedule must be left with the Team Leaders. A schedule of phone-in times must also be agreed upon. The Team Leaders must know the locations of field workers every day.
- Suitable emergency equipment must be taken. This may include, but not be restricted to food, tent, sleeping bag, survival kit, all-weather clothing, compass, maps, GPS units, bear repellent, field first aid kit, and VHF radio/cellular phone.
- Advice must be obtained from local Fish and Wildlife Branch Officers in areas where animals may pose a threat

- All personnel must be given a safety orientation regarding entering and exiting helicopters if their work requires helicopter transport.

- Pick-up or rendezvous times must be agreed upon and strictly adhered to it a person is being dropped off and met later. Contingency plans must be made for the person(s) dropped off in case it is impossible for transportation to arrive on schedule.

- For travel on logging or other restricted roads during hours of operation, radio contact should be maintained with the appropriate control center. As a minimum requirement, clearance and scheduling must be obtained through the company controlling road use.

Other Natural Environment Sites

- All the above requirements apply, except that the need for emergency equipment may be reduced.

APPENDIX V

SAMPLE PRESERVATION PROCEDURES FOR CHEMICAL, PHYSICAL, AND MICROTOX® ANALYSES

WATER PARAMETER	CONTAINER	HOLDING TIME	PRESERVATIVE
Routine Water Analyses Package #3	Plastic		No
	Plastic		1.25 mL 1:1 HNO_3 (50% nitric acid)
Calcium	Plastic	ASAP	Keep cool 4°C
Magnesium	Plastic	ASAP	Keep cool 4°C
Sodium	Plastic	ASAP	Keep cool 4°C
Potassium	Plastic	ASAP	Keep cool 4°C
Chloride	Plastic	ASAP	Keep cool 4°C
Sulphate	Plastic	ASAP	Keep cool 4°C
Total Alkalinity	Plastic	ASAP	Keep cool 4°C
pH	Plastic	ASAP	Keep cool 4°C
Carbonate	NA	ASAP	Keep cool 4°C
Bicarbonate	NA	ASAP	Keep cool 4°C
Total Hardness	NA	ASAP	Keep cool 4°C
Specific Conductance	Plastic	ASAP	Keep cool 4°C
TDS	NA	ASAP	Keep cool 4°C
Aluminum	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Barium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Beryllium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Boron	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Cadmium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Chromium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Cobalt	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Iron	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Lead	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Lithium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Manganese	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Molybdenum	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Nickel	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Silver	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Strontium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Titanium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Vanadium	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Zinc	Plastic	6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Nitrate + Nitrite	Plastic	48 hours	Keep cool 4°C
Hydride Metals Package #2	Plastic		
Arsenic		6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Selenium		6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Mercury		28 days	2 mL $K_2CF_2O_7$ HNO_3 (potassium dichromate & nitric acid)
Antimony		6 months	1.25 mL 1:1 HNO_3 (50% nitric acid)
Ammonia N	Plastic	28 days	5 mL 12.5% H_2SO_4
Total Cyanide	Plastic	14 days	2 mL 6N NaOH (sodium hydroxide)
Total Phenolics	Glass	28 days	2 mL 12.5% H_2SO_4
Organic Carbon	Plastic	ASAP	Keep cool 4°C
Suspended Solids	Plastic	ASAP	Keep cool 4°C
Chlorophyll "a"	Plastic	ASAP	1 mL 10% $MgCo_3$ (magnesium carbonate)
BOD	Plastic	ASAP	Keep cool 4°C
Total Phosphorus	Plastic	ASAP	Keep cool 4°C

SOIL PARAMETER	CONTAINER	HOLDING TIME	PRESERVATIVE
Texture (% sand, silt, clay)	Ziploc	NA	No
Atterberg limits	Ziploc	NA	No
Available H20	Ziploc	NA	No
EXCAT5 Package	Ziploc	NA	No
Cation Exchange Capacity			
Exchangeable Cations			
Exchangeable Sodium %			
Total Exchangeable Cations			
% Base Saturation			
T.O.C. & Organic Matter	Ziploc	NA	No
Total Nitrogen	Ziploc	NA	No
C:N Ratio	Ziploc	NA	No
NUTRS Package	Ziploc	NA	
Available Nitrate N			No
Ammonia N			
Phosphorus			
Sulphate			
Avail. Calcium, Magnesium, Sodium by ammonium N acetate extract	Ziploc	NA	No
pH in $CaCl_2$ 1:2 ratio	Ziploc	NA	No
Salinity Package #3	Ziploc	NA	No
pH			
EC			
% Saturation			
Calcium			
Magnesium			
Sodium			
SAR			
Theoretical Gypsum Requirement			
Total Petroleum Hydrocarbon	Ziploc	14 days	No
Mercury	Ziploc	NA	No
ICP - 14 Element Scan*	Ziploc	NA	No
Arsenic			
Barium			
Beryllium			
Cadmium			
Chromium			
Cobalt			
Copper			
Lead			
Molybdenum			
Nickel			
Selenium			
Thallium			
Vanadium			
Zinc			

* Includes dry, grind, acid digestion

SEDIMENT, TISSUE PARAMETER	CONTAINER	HOLDING TIME	PRESERVATIVE
ICP - 26 Element Profile*	Ziploc	NA	No
Aluminum			
Barium			
Beryllium			
Boron			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead			
Lithium			
Magnesium			
Manganese			
Molybdenum			
Nickel			
Phosphorus			
Potassium			
Silicon			
Silver			
Sodium			
Strontium			
Titanium			
Vanadium			
Zinc			
Uranium			
Hydride Metals Package #2	Ziploc	NA	No
Total Arsenic			
Antimony			
Selenium			
Mercury			
Organic Carbon	Ziploc		No
Chlorophyll "a"	Ziploc	NA	No

Reference No.	Description
1	Standard Methods for the Examination of Water and Wastewater
2	Methods Manual for Forests and Plant Analysis
3	Soil Sampling and Methods of Analysis - McKeague
4	Methods of Soil Analysis Chemical and Microbiological Properties
5	Soil Science Principles and Practices

PARAMETER	CONTAINER	HOLDING TIME	PRESERVATIVE
Acute Toxicity by Microtox Bioassay	glass	72 hrs	Cool/4°C
Naphthenates	glass	14 days	Cool/4°C

5. TABLE OF REQUIREMENTS FOR ANALYSIS - SUMMARY

Analysis	Bottle	Minimal Volume/ weight	Preservative	Storage
PAH/PANH/TOTAL EXTRACTABLES/PHENOLICS IN WATER	4L	4L	none	4°C
VOLATILE ORGANICS IN WATER	3 x 40mL volatile vials	3 x 40 mL /sample	sodium thiosulfute	4°C
PAH/PANH/TOTAL EXTRACTABLES SOIL	125 mL jar	100 grams	none	4°C
PAH/PANH IN INVERTEBRATES	500 mL jar	250 grams wet weight	none	frozen at -20°C
PAH/PANH IN FISH	wrapped in rinsed tin foil, in ziplock bags	100 grams	none	frozen at -20°C

APPENDIX VI

PROPOSED CHEMICAL DICTIONARY

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
1-METHNAP	1-METHYL NAPHTHALENE	PAH	PPB	
1-METPYR	1-METHYLPYRENE	TIO	PPB	
11-2CLETH	1,1-DICHLOROETHANE	VOLATILE	PPB	
11-2CLETHE	1,1-DICHLOROETHENE	VOLATILE	PPB	
111-3CLETH	1,1,1-TRICHLOROETHANE	VOLATILE	PPB	
112-3CLETH	1,1,2-TRICHLOROETHANE	VOLATILE	PPB	
1122-4CLET	1,1,2,2-TETRACHLOROETHANE	VOLATILE	PPB	
12-2CLBNZ	1,2-DICHLOROBENZENE	ABN	PPB	
12-2CLETH	1,2-DICHLOROETHANE	VOLATILE	PPB	
12-2CLETHE	1,2-DICHLOROETHENE	VOLATILE	PPB	
12-2CLPRP	1,2-DICHLOROPROPANE	VOLATILE	PPB	
12-2CLPRPE	1,2-DICHLOROPROPENE	VOLATILE	PPB	
12-2MHYZ	1,2-DIMETHYLHYDRAZINE	ABN	PPB	
12-2PHHYZ	1,2-DIPHENYLHYDRAZINE	ABN	PPB	
12-CLDHA	12-CHLORODEHYDROABIETIC ACID	RESIN-AC	PPB	
124-3CLBNZ	1,2,4-TRICHLOROBENZENE	ABN	PPB	
1245-4CLBZ	1,2,4,5-TETRACHLOROBENZENE	ABN	PPB	
13-2CLBNZ	1,3-DICHLOROBENZENE	ABN	PPB	
13-2CLPRP	1,3-DICHLOROPROPANE	VOLATILE	PPB	
13-2CLPRPE	1,3-DICHLOROPROPENE	VOLATILE	PPB	
14-2CLBNZ	1,4-DICHLOROBENZENE	ABN	PPB	
14-CLDHA	14-CHLORODEHYDROABIETIC ACID	RESIN-AC	PPB	
16-0FA	HEXADECANOIC ACID	TIO	PPB	
16-0FAME	HEXADECANOIC ACID, METHYL ESTER	TIO	PPB	
16-1FAME	HEXADECENOIC ACID METHYL ESTER	TIO	PPB	
1METPHENAN	1-METHYL PHENANTHRENE	ABN	PPB	
2,4,5-T	2,4,5-T (HERBICIDE)	PEST-PCB	PPB	
2,4-D	2,4-D (HERBICIDE)	PEST-PCB	PPB	
2-BUTANONE	2-BUTANONE	VOLATILE	PPB	
2-BUTANONE	BUTANONE_2	VOLATILE		
2-CLEVE	2-CHLOROETHYLVINYL ETHER	VOLATILE	PPB	
2-CLNAP	2-CHLORONAPHTHALENE	PAH	PPB	
2-CLPHN	2-CHLOROPHENOL	ABN	PPB	
2-HEXANONE	2-HEXANONE	VOLATILE	PPB	
2-METHNAP	2-METHYLNAPHTHALENE	PAH	PPB	
2-METPHNOL	2-METHYLPHENOL	ABN	PPB	
2-METPHNOL	METPHNOL_2	ABN		
2-METPYR	2-METHYLPYRENE	TIO	PPB	
2-MTOXPHN	2-METHOXYPHENOL	ABN	PPB	
2-NANILINE	2-NITROANILINE	ABN	PPB	
2-NPHN	2-NITROPHENOL	ABN	PPB	
24-2CLPHN	2,4-DICHLOROPHENOL	ABN	PPB	
24-2MPHN	2,4-DIMETHYL PHENOL	ABN	PPB	
24-2NPHN	2,4-DINITROPHENOL	ABN	PPB	
24-2NTOL	2,4-DINITROTOLUENE	ABN	PPB	
245-3CLPHN	2,4,5-TRICHLOROPHENOL	ABN	PPB	
246-3CLPHN	2,4,6-TRICHLOROPHENOL	ABN	PPB	
26-2NTOL	2,6-DINITROTOLUENE	ABN	PPB	
26/27-2MNP	2,6-/2,7-DIMETHYLNAPTHALENE	ABN		
2BANTH	DIBENZO(A,H)ANTHRACENE	PAH	PPB	
2BRCLETH	DIBROMOCHLOROETHANE	VOLATILE	PPB	
2BRCLMETH	DIBROMOCHLOROMETHANE	VOLATILE	PPB	
2CLBRMETHA	BROMODICHLOROMETHANE	VOLATILE	PPB	
2CLPRPANES	TOTAL DICHLOROPROPANES	VOLATILE	PPB	
2CLPRPENES	TOTAL DICHLOROPROPENES	VOLATILE	PPB	
2METPHENAN	2-METHYL PHENANTHRENE	PAH	PPB	
2NOCTP	DI-N-OCTYL PHTHALATE	PAH	PPB	
3-METHNAP	TRIMETHYLNAPHTHALENE	PAH	PPB	
3-NANILINE	3-NITROANILINE	ABN	PPB	
33-2CLBZID	CLBZID33_2	ABN		

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
33-2CLBZID	3,3'-DICHLOROBENZIDINE	ABN	PPB	
3CLETHENE	CLETHENE3	VOLATILE		
3CLETHENE	TRICHLOROETHENE	VOLATILE	PPB	
3METPHENAN	3-METHYL PHENANTHRENE	PAH	PPB	
4-BPPE	4-BROMOPHENYL PHENYL ETHER	ABN	PPB	
4-CL2-MPHN	4-CHLORO-2-METHYLPHENOL	ABN	PPB	
4-CL3-MPHN	4-CHLORO-3-METHYLPHENOL	ABN	PPB	
4-CPPE	4-CHLOROPHENYL PHENYL ETHER	ABN	PPB	
4-M2-PNTNO	4-METHYL-2-PENTANONE	VOLATILE	PPB	
4-METPHNOL	4-METHYL PHENOL	ABN	PPB	
4-NANILINE	4-NITROANILINE	ABN	PPB	
4-NPHN	4-NITROPHENOL	ABN	PPB	
4CLETHENE	TETRACHLOROETHYLENE	VOLATILE	PPB	
5CLPHN	PENTACHLOROPHENOL	ABN	PPB	
6CL-CHX-A	HEXACHLOROCYCLOHEXANE-ALPHA	PEST-PCB	PPB	
6CL-CHX-B	HEXACHLOROCYCLOHEXANE-BETA	PEST-PCB	PPB	
6CL-CHX-D	HEXACHLOROCYCLOHEXANE-DELTA	PEST-PCB	PPB	
6CL-CHX-G	HEXACHLOROCYCLOHEXANE-GAMMA (LINDAN	PEST-PCB	PPB	
6CL-CHX-T	HEXACHLOROCYCLOHEXANE-TECH GRADE	PEST-PCB	PPB	
6CLBNZ	HEXACHLOROBENZENE	ABN	PPB	
6CLBUTAD	HEXACHLOROBUTADIENE	ABN	PPB	
6CLCYPEN	HEXACHLOROCYCLOPENTADIENE	ABN	PPB	
6CLETH	HEXACHLOROETHANE	ABN	PPB	
6CLPHENE	HEXACHLOROPHENE	ABN	PPB	
6DIMETNAPH	6-DIMETHYL NAPHTHALENE	ABN	PPB	
ABIETIC	ABIETIC ACID	RESIN-AC	PPB	
ACENAPTHEN	ACENAPHTHENE	PAH	PPB	
ACENAPTHEN	ACENAPHTHE	PAH		
ACENAPTYLE	ACENAPHTHYLENE	PAH	PPB	
ACENPHEN	ACENAPHTHENE/PHENANTHRENE	PAH	PPB	
ACETONE	ACETONE	VOLATILE	PPB	
ACROLEIN	ACROLEIN	VOLATILE	PPB	
ACRYLNTRLE	ACRYLONITRILE	VOLATILE	PPB	
AH-TOT	TOTAL AROMATIC HYDROCARBONS	PAH	PPB	
ALDRIN	ALDRIN (PESTICIDE)	PEST-PCB	PPB	
ALKANOL	UNIDENTIFIED ALKANOL	TIO	PPB	
ALKLNTY	ALKALINITY	CONVENT	2	
ALUMINUM	ALUMINUM	METALS	PPM	
AMMONIA	TOTAL AMMONIA	CONVENT	2	
AMMONIA-D	DISSOLVED AMMONIA	CONVENT	2	
AMMONIA-N	AMMONIA-NITROGEN	CONVENT	2	
AMMONIUM	TOTAL NH4	CONVENT	2	
AMMONIUM-D	DISSOLVED NH4	CONVENT	2	
ANTHRACENE	ANTHRACENE	PAH	PPB	
ANTIMONY	ANTIMONY (SB)	METALS	PPM	
AROM_HCBN	AROMATIC HYDROCARBONS	ABN	PPB	
ARSENIC	ARSENIC (AS)	METALS	PPM	
ATRAZINE	ATRAZINE (PESTICIDE)	PEST-PCB	PPB	
AVS	ACID VOLATILE SULFATE	CONVENT	UM/G	
B2CEE	BIS(2-CHLOROETHYL)ETHER	ABN	PPB	
B2CIE	BIS-(2-CHLOROISOPROPYL) ETHER	ABN	PPB	
B2ETHXPHTH	BIS(2-ETHYLHEXYL)PHTHALATE	PAH	PPB	
BAA	BENZO(A)ANTHRACENE	PAH	PPB	
BAF	BENZO(A)FLUORANTHENE	PAH	PPB	
BAP	BENZO(A)PYRENE	PAH	PPB	
BARIUM	BARIUM	METALS	PPM	
BARIUM	BA	METALS		
BBF	BENZO(B)FLUORANTHENE	PAH	PPB	
BBKF	BENZO(B,K)FLUORANTHENE	PAH	PPB	
BCEOM	BIS(2-CHLOROETHOXY) METHANE	ABN	PPB	

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
BCIE	BIS(2-CHLOROISOPROPYL) ETHER	ABN	PPB	
BENZCHRY	BENZO(A)ANTHRACENE/CHRYSENE	PAH	PPB	
BENZENE	BENZENE	VOLATILE	PPB	
BENZOIC_AC	BENZOIC ACID	ABN	PPB	
BENZYL-OH	BENZYL ALCOHOL	ABN	PPB	
BEP	BENZO(E)PYRENE	PAH	PPB	
BERYLLIUM	BE	METALS		
BERYLLIUM	BERYLLIUM	METALS	PPM	
BGHIP	BENZO(G,H,I)PERYLENE	PAH	PPB	
BIPHENYL	BIPHENYL	TIO	PPB	
BKF	BENZO(K)FLUORANTHENE	PAH	PPB	
BORON	BORON	METALS	PPM	
BPK181-1	BASE PEAK M/Z 181, ISOMER 1	TIO	PPB	
BPK181-2	BASE PEAK M/Z 181,ISOMER 2	TIO	PPB	
BRMETH	BROMOMETHANE	VOLATILE	PPB	
BROMOFORM	BROMOFORM	VOLATILE	PPB	
BUTBNZ-PHT	BUTYL BENZYL PHTHALATE	PAH	PPB	
BZID	BENZIDINE	ABN	PPB	
C13-2CLPRE	C13_2CLPRE	VOLATILE		
C13-2CLPRE	CIS 1,3 DICHLOROPROPENE	VOLATILE	PPB	
C13-2CLPRP	CIS-1,3-DICHLOROPROPANE	VOLATILE	PPB	
C1PHENANS	C1-PHENANTHRENES	PAH	PPB	
C2NAPHTHS	C2-NAPHTHALENES	PAH	PPB	
C2PHENANS	C2-PHENANTHRENES	PAH	PPB	
C3NAPHTHS	C3-NAPTHALENES	PAH	PPB	
C3PHENANS	C3-PHENANTHRENES	PAH	PPB	
CADMIUM	CADMIUM (CD)	METALS	PPM	
CALCIUM	CALCIUM (CA)	METALS	2	
CAMPESTROL	CAMPESTEROL	TIO	PPB	
CARBARYL	CARBARYL (PESTICIDE)	PEST-PCB	PPB	
CARBAZOLE	CARBAZOLE	ABN	PPB	
CARBON	CARBON	CONVENT	PCT	
CARBON-TET	CARBON TETRACHLORIDE	VOLATILE	PPB	
CEC	CATION EXCHANGE CAPACITY	CONVENT	MEQ/KG	
CHLDANE-A	ALPHA CHLORDANE (PESTICIDE)	PEST-PCB	PPB	
CHLDANE-TR	TRANS-CHLORDANE	PEST-PCB	PPB	
CHLDNE-CIS	CIS-CHLORDANE	PEST-PCB	PPB	
CHLDNE-OXY	OXYCHLORDANE	PEST-PCB		
CHLORDAN-A	CHLORDANE - ALPHA	PEST-PCB		
CHLORDAN-G	CHLORDANE - GAMMA	PEST-PCB		
CHLORDANE	CHLORDANE	PEST-PCB	PPB	
CHLORIDE	TOTAL CHLORIDE	CONVENT	PPB	
CHLORINE	CHLORINE	CONVENT	PPB	
CHLOROFORM	CHLOROFORM	VOLATILE	PPB	
CHOLESTNOL	CHOLESTANOL	TIO	PPB	
CHOLESTROL	CHOLESTEROL (CHOLEST-5-EN-3[BETA]-OL)	TIO	PPB	
CHROMIUM	CHROMIUM TOTAL (CR)	METALS	PPM	
CHROMIUM-3	CHROMIUM TRIVALENT	METALS	PPM	
CHROMIUM-6	CHROMIUM HEXAVALENT	METALS	PPM	
CHRYSENE	CHRYSENE	PAH	PPB	
CLBNZ	CHLOROBENZENE	VOLATILE	PPB	
CLETH	CHLOROETHANE	VOLATILE	PPB	
CLMETH	CHLOROMETHANE	VOLATILE	PPB	
CO2	CARBON DIOXIDE	CONVENT	2	
CO3	CO3	CONVENT	PCT	
COBALT	COBALT (CO)	METALS	PPM	
CONDUCT	CONDUCTIVITY	CONVENT	8	
COPPER	COPPER (CU)	METALS	PPM	
COPROSTANL	COPROSTANOL	TIO	PPB	
CS2	CARBON DISULFIDE	VOLATILE	PPB	

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
CYANIDE	CYANIDE	METALS	PPM	
CYMENE	CYMENE (UNSPECIFIED ISOMER)	TIO	PPB	
DDD-DDT	P,P'-DDD & O,P'-DDT	PEST-PCB	PPB	
DDD-SUM	SUM OF P,P'-DDD AND O,P'-DDD	PEST-PCB	PPB	
DDE-SUM	SUM OF P,P'-DDE AND O,P'-DDE	PEST-PCB	PPB	
DDT-SUM	SUM OF P,P'-DDT AND O,P'-DDT	PEST-PCB	PPB	
DDT-TOTAL	TOTAL DDTS	PEST-PCB	PPB	
DECCL-BIPH	DECACHLORO BIPHENYLS	PCB	PPB	
DEHP	DIETHYL HEXYLPHTHALATE	ABN	PPB	
DEMETON	DEMENTON	PEST-PCB	PPB	
DEP	DIETHYL PHTHALATE	ABN	PPB	
DHA	DEHYDROABIETIC ACID	RESIN-AC	PPB	
DIAZINON	DIAZINON (PESTICIDE)	PEST-PCB	PPB	
DIBNZFURAN	DIBENZOFURAN	ABN	PPB	
DIBNZTHIO	DIBENZOTHIOPHENE	ABN	PPB	
DICL_BIPH	DICHLORO BIPHENYLS	PEST-PCB	PPB	
DICLDHA	DICHLORODEHYDROABIETIC ACID	RESIN-AC	PPB	
DIELDR+ALD	TOTAL DIELDRIN PLUS ALDRIN	PEST-PCB		
DIELDR+DDE	DIELDRIN+4,4'-DDE	PEST-PCB	PPB	
DIELDRIN	DIELDRIN (PESTICIDE)	PEST-PCB	PPB	
DIELDRIN	DIELDRIN	PEST-PCB		
DINBP	DI-N-BUTYL PHTHALATE	ABN	PPB	
DIOXIN	TOTAL DIOXINS	DIOXIN	PPB	
DIPHHYZ	DIPHENYLHYDRAZINE	ABN	PPB	
DMBA	7,12-DIMETHYLBENZ(A)ANTHRACENE	PAH	PPB	
DMP	DIMETHYL PHTHALATE	ABN	PPB	
DOSAT	DISSOLVED OXYGEN-% SATURATION	CONVENT	PCT	
DTRPHC-255	DITERPENOID HYDRCARBN (DEHYDROABIETA	TIO	PPB	
DTRPOH-271	DITERPENOID ALCOHOL (TOTAROL?)	TIO	PPB	
ENDOSLFN-A	ALPHA ENDOSULFAN	PEST-PCB	PPB	
ENDOSLFN-B	BETA ENDOSULFAN	PEST-PCB	PPB	
ENDOSLFN-S	ENDOSULFAN SULFATE	PEST-PCB	PPB	
ENDOSULFAN	ENDOSULFAN (PESTICIDE)	PEST-PCB	PPB	
ENDRIN	ENDRIN (PESTICIDE)	PEST-PCB	PPB	
ENDRIN-ALD	ENDRIN ALDEHYDE	PEST-PCB	PPB	
ENDRIN-KET	ENDRIN KETONE	PEST-PCB	PPB	
ETHYLBENZ	ETHYLBENZENE	VOLATILE	PPB	
FLUORANTHN	FLUORANTHENE	PAH	PPB	
FLUORENE	FLUORENE	PAH	PPB	
FLUORIDE	FLUORIDE	METALS	PPB	
GOLD	GOLD	METALS	PPM	
GRAINSIZE	GRAIN SIZE	CONVENT	phi	
GUTHION	GUTHION (PESTICIDE)	PEST-PCB	PPB	
H-METHANES	TOTAL HALOMETHANES	VOLATILE	PPB	
HEPCL-BIPH	HEPTACHLORO BIPHENYLS	PEST-PCB	PPB	
HEPCL-EPOX	HEPTACHLOR EPOXIDE (PESTICIDE METAB)	PEST-PCB	PPB	
HEPTACHLOR	HEPTACHLOR (PESTICIDE)	PEST-PCB	PPB	
HEPTEPO-EN	HEPTACHLOR EPOXIDE (ENDO)	PEST-PCB		
HEPTEPO-EX	HEPTACHLOR EPOXIDE (EXO)	PEST-PCB		
HEXCL-BIPH	HEXACHLORO BIPHENYLS	PEST-PCB	PPB	
HPAH	SUM OF HIGH MW PAH	PAH		
HPCDD-A		DIOXIN	PPB	
HPCDD-T		DIOXIN	PPB	
HPCDF-A		FURAN	PPB	
HPCDF-B		FURAN	PPB	
HPCDF-T		FURAN	PPB	
HSP	POREWATER HYDROGEN SULFIDE	CONVENT	MG/L	
HXCDD-A		DIOXIN	PPB	
HXCDD-B		DIOXIN	PPB	
HXCDD-C		DIOXIN	PPB	

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
HXCDD-T		DIOXIN	PPB	
HXCDF-A		FURAN	PPB	
HXCDF-B		FURAN	PPB	
HXCDF-C		FURAN	PPB	
HXCDF-D		FURAN	PPB	
HXCDF-T		FURAN	PPB	
HYZ	HYDRAZINE	ABN	PPB	
ICDP	INDENO(1,2,3-CD)PYRENE	PAH	PPB	
IRON	IRON (FE)	METALS	PPM	
ISOPHORONE	ISOPHORONE (PESTICIDE)	PEST-PCB	PPB	
ISOPIMAR	ISOPIMARADIENE	TIO	PPB	
ISOPIMARIC	ISOPIMARIC ACID	RESIN-AC	PPB	
ISOPROPANL	ISOPROPANOL	SVOC	PPB	
KAUR16EN	KAUR-16-ENE	TIO	PPB	
KELTHANE	KELTHANE (PESTICIDE)	PEST-PCB	PPB	
KEPONE	KEPONE (PESTICIDE)	PEST-PCB	PPB	
LEAD	LEAD	METALS	PPM	
LITHIUM	LITHIUM	METALS	PPM	
LPAH	SUM OF LOW MW PAH	PAH		
MAGNESIUM	MAGNESIUM (MG)	METALS	PPM	
MALATHION	MALATHION (PESTICIDE)	PEST-PCB	PPB	
MANGANESE	MANGANESE (MN)	METALS	PPM	
MERCURY	MERCURY (HG)	METALS	PPM	
METH-HYZ	METHYL HYDRAZINE	ABN	PPB	
METHOMYL	METHOMYL (PESTICIDE)	PEST-PCB	PPB	
METHOXYCL	METHOXYCHLOR (PESTICIDE)	PEST-PCB	PPB	
METHYL-HG	METHYLMERCURY	METALS	PPB	
METHYLE-CL	METHYLE_CL	VOLATILE		
METHYLE-CL	METHYLENE CHLORIDE (DICLMETHANE)	VOLATILE	PPB	
METPHNAN-T	TOTAL METHYL PHENANTHRENE (1- + 2-)	PAH	PPB	
MIREX	MIREX (PESTICIDE = DECHLORANE)	PEST-PCB	PPB	
MOLYBDENUM	MOLYBDENUM	METALS	PPM	
NAPTHALENE	NAPHTHALENE	PAH	PPB	
NBNZ	NITROBENZENE	ABN	PPB	
NEOABIET	NEOABIETIC ACID	RESIN-AC	PPB	
NICKEL	NICKEL (NI)	METALS	PPM	
NITRATE	TOTAL NO3-N (NITRATE NITROGEN)	CONVENT	2	
NITRITE	TOTAL NO2-N (NITRITE NITROGEN)	CONVENT	2	
NITROGEN	TOTAL NITROGEN (NO2+NO3+NH4)	CONVENT	2	
NITROGEN-K	TOTAL KJELDAHL NITROGEN	CONVENT	2	
NITROGEN-O	TOTAL ORGANIC NITROGEN	CONVENT	2	
NNDMA	N-NITROSO DIMETHYLAMINE	ABN	PPB	
NNDNPRA	N-NITROSO DI-N-PROPYLAMINE	ABN	PPB	
NNP	N-NITROSO DIPHENYLAMINE	ABN	PPB	
NO2NO3-N	TOTAL NITROGEN (NO2+NO3)	CONVENT	2	
NONCL-BIPH	NONACHLORO BIPHENYLS	PCB	PPB	
OCDD		DIOXIN	PPB	
OCDF		FURAN	PPB	
OCTCL-BIPH	OCTACHLORO BIPHENYLS	PCB	PPB	
OIL/GREASE	OIL AND GREASE	CONVENT	2	
OP-DDD	O,P'-DDD	PEST-PCB	PPB	
OP-DDE	O,P'-DDE	PEST-PCB	PPB	
OP-DDT	O,P'-DDT	PEST-PCB	PPB	
P-CL-MCRSL	P-CHLORO-M-CRESOL (PCMC)	ABN	PPB	
P135144124	PCB135/144/124	PCB		
P202171156	PCB202/171/156	PCB		
PAH-SUM	SUM OF PAH	PAH		
PARATHION	PARATHION (PESTICIDE)	PEST-PCB	PPB	
PB101_90	PCB101/090	PCB		
PB123_149	PCB123/149	PCB		

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
PB129_178	PCB129/178	PCB		
PB157_201	PCB157/201	PCB		
PB16_PB32	PCB016/032	PCB		
PB17_PB15	PCB017/015	PCB		
PB170_190	PCB170/190	PCB		
PB182_187	PCB182/187	PCB		
PB196_203	PCB196/203	PCB		
PB20_33_53	PCB020/033/053	PCB		
PB208_195	PCB208/195	PCB		
PB24_PB27	PCB024/027	PCB		
PB47_PB48	PCB047/048	PCB		
PB49_PB43	PCB049/043	PCB		
PB56_PB60	PCB056/060	PCB		
PB66_95_88	PCB066/095/088	PCB		
PB70_PB76	PCB070/076	PCB		
PCB-1016	AROCLOR-1016	PEST-PCB	PPB	
PCB-1221	AROCLOR-1221	PEST-PCB	PPB	
PCB-1232	AROCLOR-1232	PEST-PCB	PPB	
PCB-1242	AROCLOR-1242	PEST-PCB	PPB	
PCB-1248	AROCLOR-1248	PEST-PCB	PPB	
PCB-1254	AROCLOR-1254	PEST-PCB	PPB	
PCB-1260	AROCLOR-1260	PEST-PCB	PPB	
PCB-SUM	TOTAL PCB	PCB		
PCB006	PCB006	PCB		
PCB008	PCB008	PCB	PPB	
PCB018	PCB018	PCB	PPB	
PCB019	PCB019	PCB		
PCB022	PCB022	PCB		
PCB025	PCB025	PCB		
PCB026	PCB026	PCB		
PCB028	PCB028	PCB	PPB	
PCB029	PCB029	PCB	PPB	
PCB031	PCB031	PCB		
PCB040	PCB040	PCB		
PCB041	PCB041	PCB		
PCB042	PCB042	PCB		
PCB044	PCB044	PCB	PPB	
PCB045	PCB045	PCB		
PCB046	PCB046	PCB		
PCB050	PCB050	PCB	PPB	
PCB051	PCB051	PCB		
PCB052	PCB052	PCB	PPB	
PCB063	PCB063	PCB		
PCB064	PCB064	PCB		
PCB066	PCB066	PCB	PPB	
PCB067	PCB067	PCB		
PCB074	PCB074	PCB		
PCB077	PCB077	PCB		
PCB077/154	PCB077/154	PCB	PPB	
PCB081	PCB081	PCB		
PCB083	PCB083	PCB		
PCB084	PCB084	PCB		
PCB087	PCB087	PCB		
PCB091	PCB091	PCB		
PCB092	PCB092	PCB		
PCB097	PCB097	PCB		
PCB099	PCB099	PCB		
PCB101	PCB101	PCB	PPB	
PCB105	PCB105	PCB	PPB	
PCB107	PCB107	PCB		

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
PCB110	PCB110	PCB	PPB	
PCB114	PCB114	PCB		
PCB118	PCB118	PCB	PPB	
PCB119	PCB119	PCB		
PCB123	PCB123	PCB		
PCB126	PCB126	PCB	PPB	
PCB128	PCB128	PCB	PPB	
PCB130	PCB130	PCB		
PCB132	PCB132	PCB		
PCB134	PCB134	PCB		
PCB136	PCB136	PCB		
PCB137	PCB137	PCB		
PCB138	PCB138	PCB	PPB	
PCB141	PCB141	PCB		
PCB146	PCB146	PCB		
PCB153	PCB153	PCB	PPB	
PCB156	PCB156	PCB		
PCB157	PCB157	PCB		
PCB158	PCB158	PCB		
PCB167	PCB167	PCB		
PCB167	PCB167	PCB		
PCB169	PCB169	PCB		
PCB170	PCB170	PCB	PPB	
PCB172	PCB172	PCB		
PCB174	PCB174	PCB		
PCB176	PCB176	PCB		
PCB177	PCB177	PCB		
PCB179	PCB179	PCB		
PCB180	PCB180	PCB	PPB	
PCB183	PCB183	PCB		
PCB185	PCB185	PCB		
PCB187	PCB187	PCB	PPB	
PCB189	PCB189	PCB		
PCB191	PCB191	PCB		
PCB193	PCB193	PCB		
PCB194	PCB194	PCB		
PCB195	PCB195	PCB	PPB	
PCB199	PCB199	PCB		
PCB200	PCB200	PCB		
PCB206	PCB206	PCB	PPB	
PCB207	PCB207	PCB		
PCB208	PCB208	PCB		
PCB209	PCB209	PCB	PPB	
PCB4_PCB10	PCB004/010	PCB		
PCB5_PCB8	PCB005/008	PCB		
PCB7_PCB9	PCB007/009	PCB		
PCB82_151	PCB082/151	PCB		
PCBS-SUM	TOTAL POLYCHLORINATED BIPHENYLS	PCB	PPB	
PCBS-TOT	TPCBS, CORRECTED	PCB	PPB	
PCD-EQ	TCDD2378 EQUIVALENT	DIOXIN		
PCD-EQ	PCD AND PCF TEQ	DIOXIN		
PCD-EQ4	TCDD TEQ	DIOXIN		
PCD-EQ5	PCDD TEQ	DIOXIN		
PCD-EQ6	HxCDD TEQ	DIOXIN		
PCD-EQ7	HpCDD TEQ	DIOXIN		
PCD-EQ8	OCDD TEQ	DIOXIN		
PCD-T4	TCDDTOTAL	DIOXIN		
PCD-T4	PCD_T4	DIOXIN		
PCD-T4	TCDD TOTAL	DIOXIN		
PCD-T5	PCDD TOTAL	DIOXIN		

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
PCD-T5	PCD_T5	DIOXIN		
PCD-T5	PECDDTOTAL	DIOXIN		
PCD-T6	HXCDDTOTAL	DIOXIN		
PCD-T6	HxCDD TOTAL	DIOXIN		
PCD-T6	PCD_T6	DIOXIN		
PCD-T7	HPCDDTOTAL	DIOXIN		
PCD-T7	HpCDD TOTAL	DIOXIN		
PCD-T7	PCD_T7	DIOXIN		
PCD-T8	OCDDTOTAL	DIOXIN		
PCD1234	TCDD1234/1237/1246/1249	DIOXIN		
PCD12346	PCDD12346	DIOXIN		
PCD123467	HxCDD123467	DIOXIN		
PCD1234678	H7CDD1234678	DIOXIN		
PCD1234678	PCD1234678	DIOXIN		
PCD1234678	1,2,3,4,6,7,8-HEPTACHLORO-DD	DIOXIN		
PCD1234678	HPD1234678	DIOXIN		
PCD1234679	HpCDD1234679	DIOXIN		
PCD123469	HxCDD123469	DIOXIN		
PCD123478	1,2,3,4,7,8-HEXACHLORO-DD	DIOXIN		
PCD123478	PCD123478	DIOXIN		
PCD123478	H6CDD123478	DIOXIN		
PCD123478	HXD123478	DIOXIN		
PCD12367	PCDD12367	DIOXIN		
PCD123678	H6CDD123678	DIOXIN		
PCD123678	1,2,3,6,7,8-HEXACHLORO-DD	DIOXIN		
PCD123678	HXD123678	DIOXIN		
PCD123678	PCD123678	DIOXIN		
PCD12368	PCDD12368	DIOXIN		
PCD123689	HxCDD123679/123689	DIOXIN		
PCD12369	PCDD12369	DIOXIN		
PCD12378	1,2,3,7,8-PENTACHLORO-DD	DIOXIN		
PCD12378	P5CDD12378	DIOXIN		
PCD12378	PECDD12378	DIOXIN		
PCD12378	PCD12378	DIOXIN		
PCD123789	PCD123789	DIOXIN		
PCD123789	HXD123789	DIOXIN		
PCD123789	H6CDD123789	DIOXIN		
PCD123789	1,2,3,7,8,9-HEXACHLORO-DD	DIOXIN		
PCD12379	PCDD12379	DIOXIN		
PCD1239	TCDD1239	DIOXIN		
PCD124679	HxCDD124679/123468	DIOXIN		
PCD12469	PCDD12469/12347	DIOXIN		
PCD1247	TCDD1247	DIOXIN		
PCD12478	PCDD12478	DIOXIN		
PCD12478	1,2,4,7,8-PENTACHLOROR-DD	DIOXIN		
PCD12479	PCDD12479/12468	DIOXIN		
PCD1248	TCDD1248/1369	DIOXIN		
PCD12489	PCDD12489/12467	DIOXIN		
PCD1267	TCDD1267	DIOXIN		
PCD1268	TCDD1268	DIOXIN		
PCD1269	TCDD1269	DIOXIN		
PCD1279	TCDD1279/1236	DIOXIN		
PCD1368	TCDD1368	DIOXIN		
PCD1378	TCDD1378	DIOXIN		
PCD1379	TCDD1379	DIOXIN		
PCD1469	TCDD1469/1278	DIOXIN		
PCD1478	TCDD1478	DIOXIN		
PCD2378	PCD2378	DIOXIN		
PCD2378	2,3,7,8-TETRACHLORO-DD	DIOXIN		
PCD2378	TCDD2378	DIOXIN		

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
PCD2378	TCDD2378	DIOXIN		
PCD8	PCD8	DIOXIN		
PCD8	OCDD12346789	DIOXIN		
PCD8	OCTACHLORO-DD	DIOXIN		
PCF-EQ	TCDF 2378 EQUIVALENT	FURAN		
PCF-EQ4	TCDF TEQ	FURAN		
PCF-EQ5	PCDF TEQ	FURAN		
PCF-EQ6	HxCDF TEQ	FURAN		
PCF-EQ7	HpCDF TEQ	FURAN		
PCF-EQ8	OCDF TEQ	FURAN		
PCF-T4	TCDFTOTAL	FURAN		
PCF-T4	PCF_T4	FURAN		
PCF-T4	TCDF TOTAL	FURAN		
PCF-T5	PCF_T5	FURAN		
PCF-T5	PCDF TOTAL	FURAN		
PCF-T6	HxCDF TOTAL	FURAN		
PCF-T6	PCF_T6	FURAN		
PCF-T6	HXCDFTOTAL	FURAN		
PCF-T7	HpCDF TOTAL	FURAN		
PCF-T7	HPCDFTOTAL	FURAN		
PCF-T7	PCF_T7	FURAN		
PCF-T8	OCDFTOTAL	FURAN		
PCF-T8	PECDFTOTAL	FURAN		
PCF1234	TCDF1234/2349	FURAN		
PCF12346	PCDF12346/12379	FURAN		
PCF123467	HxCDF123467	FURAN		
PCF1234678	PCF1234678	FURAN		
PCF1234678	1,2,3,4,6,7,8-HEPTACHLORO-DF	FURAN		
PCF1234678	H7CDF1234678	FURAN		
PCF1234678	HPF1234678	FURAN		
PCF1234679	HpCDF1234679	FURAN		
PCF123468	HxCDF123468	FURAN		
PCF1234689	HpCDF1234689	FURAN		
PCF123469	HxCDF123469/123689	FURAN		
PCF123478	PCF123478	FURAN		
PCF123478	1,2,3,4,7,8-HEXACHLOROR-DF	FURAN		
PCF123478	H6CDF123478	FURAN		
PCF1234789	PCF1234789	FURAN		
PCF1234789	1,2,3,4,7,8,9-HEPTACHLORO-DF	FURAN		
PCF1234789	H7CF1234789	FURAN		
PCF1234789	HPF1234789	FURAN		
PCF123479	HxCDF123479/123478	FURAN		
PCF12348	PCDF12348/12378	FURAN		
PCF123489	HxCDF123489	FURAN		
PCF12349	PCDF12349	FURAN		
PCF12367	PCDF12367	FURAN		
PCF123678	1,2,3,6,7,8-HEXACHLORO-DF	FURAN		
PCF123678	PCF123678	FURAN		
PCF123678	HXF123678	FURAN		
PCF123678	H6CDF123678	FURAN		
PCF123678	HxCDF124678/123467	FURAN		
PCF123679	HxCDF123679	FURAN		
PCF12369	PCDF12369	FURAN		
PCF1237	TCDF1237/1268/1478/1369	FURAN		
PCF12378	1,2,3,7,8-PENTACHLORO-DF	FURAN		
PCF12378	PCF12378	FURAN		
PCF12378	P5CDF12378	FURAN		
PCF123789	HXF123789	FURAN		
PCF123789	H6CDF123789	FURAN		
PCF123789	1,2,3,7,8,9-HEXACHLORO-DF	FURAN		

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
PCF123789	PCF123789	FURAN		
PCF1238	PCDF1238/1467/2468/1236	FURAN		
PCF12389	PCDF12389	FURAN		
PCF1239	TCDF1239/2347	FURAN		
PCF1246	TCDF1246	FURAN		
PCF12467	PCDF12467	FURAN		
PCF124679	HxCDF124679	FURAN		
PCF12468	PCDF12468	FURAN		
PCF124689	HxCDF124689	FURAN		
PCF1247	TCDF1247/1367	FURAN		
PCF12478	PCDF12478	FURAN		
PCF12479	PCDF12479/13467	FURAN		
PCF12489	PCDF12489	FURAN		
PCF1249	TCDF1249/2368	FURAN		
PCF1267	TCDF1267	FURAN		
PCF1269	TCDF1269	FURAN		
PCF1346	TCDF1346	FURAN		
PCF134678	HxCDF134678	FURAN		
PCF13468	PCDF13468	FURAN		
PCF13469	PCDF13469	FURAN		
PCF1347	TCDF1347	FURAN		
PCF13478	PCDF13478	FURAN		
PCF13479	PCDF13479/12368	FURAN		
PCF1348	TCDF1348	FURAN		
PCF13489	PCDF13489	FURAN		
PCF1349	TCDF1349/1278	FURAN		
PCF1368	TCDF1368	FURAN		
PCF1379	TCDF1379/1378	FURAN		
PCF1468	TCDF1468	FURAN		
PCF1469	TCDF1469	FURAN		
PCF2346	TCDF2346	FURAN		
PCF23467	PCDF23467	FURAN		
PCF234678	2,3,4,6,7,8-HEXACHLORO-DF	FURAN		
PCF234678	HXF234678	FURAN		
PCF234678	PCF234678	FURAN		
PCF234678	H6CDF234678	FURAN		
PCF23468	PCDF23468/12469	FURAN		
PCF23469	PCDF23469/12347	FURAN		
PCF23478	P5CDF23478	FURAN		
PCF23478	2,3,4,7,8-PENTACHLORO-DF	FURAN		
PCF23478	PCF23478	FURAN		
PCF23479	PCDF23479	FURAN		
PCF2348	TCDF2348	FURAN		
PCF23489	PCDF23489	FURAN		
PCF2367	TCDF2367	FURAN		
PCF2378	2,3,7,8-TETRACHLORO-DF	FURAN		
PCF2378	TCDF2378	FURAN		
PCF2378	PCF2378	FURAN		
PCF2378	TCDF2378	FURAN		
PCF2467	TCDF2467	FURAN		
PCF3467	TCDF3467	FURAN		
PCF8	OCDF12346789	FURAN		
PCF8	PCF8	FURAN		
PCF8	OCTACHLORO-DF	FURAN		
PCL-BIPH	PENTACHLORO BIPHENYLS	PCB	PPB	
PCT_CLAY	PERCENT CLAY	CONVENT	PCT	
PCT_FINES	PERCENT FINES (CLAY & SILT)	CONVENT	PCT	
PCT_MOIS	PERCENT MOISTURE	CONVENT	PCT	
PCT_ROCKS	PERCENT ROCKS	CONVENT	PCT	
PCT_SAND	PERCENT SAND	CONVENT	PCT	

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
PCT_SILT	PERCENT SILT	CONVENT	PCT	
PECDD-A		DIOXIN	PPB	
PECDD-T		DIOXIN	PPB	
PECDF-A		FURAN	PPB	
PECDF-B		FURAN	PPB	
PECDF-T		FURAN	PPB	
PERYLENE	PERYLENE	PAH	PPB	
PH	PH	CONVENT	PH	
PHENANTHRN	PHENANTHRENE	PAH	PPB	
PHENOL	PHENOL	ABN	PPB	
PHOSPHATE	TOTAL PHOSPHATE	CONVENT	2	
PHOSPHORUS	PHOSPHORUS	CONVENT	2	
PHOSPHTE-D	DISSOLVED PHOSPHATE	CONVENT	2	
POTASSIUM	POTASSIUM (K)	METALS	2	
PP-DDD	P,P'-DDD	PEST-PCB	PPB	
PP-DDE	P,P'-DDE	PEST-PCB	PPB	
PP-DDT	P,P'-DDT	PEST-PCB	PPB	
PYRENE	PYRENE	PAH	PPB	
RETENE	RETENE	TIO	PPB	
SALINITY	SALINITY	CONVENT	9	
SANDARACOP	SANDARACOPIMARIC ACID	RESIN-AC	PPB	
SE ALUMINM	SE_ALUMINM	METALS		
SE ANTIMNY	SE_ANTIMNY	METALS		
SE ARSENIC	SE_ARSENIC	METALS		
SE CADMIUM	SE_CADMIUM	METALS		
SE CHROMIU	SE_CHROMIU	METALS		
SE COPPER	SE_COPPER	METALS		
SE IRON	SE_IRON	METALS		
SE LEAD	SE_LEAD	METALS		
SE MERCURY	SE_MERCURY	METALS		
SE NICKEL	SE_NICKEL	METALS		
SE SELENUM	SE_SELENUM	METALS		
SE SILVER	SE_SILVER	METALS		
SE TIN	SE_TIN	METALS		
SE ZINC	SE_ZINC	METALS		
SELENIUM	SELENIUM	METALS	PPM	
SILICATE	SILICATE	CONVENT	2	
SILICON	SILICON	CONVENT	PPB	
SILVER	SILVER (AG)	METALS	PPM	
SILVEX	SILVEX (PESTICIDE)	PEST-PCB	PPB	
SIMAZINE	SIMAZINE (PESTICIDE)	PEST-PCB	PPB	
SO4	SULFATES	CONVENT	2	
SODIUM	SODIUM (NA)	METALS	2	
SOLIDS-T	TOTAL SOLIDS (DRY WT. AS % OF WET WT.)	CONVENT	PPM	
STYRENE	STYRENE	PAH	PPB	
SULFATE	TOTAL SULFATE	CONVENT	2	
SULFIDES	SULFIDES	CONVENT	2	
SYSTOX	SYSTOX (PESTICIDE)	PEST-PCB	PPB	
T13-2CLPRE	TRANS-1,3-DICHLOROPROPENE	VOLATILE	PPB	
T13-2CLPRE	T13_2CLPRE	VOLATILE		
T13-2CLPRP	TRANS-1,3-DICHLOROPROPANE	VOLATILE	PPB	
TBFLANTH	TOTAL BENZOFLUORANTHENES (B + K)	PAH	PPB	
TCDD	2,3,7,8-TETRACHLORODIBENZODIOXIN	DIOXIN	PPB	
TCDD-T		DIOXIN	PPB	
TCDF		FURAN	PPB	
TCDF-T		FURAN	PPB	
TCE	TETRACHLOROETHENE	VOLATILE	PPB	
TETCL_BIPH	TETRACHLORO BIPHENYLS	PCB	PPB	
THALLIUM	THALLIUM (TH)	METALS	PPM	
THORIUM	THORIUM	METALS	PPM	

CHEMCODE	CHEMNAME	CHEMCLASS	UNITS	METHOD
TIN	TIN (SN)	METALS	PPM	
TITANIUM	TITANIUM	METALS	PPM	
TOC	TOTAL ORGANIC CARBON	CONVENT	PPM	
TOLUENE	TOLUENE	VOLATILE	PPB	
TOT_PHTHAL	TOTAL PHTHALATES	PAH	PPB	
TOTBUTLTIN	TOTAL BUTYL TINS	METALS	PPB	
TOTPESTCDE	TOTAL PESTICIDES	PEST-PCB	PPB	
TOXAPHENE	TOXAPHENE (PESTICIDE)	PEST-PCB	PPB	
TR-NONACHL	TRANS NONACHLOR	PEST-PCB	PPB	
TRICHLORFO	TRICHLORFON (PESTICIDE)	PEST-PCB	PPB	
TRICL_BIPH	TRICHLORO BIPHENYLS	PCB	PPB	
TTHIOLANE	1,2,4-TRITHIOLANE	TIO	PPB	
TVS	TOTAL VOLATILE SOLIDS	CONVENT	PPM	
VANADIUM	VANADIUM (VA)	METALS	PPM	
VINYL_ACET	VINYL ACETATE	VOLATILE	PPB	
VINYL_CL	VINYL CHLORIDE (CH2--CHCL)	VOLATILE	PPB	
WATER		CONVENT	PCT	
XYLENE	XYLENE	VOLATILE	PPB	
XYLENE-T	TOTAL XYLENE	VOLATILE	PPB	
YPHPA	ANTHRACENE + PHENANTHRENE	PAH	PPB	
ZINC	ZINC (ZN)	METALS	PPM	

APPENDIX VII

SPECIFIC WORK INSTRUCTIONS AND TECHNICAL PROCEDURES FOR THE SPRING AND SUMMER 1995 AQUATIC SAMPLING PROGRAM

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No: SWI1.0**

Project: Suncor EIA Study: Spring Survey (Water Quality)

Date: April 25, 1995

Author: Randy Shaw

To: Chris Bjornsen

cc: Brenda Brassard **File No.:** 5050
File

Subject: Spring 1995 Water Quality Program **Job/Task No.:** 952-2307/5230

Scope of Work/Specific Instructions:
Surface water sampling - collect surface water grab samples in the Athabasca River at five points across the channel at both upstream (u/s) Lease 19 and downstream (d/s) of Lease 25. Additional samples are to be collected from the Steepbank River at a site u/s of Lease 19 and at the mouth and from designated small tributary streams within the lease area. These sites will be defined after a helicopter reconnaissance survey in the spring. Analytes will vary between sites; specific analytes and analytical laboratories will be defined in the very near future. Follow standard operating protocol (SOP) for the collection of surface water samples as defined in Golder Technical Procedures Manual, TP 8.3-0, SURFACE WATER.
Porewater sampling - collect samples at three sites along the Steepbank River. Sites are to correspond to sites where benthic invertebrates were collected by EVS Consultants. Collect porewater samples based on Golder SOP #TP 8.4-0, POREWATER and submit to laboratory for analyses as listed in the attached table.
Sediment sampling - collect samples at sites along the Steepbank River where porewater collected. Collect sediment samples based on Golder SOP #TP 8.2-0, SUBSTRATE and submit to laboratory for analyses as listed in the attached table.
Crew Leader - Chris Bjornson
Sample collection - Chris Bjornson
Project Manager Aquatics - Randy Shaw

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 8

Subcontractor (as applicable): N/A

Special Handling Requirements: All samples to be supported by analytical request forms, detailed field notes, chain of custody forms. Any time sensitive samples; i.e. Biochemical Oxygen Demand (BOD) must be to the appropriate analytical facility before the recommended time frame has elapsed (24 hours for BOD samples). Ensure that all samples are correctly preserved for shipment to the laboratories involved.

Applicable Specs. and Procedures: Golder TP 8.3-0, 8.2-0, and 8.4-0

Technical Review Process:

Project Manager Approval/Date:

QA Manager/Date Judy Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No: SWI2.0**

Project: Suncor EIA Study: Spring Survey (Aquatic Program)

Date: April 27, 1995

Author: Hal Hamilton

To: Chris Bjornson

cc: Brenda Brassard
File

File No.: 5050

Subject: Project Duties **Job/Task No.:** 952-2307/5230

Scope of Work/Specific Instructions:
Serve as component leader for the aquatic habitat and resource studies. This includes: assisting in the development of the aquatic workplan; assisting in the selection of the sentinel fish species; and supervising the aquatic field crews. Moreover, responsibilities while in the field include: supervison of spring, summer, fall and winter crew members; supervising the mapping of the spawning areas and Athabasca River at the proposed bridge crossing location; collecting fish for population analysis and age structure data; obtaining biomarker data for sentinel species; ensuring that the QA/QC requirements are adhered to while in the field; serving as the Health and Safety Officer for on-site field work; and, archiving tissue samples from sentinel species. Also, act as the onsite contact for Suncor during field work. Assist with the preparation of any written progress reports regarding the aquatic habitat and resource studies program.
Crew Leader: Chris Bjornson
Project Manager Aquatics: Randy Shaw
Technical Supervisor (Biomarkers): Stella Swanson
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: January 1, 1996

Allocated Manhours: 1152

Subcontractor (as applicable): n/a

Special Handling Requirements: Numerous photographs should be taken at every site, record on photo-log sheets.

Applicable Specs. and Procedures: TP 8.1-0, TP 8.2-0, TP 8-3.0, USEPA 823-R-93-002

Technical Review Process:

Project Manager Approval/Date:

QA Manager/Date: Judy Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS	**SWI No: SWI3.0**
Project: Suncor EIA Study: Spring Survey (Biomarkers)	
Date: April 29, 1995	
Author: Hal Hamilton	
To: Stella Swanson	
cc: Brenda Brassard File	**File No.:** 5050
Subject: Aquatic Field Program	**Job/Task No.:** 952-2307/5230

Scope of Work/Specific Instructions:
Supervise all aspects of the fish health (biomarker) portion of the Suncor fisheries field program. This includes: review of existing biomarker information from the Suncor study area; development of the final Work Plan as it relates to biomarkers; approval of Technical Procedures and Specific Work Instructions to be used by the field crew; availability as the senior contact for field personnel when questions arise; availability to Hal Hamilton and Suncor to answer questions about biomarkers; availability to contact on Suncor's behalf regulatory personnel and government scientists re: biomarkers; assistance with preparation for meetings with stakeholders and regulators; and, preparation of any written progress reports regarding the Suncor fish biomarker program.
Project Manager Aquatics: Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By:	April 1, 1996
Allocated Manhours:	168
Subcontractor (as applicable):	n/a
Special Handling Requirements:	
Applicable Specs. and Procedures:	Golder TP 8.1-0
Technical Review Process:	QP-9.2
Project Manager Approval/Date:	**QA Manager/Date** Gene May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS	**SWI No:** SWI4.0
Project: Suncor EIA Study: Spring Survey (Aquatic Program)	
Date: April 27, 1995	
Author: Hal Hamilton	
To: Brenda Brassard	
cc: Kym Holley File	**File No.:** 5050
Subject: Project Coordinator	**Job/Task No.:** 952-2307/5230
Scope of Work/Specific Instructions: Ensure the task definition and cost control systems are implemented, provide logistics coordination with the discipline groups and Suncor and generally facilitate communication. Provide weekly cost updates to team leaders and Suncor using COSTAID.XLS. Update Project Control Forms monthly and review Estimate to Complete for each sub-task. Overall Project Manager: Hal Hamiton	
Work Product(s) Due By:	January 1, 1996
Allocated Manhours:	1560
Subcontractor (as applicable):	n/a
Special Handling Requirements:	
Applicable Specs. and Procedures:	Suncor Quality Assurance Plan
Technical Review Process:	
Project Manager Approval/Date:	**QA Manager/Date** Judith Crane, May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS	**SWI No: SWI5.0**
Project: Suncor EIA Study: Spring Survey (Water Quality)	
Date: April 27, 1995	
Author: Hal Hamilton	
To: Randy Shaw	
cc: Brenda Brassard File	**File No.:** 5050
Subject: Aquatic Field Program	**Job/Task No.:** 952-2307/5230

Scope of Work/Specific Instructions:
Supervise all aspects of the water quality portions of the Suncor aquatics field program. This includes: review of existing water quality reports, development of the final work plan as it relates to water quality, approval of Technical Procedures and Specific Work Instructions to be used by the field crew, availability as a senior contact for field personnel when questions arise, availability to Hal Hamilton and Suncor to answer questions related to water quality, availability to contact on Suncor's behalf regulatory personnel and government scientists re: water quality, assistance with preparations for meetings with stakeholders and regulators, preperation of any written progress reports regarding the Suncor water quality program, liason between Golder and EVS pertaining to benthic invertebrate program, assistnce with tracking budget for aquatics program.
Overall Project Manager: Hal Hamilton

Work Product(s) Due By:	April 1, 1996
Allocated Manhours:	208
Subcontractor (as applicable):	n/a
Special Handling Requirements:	n/a
Applicable Specs. and Procedures:	n/a
Technical Review Process:	n/a
Project Manager Approval/Date:	**QA Manager/Date** Judith Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS		**SWI No.:**	SWI6.0
Project: Suncor EIA Study: Spring Survey (Fisheries)			
Date:	April 30, 1995		
Author:	Hal Hamilton		
To:	Lynda Gummer		
cc:	Brenda Brassard	**File No.:**	5050
	File		
Subject:	Spring 1995 Aquatic Field Program	**Job/Task No.:**	952-2307/5230

Scope of Work/Specific Instructions:

Examine five tributaries (the mouth areas) for fish presence, habitat conditions, fish passage and potential use as spawning streams (for fish from the mainstem Athabasca River) by portable boat shocking and backpack electroshocking. The tributaries to be examined are: Mclean Creek, Wood Creek, Legget Creek, an unnamed tributary to the Athabasca River, and an unnamed tributary to the Steepbank River. The Athabasca River is to be boat electrofished for large fish species. The lower sections (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. Fry drift-traps are to be used to sample for the presence of post-emergent fry, particularly walleye in the Athabasca River. For the Athabasca and Steepbank Rivers, examine for spawning activity and location of spawning areas for all large fish species, with an emphasis on Walleye in the mainstem river and Arctic grayling, northern pike and longnose and white sucker in the Steepbank River. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weigh and sacrificed to obtain ageing materials. Assist in habitat mapping the habitats in the Athabasca River within the area of the porposed bridge crossing (as per TP8.5-0). GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, fecundity counts, egg diameters, external/internal pathology, collection of liver samples for MFO analysis, collection of blood plasma samples for sex steroid levels, one fillet is to be archived for contaminant analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Crew Leader - Chris Bjornson
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 344

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date:

QA Manager/Date: Mar 3. 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS		**SWI No.:**	SWI7.0
Project: Suncor EIA Study: Spring Survey (Fisheries)			
Date:	April 30, 1995		
Author:	Hal Hamilton		
To:	Christine Godwin-Shepard		
cc:	Brenda Brassard	**File No.:**	5050
	File		
Subject:	Spring 1995 Aquatic Field Program	**Job/Task No.:**	952-2307/5230

Scope of Work/Specific Instructions:

Examine five tributaries (the mouth areas) for fish presence, habitat conditions, fish passage and potential use as spawning streams (for fish from the mainstem Athabasca River) by portable boat shocking and backpack electroshocking. The tributaries to be examined are: Mclean Creek, Wood Creek, Legget Creek, an unnamed tributary to the Athabasca River, and an unnamed tributary to the Steepbank River. The Athabasca River is to be boat electrofished for large fish species. The lower sections (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. Fry drift-traps are to be used to sample for the presence of post-emergent fry, particularly walleye in the Athabasca River. For the Athabasca and Steepbank Rivers, examine for spawning activity and location of spawning areas for all large fish species, with an emphasis on Walleye in the mainstem river and Arctic grayling, northern pike and longnose and white sucker in the Steepbank River. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weigh and sacrificed to obtain ageing materials. Assist in habitat mapping the habitats in the Athabasca River within the area of the porposed bridge crossing (as per TP8.5-0). GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, fecundity counts, egg diameters, external/internal pathology, collection of liver samples for MFO analysis, collection of blood plasma samples for sex steroid levels, one fillet is to be archived for contaminant analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Crew Leader - Chris Bjornson
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 304

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date:

QA Manager/Date: Crane Mar 3. 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS		**SWI No.:**	SWI8.0
Project: Suncor EIA Study: Spring Survey (Fisheries)			
Date:	April 30, 1995		
Author:	Hal Hamilton		
To:	Ken Allen		
cc:	Brenda Brassard	**File No.:**	5050
	File		
Subject:	Spring 1995 Aquatic Field Program	**Job/Task No.:**	952-2307/5230

Scope of Work/Specific Instructions:

Examine five tributaries (the mouth areas) for fish presence, habitat conditions, fish passage and potential use as spawning streams (for fish from the mainstem Athabasca River) by portable boat shocking and backpack electroshocking. The tributaries to be examined are: Mclean Creek, Wood Creek, Legget Creek, an unnamed tributary to the Athabasca River, and an unnamed tributary to the Steepbank River. The Athabasca River is to be boat electrofished for large fish species. The lower sections (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. Fry drift-traps are to be used to sample for the presence of post-emergent fry, particularly walleye in the Athabasca River. For the Athabasca and Steepbank Rivers, examine for spawning activity and location of spawning areas for all large fish species, with an emphasis on Walleye in the mainstem river and Arctic grayling, northern pike and longnose and white sucker in the Steepbank River. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weigh and sacrificed to obtain ageing materials. Assist in habitat mapping the habitats in the Athabasca River within the area of the porposed bridge crossing (as per TP8.5-0). GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, fecundity counts, egg diameters, external/internal pathology, collection of liver samples for MFO analysis, collection of blood plasma samples for sex steroid levels, one fillet is to be archived for contaminant analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Crew Leader - Chris Bjornson
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 100

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date:

QA Manager Date: Crane - Mar 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS		SWI No.:	SWI9.0
Project: Suncor EIA Study: Spring Survey (Fisheries)			
Date:	April 30, 1995		
Author:	Hal Hamilton		
To:	Chris Bjornson		
cc:	Brenda Brassard	File No.:	5050
	File		
Subject:	Spring 1995 Aquatic Field Program	Job/Task No.:	952-2307/5230

Scope of Work/Specific Instructions:

Act as crew leader and supervisor for the following field work to be completed during Spring 1995. Examine five tributaries (the mouth areas) for fish presence, habitat conditions, fish passage and potential use as spawning streams (for fish from the mainstem Athabasca River) by portable boat shocking and backpack electroshocking. The tributaries to be examined are: Mclean Creek, Wood Creek, Legget Creek, an unnamed tributary to the Athabasca River, and an unnamed tributary to the Steepbank River. The Athabasca River is to be boat electrofished for large fish species. The lower sections (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. Fry drift-traps are to be used to sample for the presence of post-emergent fry, particularly walleye in the Athabasca River. For the Athabasca and Steepbank Rivers, examine for spawning activity and location of spawning areas for all large fish species, with an emphasis on Walleye in the mainstem river and Arctic grayling, northern pike and longnose and white sucker in the Steepbank River. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weigh and sacrificed to obtain ageing materials. Assist in habitat mapping the habitats in the Athabasca River within the area of the porposed bridge crossing (as per TP8.5-0). GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, fecundity counts, egg diameters, external/internal pathology, collection of liver samples for MFO analysis, collection of blood plasma samples for sex steroid levels, one fillet is to be archived for contaminant analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 320

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date:

QA Manager/Date: Mark Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No: 10.0 Addendum to SWI 1.0**

Project: Suncor EIA Study: Spring Survey (Water Quality)

Date: May 26, 1995

Author: Randy Shaw

To: Chris Bjornsen

cc: Brenda Brassard **File No.:** 5050
File

Subject: Spring 1995 Water Quality Program **Job/Task No.:** 952-2307/5230

Scope of Work/Specific Instructions:
Note: this is an adendum to SWI1.0. All surface water samples are to be analyzed for total metals (ICP and hydride) and porewater is to be analyzed for dissolved metals (ICP and hydride). The lab, Chemex, will filter dissolved metal samples, but indicate on Chemex Analytical Request Form whether dissolved or total metals are to be analysed.

QA/QC samples are to consist of triplicate samples from the mouth of the Steepbank for all parameters except trace organics, where duplicates will be done instead. Given the difficulty in obtaining adequate water from mini-piezometers, replicates will be restricted to more conventional parameters (trace organics will be excluded). Field blanks are to be prepared by taking Suncor's laboratory distilled/deionized water into the field and pouring into sample containers (surface water blank) and by pumping water up through mini-piezometer (porewater blank).

Sample site locations for the spring water quality program are detailed on the attached table. Note that sample site locations are hypothetical and could be changed as necessary to conform to existing codes.

Crew Leader - Chris Bjornson
Sample collection - Chris Bjornson
Project Manager Aquatics - Randy Shaw

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 8

Subcontractor (as applicable): N/A

Special Handling Requirements: All samples to be supported by analytical request forms, detailed field notes, chain of custody forms. Any time sensitive samples; i.e. Biochemical Oxygen Demand (BOD) must be to the appropriate analytical facility before the recommended time frame has elapsed (24 hours for BOD samples). Ensure that all samples are correctly preserved for shipment to the laboratories involved.

Applicable Specs. and Procedures: SWI1.0, Golder TP 8.3-0, 8.2-0, and 8.4-0

Technical Review Process:

Project Manager Approval/Date:

QA Manager/Date Judyth Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS	**SWI No: SWI11.0**
Project: Suncor EIA Study: Spring Survey (Aquatic Program)	
Date: April 29, 1995	
Author: Hal Hamilton	
To: Kym Holley	
cc: Brenda Brassard File	**File No.:** 5050
Subject: Spring 1995 Aquatic Field Program	**Job/Task No.:** 952-2307/5230

Scope of Work/Specific Instructions:
Act as the key office contact person for crews in the field. Function as the internal Golder QA/QC coordinator and the Golder internal (Aquatics) database/file administrator. Assist in the preparation of SWI's for all personnel on the project. Assist in preparation of Technical Procedures that are applicable to the Suncor EIA. Assist in the NRBS data review. Assist in the fish tainting review. Availability to Stella Swanson, Randy Shaw and Hal Hamilton to answer questions about internal QA/QC.
Project Manager Aquatics: Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By:	December 1, 1996
Allocated Manhours:	176
Subcontractor (as applicable):	n/a
Special Handling Requirements:	
Applicable Specs. and Procedures:	Golder Technical Procedures; Golder Quality Assurance Manual
Technical Review Process:	QP-9.2
Project Manager Approval/Date:	**QA Manager/Date** Judyth Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS	**SWI No: SWI2.0**
Project: Suncor EIA (Aquatics - Spring Survey)	
Date: April 27, 1995	
Author: Hal Hamiton	
To: Chris Bjornson	
cc: Brenda Brassard File	**File No.:** 5050
Subject: Project Duties	**Job/Task No.:** 952-2307/5210

Scope of Work/Specific Instructions:
Serve as component leader for the aquatic habitat and resource studies. This includes: assisting in the development of the aquatic workplan; assisting in the selection of the sentinel fish species; and supervising the aquatic field crews. Moreover, responsibilities while in the field include: supervison of spring, summer, fall and winter crew members; supervising the mapping of the spawning areas and Athabasca River at the proposed bridge crossing location; collecting fish for population analysis and age structure data; obtaining biomarker data for sentinel species; ensuring that the QA/QC requirements are adhered to while in the field; serving as the Health and Safety Officer for on-site field work; and, archiving tissue samples from sentinel species. Also, act as the onsite contact for Suncor during field work. Assist with the preparation of any written progress reports regarding the aquatic habitat and resource studies program.
Crew Leader: Chris Bjornson
Project Manager Aquatics: Randy Shaw
Technical Supervisor (Biomarkers): Stella Swanson
Overall Project Manager: Hal Hamilton

Work Product(s) Due By:	January 1, 1996
Allocated Manhours:	1152
Subcontractor (as applicable):	n/a
Special Handling Requirements:	Numerous photographs should be taken at every site, record on photo-log sheets.
Applicable Specs. and Procedures:	TP 8.1-0, TP 8.2-0, TP 8-3.0, USEPA 823-R-93-002
Technical Review Process:	
Project Manager Approval/Date:	**QA Manager/Date** Judith Crane May 3, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No.:** SWI13.0

Project: Suncor EIA Study: Summer Survey (Fisheries)

Date: April 30, 1995

Author: Hal Hamilton

To: Chris Bjornson

cc: Brenda Brassard **File No.:** 5050

File

Subject: Summer 1995 Aquatic Field Program **Job/Task No.:** 952-2307/5240 and 5245

Scope of Work/Specific Instructions:

Act as crew leader and supervisor for the following field work to be completed during Summer 1995. Work to be completed during the summer sampling season includes: investigation of the mainstem Athabasca and Steepbank Rivers for (1) presence of any fish rearing areas; (2) special side channels and backwaters for use by fish; (3) mapping the feeding habitat and note relative availability; (4) recording the general population data for all large fish captured; (5) collection of seasonal abundance data; (6) recording general population data for all forage fish captured; and (7) recording age/size data for a subsample of forage fish. Furthermore, confirm goldeye summer feeding areas in the Athabasca River only. The Athabasca River is to be boat electrofished for large fish species. The lower section (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weight and sacrificed to obtain ageing materials. GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, external/internal pathology, collection of liver samples for MFO and Retinol analysis (save remaining in liquid nitrogen for possible DNA adducts), collection of blood plasma samples for sex steroid (5 ml - first priority) and blood chemistry (any remaining plasma - 2nd priority), one fillet is to be archived for organic analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. If in doubt about maturity, preserve. If stomach contents can not be identified or if time is short, preserve for later identification. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: August 20, 1995

Allocated Manhours: 192 - Task 5240 144 - Task 5245

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Chain of Custody; Analytical Request Forms, Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date:

QA Manager/Date: Dwight Crane Aug 21, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No.:** SWI14.0

Project: Suncor EIA Study: Summer Survey (Fisheries)

Date: July 24, 1995

Author: Hal Hamilton

To: Lynda Gummer

cc: Brenda Brassard **File No.:** 5050

File

Subject: Summer 1995 Aquatic Field Program **Job/Task No.:** 952-2307/5240 and 5245

Scope of Work/Specific Instructions:

Investigate the mainstem Athabasca and Steepbank Rivers for (1) presence of any fish rearing areas; (2) special side channels and backwaters for use by fish; (3) mapping the feeding habitat and note relative availability; (4) recording the general population data for all large fish captured; (5) collection of seasonal abundance data; (6) recording general population data for all forage fish captured; and (7) recording age/size data for a subsample of forage fish. Furthermore, confirm goldeye summer feeding areas in the Athabasca River only. The Athabasca River is to be boat electrofished for large fish species. The lower section (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weight and sacrificed to obtain ageing materials. GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, external/internal pathology, collection of liver samples for MFO and retinol analysis (save remaining liver in liquid nitrogen for possible DNA adducts), collection of blood plasma samples for sex steroid and blood chemistry (note: sex steroid analysis is first priority (5ml) (send to Dr. Tracy Marchant at the University of Saskatchewan), if there is blood plasma remaining forward it to Hydroqual Laboratories for blood chemistry), one fillet is to be archived for organic analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. If in doubt about stage of maturity, preserve gonads. If stomach contents can not be identified or there is not enough to, preserve for later analysis. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Crew Leader - Chris Bjornson
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 136 for Task 5240; 144 for Task 5245

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Analytical Request Forms, Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date:

QA Manager/Date: Judy L Crane Aug 21, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS SWI No.: SWI15.0

Project: Suncor EIA Study: Summer Survey (Fisheries)

Date: July 24, 1995

Author: Hal Hamilton

To: Ken Allen

cc: Brenda Brassard **File No.**: 5050

File

Subject: Summer 1995 Aquatic Field Program **Job/Task No.**: 952-2307/5240 and 5245

Scope of Work/Specific Instructions:

Investigate the mainstem Athabasca and Steepbank Rivers for (1) presence of any fish rearing areas; (2) special side channels and backwaters for use by fish; (3) mapping the feeding habitat and note relative availability; (4) recording the general population data for all large fish captured; (5) collection of seasonal abundance data; (6) recording general population data for all forage fish captured; and (7) recording age/size data for a subsample of forage fish. Furthermore, confirm goldeye summer feeding areas in the Athabasca River only. The Athabasca River is to be boat electrofished for large fish species. The lower section (assessable from the mainstem river) of the Steepbank River is to be sampled using a portable boat electroshocker, while the upper sections will be sampled using a backpack electrofishing unit. Sampling for forage fish in both the Steepbank and Athabasca Rivers is to be conducted by backpack electrofishing and beach seining. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. CPUE data is to be recorded for all sampling equipment and events. All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weight and sacrificed to obtain ageing materials. GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Collect biomarker data for each VEC species (20/sex) as per TP8.1-0. Note: Gonad weights, liver weights, external/internal pathology, collection of liver samples for MFO and retinol analysis (save remaining liver in liquid nitrogen for possible DNA adducts), collection of blood plasma samples for sex steroid and blood chemistry (note: sex steroid analysis is first priority (5ml) (send to Dr. Tracy Marchant at the University of Saskatchewan), if there is blood plasma remaining forward it to Hydroqual Laboratories for blood chemistry), one fillet is to be archived for organic analysis and one fillet is to be archived for metal analysis. Collect any abnormal tissues for histopathology and preserve in 10% buffered formalin. If in doubt about stage of maturity, preserve gonads. If stomach contents can not be identified or there is not enough to, preserve for later analysis. In order to ensure the utility and integrity of samples, Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method, must be followed.
Crew Leader - Chris Bjornson
Sample Collection Preparation and Analysis (Biomarkers) - Stella Swanson
Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By: June 30, 1995

Allocated Manhours: 192 for Task 5240; 144 for Task 5245

Subcontractor (as applicable): n/a

Special Handling Requirements: Forms to use: Analytical Request Forms, Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. MFO samples to be stored in liquid nitrogen; other tissues to be stored on dry ice. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive indentification. Abnormal tissues and mid-section of ovaries are to be preserved in 10% buffered formalin. Calculate egg diameter as per Golder TP8.1-0.

Applicable Specs. and Procedures: Golder TP 8.1-0; and 8.5-0

Project Manager Approval/Date: **QA Manager/Date**: Aug 21, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No: 16.0**

Project: Suncor EIA Study: Summer Survey (Water Quality)

Date: July 31, 1995

Author: Randy Shaw

To: Chris Bjornson/Tony Calverley

cc: Brenda Brassard
File

File No.: 5050

Subject: Summer 1995 Water Quality Program

Job/Task No.: 952-2307/5240

Scope of Work/Specific Instructions:
Surface water sampling - collect surface water grab samples in the Athabasca River at five points across the channel at both upstream (u/s) Lease 19 and downstream (d/s) of Lease 25. Prepare composite samples at each of these sites. Additional samples are to be collected from the Steepbank River at a site u/s of Lease 19 and at the mouth and from designated small tributary streams within the lease area. Site locations should be the same as in the spring (see enclosed table). Note, that samples for naphthenic acids should be collected in 1-L amounts (use four 250-mL bottles per sample). Analytes will vary between sites; analytical laboratories and analytes are defined in the attached table.

QA/QC samples include a triplicate at the mouth of the Steepbank River and a field blank. Follow standard operating protocol (SOP) for the collection of surface water samples as defined in Golder Technical Procedures Manual, TP 8.3-0, SURFACE WATER.

Crew Leader - Chris Bjornson
Sample collection - Chris Bjornson/Tony Calverley
Project Manager Aquatics - Randy Shaw

Work Product(s) Due By: Aug 15, 1995

Allocated Man-hours: 8

Subcontractor (as applicable): N/A

Special Handling Requirements: All samples to be supported by analytical request forms, detailed field notes, chain of custody forms. Any time sensitive samples must be delivered to the appropriate analytical facility before the recommended time frame has elapsed. Ensure that all samples are correctly preserved for shipment to the laboratories involved.

Applicable Specs. and Procedures: Golder TP 8.3-0, 8.2-0, and 8.4-0

Technical Review Process:

Project Manager Approval/Date: 31 July 95

QA Manager/Date: Judy Crane July 31, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS	**SWI No.:** SWI17.0
Project: Suncor EIA Study: Summer Survey (Fisheries)	
Date: August 8, 1995	
Author: Randy Shaw	
To: Field Technician #1 and # 2 , as determined by field crew leader	
cc: Brenda Brassard	**File No.:** 5240
File	
Subject: Summer 1995 Aquatic Field Program	**Job/Task No.:** 952-2307/5240

Scope of Work/Specific Instructions:

As directed by field crew leader perform the following tasks:

Fly into Legget Creek and examine it for fish presence, habitat conditions, fish passage and potential use as spawning stream (for fish from the mainstem Athabasca River), using backpack shocker, seine and gill nets. Gill nets and set lines are to be used to sample habitats in which electrofishing effectiveness is reduced and to sample for fish species which are not as susceptible to capture by electrofishing. Spend one day at the headwaters, and one day at the mouth going upstream as far as time allows. In addition, spend one day in the wetland, mapping habitat and installing gill net. Retrieve gill net the following day.

All captured individuals of all fish species are to be identified to species and enumerated. Large fish species are to be measured for fork length and weight and the appropriate non-lethal ageing structure is to be collected. The life history stage, sex and state of maturity is to be recorded for each fish, when discernible from external examination. External pathology is to be recorded and all abnormalities are to be recorded as per the external examination form classification. Incidental mortalities are to be examined internally and results are to be recorded on internal examination forms and lethal ageing structures collected. For forage fish species, a sub-sample is to be measured for fork length and weight and sacrificed to obtain ageing materials. GPS techniques are to be used to record the location of all significant habitat areas, locations of significant concentrations of fish and all sampling locations. Golder TP 8.1-0 Fish Inventory and Fish Biomarker Method must be followed.

Project Manager Aquatics - Randy Shaw
Overall Project Manager: Hal Hamilton

Work Product(s) Due By:	Aug 25, 1995
Allocated Manhours:	36
Subcontractor (as applicable):	n/a
Special Handling Requirements:	Forms to use: Chain of Custody; Catch and Sample Records; Autopsy forms; Photo-logs. Any unidentifiable whole fish will be stored in 10% buffered formalin, clearly labelled and returned to the lab for positive identification. Calculate egg diameter as per Golder TP8.1-0.
Applicable Specs. and Procedures:	Golder TP 8.1-0
Project Manager Approval/Date:	8 Aug 95
QA Manager/Date:	Crane Aug 9, 1995

SPECIFIC WORK INSTRUCTIONS

SPECIFIC WORK INSTRUCTIONS **SWI No: EVS1.0**

Project: Suncor EIA Study: Fall Survey (Benthos)

Date: August 18, 1995

Author: Patrick Allard

To: Randy Shaw

cc: Brenda Brassard **File No.:** 3/540-04.2
File

Subject: Fall 1995 Benthic Field Program **Job/Task No.:** 952-2307/5250

Scope of Work/Specific Instructions:
The baseline benthic program field work will be completed in the fall of 1995, and it will include the following tasks: 1) collection of samples from the Athabasca River and the Steepbank River for community assessment, 2) collection of benthic biomass for bioaccumulation analysis on the Athabasca River. To assess community structure, 4 artifical substrates (AS) will be placed at 12 sites in the Athabasca River. The AS will be of the "barbecue chicken-basket" variety assembled as per ASTM protocols. The AS will be suspended using iron bars at approximately 0.5 m from the sediment. The colonization period for the AS will be approximately 6-8 weeks. A shorter colonization period may have to be considered depending on weather ans river flow conditions. All 4 AS will be retrieved but only three will be randomly selected and submitted for analysis, the others will be archived. As each AS is retrieved, the natural sediment will be grab-sampled using a pole-mounted Eckman. Three grab samples corresponding to the three AS sites randomly selected will be composited and submitted for analysis. The remaining third of each grab samples not composited will be archived. At 3 sites on the Steepbank River, 5 samples of sediment will be collected using the sampler most appropriate to the substrate (e.g., Hess) and analysed for community structure. All samples will be screened on-site. At each site where a sample is collected, water quality (DO, pH, conductivity, turbidity and flow) will be measured following Golder TP-8.3-0 as appropriate. Identifications of benthos will be done to levels required by pulp mill EEM. Data analysiss will include standard calculations such as species abundance, and richness in support of the impact hypothesis; a variety of statistical approaches will be used.

Benthic biomass for bioaccumulation analysis will be collected from 4 sites in the Athabasca River using a kick net. All samples will be screened on-site and the benthos preserved as appropriate and shipped in appropriate containers with correct labelling and chain-of-custody forms. As this study is part of the larger risk assessment work, the results of the chemical analysis will be reported but not interpreted.

Work Product(s) Due By: We will endeavour to produce a final draft by end of January, 1996.

Allocated Manhours: 98.5

Subcontractor (as applicable): Dr. Mike Paine, Paine, Ledge and Associates

Special Handling Requirements: Forms to use: Chain-of-Custody, Analytical Request Forms, Photo-logs and sample sheets. Samples for community structure to be preserved in 10% buffered formalin. Bioaccumulation samples put in jars and preserved with reagents supplied by laboratory.

Applicable Specs. and Procedures: Golder TP 8.3-0

Technical Review Process:

Project Manager Approval/Date: **QA Manager/Date**

1. PURPOSE

This technical procedure establishes the methodology to be used for the standard sampling of fish. Because of the nature of fisheries work, decisions regarding the type of sampling gear to use and the timing of sampling will depend upon conditions in the field. The following methods are covered in this technical procedure:

- General Fisheries Work
- Biomarkers
- Organochlorine Contaminants Sampling
- Mixed Function Oxidase Sampling
- Sex Steroid Sampling
- Biomarker Number
- Field Records and Logbook
- Chain-of-Custody Form

2. APPLICABILITY

This technical procedure is applicable to all personnel involved in fish surveys.

3. DEFINITIONS

3.1 Ageing Structures

Parts of the fish which are taken for ageing analyses. These structures contain bands (annuli) which delineate seasonal variation in growth which can be counted. Primary examples of these structures are scales, fin rays, otoliths, eleithra and opercula. The appropriate ageing structures to collect vary according to fish species and lifestage and include lethal and non-lethal sampling measures.

3.2 Tagging

3.2.1 Anchor (Floy) Tagging

A practical and inexpensive method of permanently marking individual fish. The tag, shaped like an inverted "T", is most commonly inserted in the epipleural bones of the dorsal spine. The posterior of the tag is usually brightly coloured and carries a numeric identification code. This method is prefered when seeking angler return data to aid in establishing fish movements.

3.2.2 Visual Implant (VI) Tagging

A "micro-tag" method suitable for use when a tagging method is required which has minimal effects on the swimming and feeding efficiency of the fish. Good for tagging smaller fish than is possible with the anchor

tag method, such as small fish species or juvenile fish. Each tag consists of a small metal strip with an individual alpha-numeric code which is inserted using an injector into a clear tissue somewhere on the fishes body (i.e. post-ocular tissue for salmonids).

3.2.3 Batch Marking

A marking method which does not distinguish between individual fish. Common methods are fin clipping or dye marking.

3.3 Archive Samples

Extra samples which are taken and kept in storage for possible later analysis.

3.4 Bile

An alkaline secretion of the vertebrate liver, which is temporarily stored in the gall bladder. It is composed of organic salts, excretion products and bile pigment. It is responsible primarily for emulsifying fats in the small intestine.

3.5 Biomarker

Biomarker refers to a chemical, physiological or pathological measurement of exposure or effect in an individual organism from the laboratory or the field. Examples include: contaminants in liver enzymes; bile; sex steroids.

3.6 Chain-of-Custody Forms

Standardized forms which are used as a means of keeping close track of samples which are taken from the field and transported to laboratories for analysis. Whenever the samples are transported from the field, the custody is relinquished from the delivery person to the receiver by signatures on the forms. These forms substantially decrease the risk of losing samples because they provide a clear record of the chain of transport and handling of the samples.

3.7 Contaminants

A general term referring to any chemical compound added to a receiving environment in excess of natural concentrations. The term includes chemicals not generally regarded as "toxic", such as nutrients, colour and salts.

3.8 CPUE

Catch-Per-Unit-Effort. A measure which relates the catch of fish, with a particular type of gear, to the sampling effort expended; it is expressed as: number of fish captured/unit of effort. Results can be given for a particular species or the entire catch. CPUE is used to define species relative abundance and compare abundance between sites and/or seasons. Effort can be expressed a number of ways depending on

the sampling equipment. Some examples are time (sec/hr), area (m^3) and net length (m). If CPUE data is required, sampling effort must be recorded.

3.9 Effluent

A waste material discharged into the environment.

3.10 Effluent Plume

The portion of a water body exposed to discharge; the plume is delineated by tracking concentrations of compounds known to occur in the discharge. A plume ends when concentrations are equal to natural background levels or when they reach an arbitrary limit, for example 0.1%.

3.11 Electroshocking

The use of electricity to stun and capture fish. An electrical current is passed between electrodes placed in the water and attracts passing fish (galvanotaxis) toward the positive electrode (anode). Once fish pass close to the anode the current acts as a narcotic and stuns the fish (galvanonarcosis), allowing them to be easily netted. Once captured, the fish may be identified, weighed, measured, tagged and then returned to the water. Fish taken by electrofishing revive quickly when returned to the water. Effort is automatically recorded by the electrofishing unit as the number of seconds of active electrofishing (i.e. time current is applied to the water).

3.12 EROD

Ethoxyresorufin-O-deethylase. EROD is a laboratory technique that indirectly measures the presence of catalytic proteins that remove a CH_3CH_2-group from the substrate ethoxyresorufin. The substrate was chosen because of the fluorescent product formed is very easy to monitor in the laboratory. In the animal, various hydrophobic compounds can be transformed by this more polar products, which prepares them for eventual elimination from the body. Thus, this is a "detoxification" system that reduces the amounts of potentially harmful substances in the body. Cytochrome P4501A is the scientific designation of the dominant protein that carries out this catalytic function in fish and animals. EROD activity refers to the rate of deethylation and indirectly reflects the amount of protein present.

3.13 Fecundity

The most common measure of reproductive potential in fish. It is the total number of eggs in the ovary of a gravid female fish. Fecundity normally increases with the size of the female within a given species.

3.14 Forage Fish

A general term applied to smaller species of fish that "forage" on small invertebrate animals or plant materials.

3.15 Game Fish

Fish used by anglers for recreational fishing, e.g., northern pike, walleye.

3.16 Gillnetting

A method of capturing fish that involves the setting of nets of various mesh sizes (usually from about 2 to 10 cm) anchored in place in a river or lake. The nets function by catching on the gills of fish as they attempt to swim through. Effort should be recorded as the number of hours the net is set and expressed as either duration (hrs), panel-hours, or meter-hours, depending on the type and variety of nets set.

3.17 Gonads

Organs which are responsible for producing haploid reproductive cells in multicellular animals. In the male, these are the testes and in the female, the ovaries.

3.18 GSI

Gonad-Somatic Index. The proportion of reproductive tissue in the body of a fish. It is calculated by dividing the total weight of the gonad by the total body weight and multiplying the result by 100. It is used as an index of the proportion of growth allocated to reproductive tissues in relation to somatic growth.

3.19 LSI

Liver-Somatic Index. Ratio of liver versus total body weight. Expressed as a percentage of total body weight.

3.20 Lesions

Pathological change in body tissue.

3.21 m^3/s

Cubic metres per second. The standard measure of water flows in rivers, i.e., the volume of water in cubic metres that passes a given point in one second.

3.22 Necrosis

The death of a tissue due to injury or disease.

3.23 Reach

A reach is a relatively homogenous section of stream having repetitious sequence of assigned characteristics and habitat types. A reach is relatively uniform with respect to channel morphology, flow volume, gradient and habitat types and is separated from other reaches by changes in these characteristics.

Conventionally, reach numbers are assigned upstream ascending order starting from the mouth of the stream. Reach boundaries are identified using maps or air photos, then verified in the field.

3.24 Reference Site

A site used for comparison with a site exposed to the discharge being studied. Ideally, reference sites should be as similar as possible to the exposed site, but without the discharge.

3.25 Relative Abundance

The proportional representation of a species in a sample or a community.

3.26 Sampling Error

Sample inaccuracy caused by bias or imprecision in sampling; e.g., bias towards large fish because of the type of sampling gear. In statistics, sample error is expressed by the standard deviation, which expresses the variability of results around the mean.

3.27 Secondary Sex Characteristics

External physical characteristics displayed by fish, particularly during spawning season. Examples are tubercles on fins or body coloration.

3.28 Seine Netting

The use of a large, fine mesh net to catch fish from shallow (wadable) areas. The net is dragged along the bottom or through the water column to collect fish by straining them from the water. This technique is typically used to catch forage species, using fine mesh nets.

3.29 Set Lines

A series of leaders and baited hooks strung from one central line which is anchored to shore. Set lines are usually set out overnight to catch predatory fish..

3.30 Sex Determination (Lethal)

To determine the sex of a fish, an incision should be made on the ventral surface of the body from a point immediately anterior to the anus toward the head to a point immediately posterior to the pelvic fins exposing the gonads. If necessary, a second incision may be made on the left side of the fish from the initial point of the first incision toward the dorsal fin (USEPA, 1993). To observe the gonads, fold back the tissue. Ovaries appear whitish to greenish to orange and have a granular texture. Testes appear creamy white and have a smooth texture (Texas Water Commission, 1990).

3.31 Sex Determination (Non-Lethal)

For some species, sex may be determined from external secondary sexual characteristics, observable either during the spawning season (e.g. suckers - tubercles) or at any time of year (e.g. goldeye - anal fin morphology). For most fish species, sex can be determined during the spawning season by forcing extrusion of the sexual product (milt/roe)

3.32 Species Composition

A term that refers to the species found in the sampling area.

3.33 Species Distribution

Where the various species in an ecosystem are found at any given time. Species distribution varies with season and life history stage.

3.34 Standard Deviation

A measure of the variability or spread of the measurements about the mean. It is calculated as the positive square root of the variance.

4. REFERENCES AND SUGGESTED READING

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5. DISCUSSION

5.1 General Fisheries Survey

A combination of sampling techniques should be used according to river flow conditions lake morphometry, season, fish species and previous sampling success. These sampling techniques include: boat electroshocking, back-pack electroshocking, gillnetting, seine netting, set lines, minnow traps, fry traps, drift traps, underwater videos, counting fence and angling. However, only the sampling techniques

specified for in the project fish collection permit are allowed. If a change in sampling techniques is deemed necessary, the Project Manager should be informed before altering planned fishing methods. Therefore, all techniques that may be required, including those in contingency plans, must be included in the request for a collection permit. Note: for targeting a specific species, the sampling gear used can be selective to minimize variance in fish size, thus reducing sample size and processing requirements.

For seine netting, gill netting, back-pack electroshocking, set lines and angling, the sample site should be described fully and a sketch map of the location provided in the field book. Sufficient detail on the site must be known to enable accurate assignment of grid coordinates. It is preferable to note the location on a topographical map directly when in the field. Some studies may require that sites be located by a Geographic Positioning System. Specific Work Instructions will note this requirement. Assign a code number for each sample site according to the main sites in the study area. For example, if gill net set #2 is within site 2, then code number would be #GS2-2. This code is to marked on the topographical map. For boat electroshocking, the reach (start point to end point of boat run) should be recorded on the map. For all sampling types, the effort set should be recorded. That is, the start and end times, using a 24 hour clock, for each individual effort and the number of fish caught during that effort. In addition, time of active electrofishing for each run should be recorded from the counter on the electrofishing unit. Moreover, all seine netting effort should be recorded by pacing or measuring the distance seined and recording the haul type (upstream or downstream). The dimensions (length/panel, depth, mesh size(s)) of all seine nets and gill nets used should be recorded.

At each site, supporting receiving environment measurements are to be taken and recorded. These measurements include: water temperature, pH, dissolved oxygen, conductivity, secchi reading and current weather conditions (e.g., cloud cover, air temperature, approximate wind speed, precipitation, etc.).

All fish that are captured should be identified to species, assigned a fish number, weighed (g), measured for length (mm), determined for life history stage (fry, juvenile, adult), sex (refer to Section 3.27) and sexual maturity (if possible), noted for abnormal external pathology (e.g., fin erosion, ulcers, skeletal anomalies, neoplasms) and aging structures taken. Ageing materials to be collected for each fish species are specified in MacKay et al. 1990. For field collections, refer to Table 2 for recommended ageing structures. Non-target species or specimens of target species that do not meet size requirements should be tagged if necessary (refer to Specific Work Instructions) and returned to the water. If required, tag fish with either Floy Tags, Visual Implant Tags or Dye Marks depending on age and size of fish. Fish should be identified to species by experienced crew members. Taxonomic keys appropriate for the sampling waters, should be reviewed. Any fish that cannot be identified in the field should be sacrificed and preserved in 10% neutral buffered formalin with the appropriate label showing date and location of capture. Collected fish should be marked on the data sheets as unidentified and collected and following identification, the data sheets should be updated. For fish selected for biomarker processing, record time (24-hour clock) of capture. Large fish that are moribund or dead should be fully processed for biological data (sex maturity, internal pathology).

Standard abbreviation of fish species names is based on the following rules (MacKay et al. 1990):

a) use a four letter base abbreviation
b) for a one word name - use the first four letters
e.g., GOLD for goldeye

c) two word names - use the first letter in each word plus the next consonant in each word
e.g., ARGR for Arctic grayling,
LKWH for lake whitefish, and,
WHSC for white sucker

d) three word names - use the first letter in the first two words and the first letter and next consonant in the last word
e.g., NRDC for northern redbelly dace

5.1.1 General Safety

Refer to Golder Associates Ltd. Safety Manual.

5.1.2 Electrofishing Safety

All crew leaders must be thoroughly familiar with electrofishing safety standards. All crew leaders must ensure that each crew member is instructed in safety requirements and complies with safety measures. Please refer to the Golder Safety Manual and Electrofishing Manual by the United States Department of the Interior, Fish and Wildlife Service, section on Electrical Safety and Electrofishing.

5.2 Fish Biomarkers Collection

Note: The full biomarker procedure may not be required for a particular project. Refer to the Specific Work Instructions for your project.

Preparation

1. All new personnel must read the protocol, have it demonstrated and then practice the procedures on at least 2 practice fish.

2. All dissecting instruments and aluminum foil (assuming no metal analysis samples to be taken) should be cleaned in a acetone wash followed by a hexane wash. Dirt and tissues should be removed from the instruments with organic-free water before the acetone/hexane wash. All dissecting equipment is to be wrapped in the washed foil.

3. Battery operated balances are to be checked daily. Level balance at work area and check calibration using standard weights. A vial, weigh paper; anything that has been weighed on a calibrated lab balance may be used. Shield from wind if necessary.

4. All biomarker data are to be recorded in waterproof field notebooks, Biomarker forms (Exhibit A), Internal and External Examination forms (Exhibit B and C).

5. All dissecting equipment, sample containers, sample wrapping and wash equipment must be shipped and stored in clean waterproof containers with leak-proof lids.

6. All solvents and preservatives required for field work must be packaged and labelled according to WHMIS and TDG regulations.

Sampling

1. Put on a clean pair of non-chlorinated, non-powdered latex examination gloves.

2. Select fish from holding facility. Only live fish are to be sampled. Excessive handling of fish and stress is to be avoided. *Any fish that has been held after capture for more than an hour must be rejected*, refer to time of capture. If necessary, fish can be marked with temporary tags for identification at time of capture. Ensure that the skin on the specimen has not been lacerated during sampling. If there has been laceration and loss of fluids, reject the specimen.

3. Assign a biomarker number to fish based on instructions in 5.7.

4. Take blood from fish via the caudal artery using a 10 cc syringe and an 18-21 gauge needle. Label and store blood on wet ice (4°). Within 24 hours, blood tubes are to be centrifuged for at least 10 minutes. Decant the resulting separated serum using a micro-pipette and placed in a 3-5 ml cryovial. Preserve samples on dry ice until shipment to a laboratory.

5. Sacrifice the fish with a blow to the head. Note sacrifice time (24 hour clock) on log sheet.

6. Weigh and measure the fish (to nearest gram and mm) and record results. Use fork length measurement except for species with no anal fin indentation which should be measured for total length.

7. Rinse the fish in ambient water to remove any foreign material from the external surface.

8. Place the fish on a piece of acetone/hexane washed foil on a clean cutting board.

9. Make an full incision just below the area between the left pectoral fin and midline. Carefully remove liver and gall bladder. Clamp bile duct with a hemostat. Separate gall bladder from liver. Weigh liver to nearest 0.1 gr., note colour and firmness and record. If analysing for Mixed Function Oxidase (MFO), quickly place liver on a small rectangle of washed foil, wrap, place label between folds of foil (no contact with liver) and freeze immediately in liquid nitrogen. If mincing of liver is required by Specific Work Instructions, rinse the liver first in 0.15 M KCl, mince, wrap in washed foil and then freeze in liquid nitrogen (Hodson et al., 1991). **MFO analysis requires approximately 1.00 g liver, MFO samples must be taken within 2 - 5 minutes of sacrifice of fish. Samples not meeting this requirement must be rejected.** For species with diffuse livers (e.g., longnose sucker), quickly sample a representative portion of the liver from several locations along the intestine.. If analysing for organic contaminants (i.e., non-metal), quickly place liver on a small rectangle of washed foil, wrap, place label between folds of foil (no contact with liver), wrap with medical tape and label externally. Place sample in cooler of dry ice. NOTE: ANY PORTIONS OF LIVER FOR CONTAMINANTS ANALYSIS WHICH COME IN CONTACT WITH BILE FROM A RUPTURED GALL BLADDER SHOULD BE RINSED WITH 0.15 KCl. Remove bile from gall bladder with a 5 ml syringe and a 27-28 gauge

needle. Note and record bile volume and colour on biomarker form. Place bile sample in a labelled 5 ml cryovial and store on dry ice.

10. Complete external examination and record on external examination form.

11. **REFER TO SPECIFIC WORK INSTRUCTIONS FOR PROJECT APPLICABLE PROCEDURES.**

For individual fillet contaminant samples: remove approximately two 100 g fillets with a filleting knife that has been washed in acetone/hexane. Remove skin from fillets and ensure that no part of the fillet touches a surface that has not been washed in acetone/hexane. Place each fillet on a piece of washed foil and record weight. Wrap each fillet in the washed foil, insert label between folds of foil taking care not to touch the fillet. Securely tape a label onto the foil, make sure that one fillet per fish is labeled as an archive sample for possible later analysis. Place one fillet sample from each fish in a cooler with dry ice and store there until shipment to a lab. Place the archive fillet sample per fish in a cooler with dry ice clearly marked "archive samples or QC samples". Note: an alternative packaging for contaminant samples is organic-free plastic bags.

For samples taken for metals analysis: take care that the tissues designated as metal samples are dissected on a glass (preferably) or washable plastic surface, rather than on the foil. Dissecting instruments and knives used to take samples for metals analysis should be made of quartz, PTFE, ceramic, polypropylene or polyethylene. Stainless steel dissecting instruments are made predominantly of chromium and nickel. If these metals are not of concern, the use of high-quality, corrosion-resistant stainless steel sample processing is acceptable (USEPA 1993). Knives with titanium blades and PTFE handles are recommended for performing tissue resections (Lowenstien and Young 1986, USEPA 1993). For fillets, it is recommended that the fillet destined for organics analysis be taken first on the washed foil. Then the fish should be transferred to a plastic dissection surface and the fillet for metals taken. The fillet for metals must be placed in a plastic bag. If other organs are also being taken for contaminants analysis (e.g. liver, kidney) special care will have to be taken to isolate the section of the organ to be used for organics and take it while still on foil and then carefully remove the other section of the organ without contacting foil. ALL SAMPLES TO BE ANALYSED FOR METALS MUST BE PLACED IN PLASTIC BAGS, NOT FOIL. Utensils and containers should be cleaned thoroughly with a detergent solution, rinsed with tap water, soaked in acid, and then rinsed with metal-free water. Quartz, PTFE, glass, or plastic containers should be soaked in 50% HNO_3 for 12 to 24 hours at room temperature (USEPA 1993). **Chromic acid should not be used for cleaning any materials.** A minimum of regeant grade acids should be used. Stainless steel parts may be cleaned as stated for glass or plastic, omitting the acid soaking step (Stober 1991, USEPA 1993).

NOTE: THE SAMPLE MUST NOT THAW ONCE FROZEN. ONCE FROZEN, PROTECT SAMPLE INTEGRITY BY ENSURING ADEQUATE ICE LEVELS IN COOLER AND THEN TAKE MEASURES TO EXPEDITE SHIPPING TO THE ANALYTICAL LABORATORY.

For composite fillet contaminant samples: remove approximately two 100 g fillets with a filleting knife that has been washed in acetone/hexane. Remove skin from fillets and ensure that no part of the fillet touches a surface that has not been washed in acetone/hexane. Place each fillet on a piece of

washed foil and record weight. Wrap each fillet in the washed foil, insert label between folds of foil taking care not to touch the fillet). Place one wrapped fillet per fish into a plastic "zip-loc" bag and then place the Zip-loc bag into a large plastic bag that will hold all the specimens to be made into the composite. Put a "composite identification label" on the large plastic bag with tape or string. Place the other wrapped fillet per fish into a zip-loc bag and place into another large plastic bag that will hold all of the specimens to be archived for possible individual identification or QC analysis. Place an "archive sample label" on the large plastic bag with tape or string and store on dry ice until shipment. Note: only fillets from same species may make up a composite sample.

NOTE: IF SAMPLES ARE FOR ANALYSIS OF METALS, THEY MUST BE PLACED IN PLASTIC BAGS, NEVER WRAP METALS SAMPLES IN FOIL

NOTE: THE SAMPLE MUST NOT THAW ONCE FROZEN. ONCE FROZEN, PROTECT SAMPLE INTEGRITY BY ENSURING ADEQUATE ICE LEVELS IN COOLER AND THEN TAKE MEASURES TO EXPEDITE SHIPPING TO THE ANALYTICAL LABORATORY.

For composite internal organ contaminant samples: composite homogenates should be prepared from equal weights of individual homogenates (internal organ). The same type of homogenate should always be used in a given composite sample (USEPA 1993). Remove homogenate sample and any associated liquid using a washed scalpel or dissecting scissors. Divide into two 100 g samples (if sample is large enough). Ensure that no part of the sample touches a surface that has not been washed in acetone/hexane. Place each sample on a piece of washed foil and record weight. Wrap each sample in the washed foil, insert label between folds of foil taking care not to touch the fillet). Place one wrapped sample per fish into a plastic "zip-loc" bag and then place the Zip-loc bag into a large plastic bag that will hold all the specimens to be made into the composite. Put a "composite identification label" on the large plastic bag with tape or string. Place the other wrapped fillet per fish into a zip-loc bag and place into another large plastic bag that will hold all of the specimens to be archived for possible individual identification or QC analysis. Place an "archive sample label" on the large plastic bag with tape or string and store on dry ice until shipment.

NOTE: SAMPLES TO BE ANALYSED FOR METALS MUST BE PLACED IN PLASTIC BAGS; NEVER WRAP METALS SAMPLES IN FOIL.

NOTE: THE SAMPLE MUST NOT THAW ONCE FROZEN. ONCE FROZEN, PROTECT SAMPLE INTEGRITY BY ENSURING ADEQUATE ICE LEVELS IN COOLER AND THEN TAKE MEASURES TO EXPEDITE SHIPPING TO THE ANALYTICAL LABORATORY.

For whole fish contaminant samples to be later resected in the laboratory: each fish should be individually wrapped in extra heavy duty wash aluminum foil. Spines on fish should be sheared to minimize punctures in the aluminum foil packaging (Stober, 1991). The sample identification label should be taped to the outside of the package, each individual fish should be placed into a waterproof plastic bag and sealed. The Chain-of-Custody form should be attached to the outside of the plastic bag with string or tape. Note: for specimens making up a composite sample, keep all composite sample specimens together (if possible) in the same shipping container for transport. Once packaged, samples should be cooled on wet ice or blue ice immediately. Samples are to be shipped to the processing

laboratory within 24 hours (Smith 1985; USEPA, 1990d). If the shipping time to the laboratory is to exceed 24 hours, dry ice should be used. Note: if analyses will include edible tissue, freezing may cause internal organs to rupture and contaminate fillets or other edible tissues (Stober, 1991, USEPA 1986b).

12. Examine and record the internal condition of the fish on the Internal Examination Form. Preserve any abnormal tissues in 10% neutral, buffered formalin for later histopath analysis. Ensure that histopath samples contain both internal labels (waterproof paper and pencil) and external labels. Record tissues taken on the internal examination sheet as well as in field notebook.

13. Examine gonad, remove and weigh to nearest 0.1 g. Note sex (refer to Section 3.27) and assign maturity rating (refer to Table 1 for maturity codes). If there is uncertainty regarding the maturity code to assign, take a section of the gonad (mid-section) and preserve it in 10% buffered formalin for later examination in the laboratory. If collecting for fecundity and egg diameters, then remove 1 gram of eggs from the midregion of the ovary and place them in round histology cassettes that are lined with foil. Tare the balance to the weight of any empty cassette and then weigh the samples. Label the cassette. A minimum of 50% of the total sample size per species per site must have fresh measurements of egg diameter. Measure 30 individual fresh eggs/female using a micrometer for egg diameter. Record, label and store each egg individually in a histology cassette with 10% neutral, buffered formalin. After the minimum sample size for fresh measruements has been reached, store 30 eggs/female together in a histology cassette with 10% neutral, buffered formalin for analysis at the lab. At the lab, the individual eggs measured fresh in the field will be remeasured and calculated for % shrinkage. The % shrinkage will be used to correct measurement of the samples that were not measured fresh in the field. Volumetric determinations of egg size are made by counting 100 eggs and placing in a graduated cylinder with a pre-measured volume of water. Measure the new volume after the eggs have been added and record. Eg. Pre-volume = 5 ml. Volume with eggs = 5.5 ml. Volume of eggs = 0.5 ml. Precision of volumetric measurements will be dependent upon the graduated cylinder used. NOTE: The precision required for volumetric measurements of egg size in Environmental Effects Monitoring studies is $\pm$ 1%. (E.g. if a 10-ml cylinder is used, measurements are expected to be precise to 0.1 ml. This may not be achievable with 100 very small eggs. If not achievable, make note in the field notes and record the actual precision - e.g. 0.5 ml).

14. Observe and record qualitative stomach contents on internal examination form. Qualitative measurement of stomach contents is to be done by estimating the % of total volume of contents taken up by each food item. Be as specific as possible. For example, mayflies, stoneflies, caddisflies, water boatmen, water striders, beetles, not just "insects". Include % sediment or detritus and % plant material. Identify fish to species if possible, e.g., longnose sucker. Identify amphibian, bird or mammal prey as accurately as possible.

15. Collect two different ageing structure materials (i.e., scales, pectoral fin ray, otoliths) as per species requirements in Table 2, unless otherwise specified in the Specific Work Instructions. Place ageing materials in an "ageing materials" envelope and label.

16. Discard the remains of the specimen into a sealed bag for later disposal at a landfill. Discard latex gloves.

17. Rinse off cutting board with ambient water. Put on a clean pair of latex gloves and place a fresh piece of washed foil on the board. Proceed to the next fish.

    NOTE: IF YOU ARE COLLECTING CONTAMINANT SAMPLES, USE A FRESH FILLETING KNIFE AND DISSECTING EQUIPMENT FOR EACH FISH. FRESH SYRINGES MUST ALSO BE USED FOR EACH BILE AND BLOOD SAMPLE.

18. Once all samples have been taken from one site, ensure adequate ice levels in the cooler, attach a Chain-of-Custody (Exhibit D) to the inside lid of the cooler and then seal the cooler using duct tape. Do not mix samples from different sites in one cooler.

19. All used "sharp" dissecting/sampling equipment (needles, scalpel blades, etc.) must be placed in a designated "sharps" disposal container.

5.3 Field Recordkeeping

For proper interpretation of field survey results, thorough documentation of all field sample collection and processing activities is required. All logbooks should be perfect-bound and waterproof, forms should be preprinted on waterproof paper, and only indelible ink and pencil (if form or paper is wet) should be used.

To document field activities, sample identification labels, Chain-of-Custody forms, field logbooks, biomarker form, internal/external examination forms, catch records (Exhibit E) and fish sample records (Exhibit F) should be used. This will serve as an overall "Chain-of-Custody" documenting all field samples and field events beginning with sample collection through biomarker processing and preservation and shipment to the laboratory.

5.3.1 Sample Identification Label

<u>Individual Contaminant Samples</u>

All individual samples must be labelled. Each label must be completed in indelible ink for each sample. For contaminant samples, the following information must be included on the label:

Project number
Collecting Agency or Firm-Golder
Sampler (name)
Biomarker number
Length/weight of specimen
Sampling date/time (24 hour clock)
Sample type: F = fillet, W = whole, ungutted, L = liver, B = bile, G = gonad, S = stomach, K = kidney.
Time-frame for analysis - immediate or archive

A completed sample identification label must be taped securely onto each foil-wrapped or bagged sample.

Composite Contaminant Samples

All composite samples must be labelled. Each label must be completed in indelible ink for each sample. For contaminant samples, the following information must be included on the label:

Project number
Collecting agency or firm
Sampling date/time (24 hour clock)
Sample Site
Sampler (name and signature)
Composite number
Species abbreviation
Sample type: F = fillet, W = whole, ungutted, L = liver, B = bile, G = gonad, S = stomach, K = kidney.
Chemical analysis requested - or refer to an accompanying Chain-of-Custody Form or Analysis Request Form
Time-frame for analysis - immediate or archive

A completed sample identification label must be taped securely onto each foil-wrapped or bagged sample. An additional label identifying the composite sample must be placed on each plastic bag containing the foil-wrapped or bagged samples. The same type of label may also be used for archive samples; simply indicate on the label that the samples are to be archived.

MFO's, Blood and Bile Samples

All MFO, blood and bile samples must be labelled. Each label must be completed in indelible ink for each sample. For MFO, blood and bile samples, the following information must be included on the label:

Biomarker number
Sampling date/time (24 hour clock)

Then place a label on outside of the dewar, bag or cooler containing several bile, blood or MFO samples and including the following information on the label:

Project number
Collecting agency or firm
Sampler (name)
Time frame for analysis - immediate or archive
General sample type (eg., bile, liver, etc.)

Histopathology and Egg Samples

All histopathology and egg samples must be labelled. Each label must be completed in indelible ink for each sample. For histopathological and egg samples, the following information must be included on the label:

Project number
Sampling date/time (24 hour clock)
Biomarker number
Tissue type:

O = ovary	T = testes
L = liver	S = spleen
H = heart	K = kidney
G = gill	I = intestine
ST = stomach	SK = skin
F = fin	AB = air bladder

An additional label must be placed on the jar or plastic bag identifying the several cassettes or jars of preserved specimens contained within. The label must include the following:

Project number
Collecting agency or firm
Sampler (name)
Time frame for analysis - immediate or archive
General sample type (eg., eggs for fecundity, histopathology samples)

NOTE: THE USE OF PRE-PRINTED LABELS IS STRONGLY ENCOURAGED.

5.4 Chain-of-Custody Form

Sample possession and proper handling of samples must be traceable from the time of sample collection, through laboratory and data analysis. A Golder Chain-of-Custody form must be completed and signed in indelible ink for each shipping container (e.g. ice cooler) used. Prior to sealing the cooler, two copies of the Chain-of-Custody form must be sealed in a plastic bag and taped to the inside cover of the cooler. Ensure that the carrier responsible for delivering the samples also signs and dates all Chain-of-Custody forms.

5.5 Field Records and Logbook

All pertinent information on field activities and sampling efforts must be recorded in an appropriate (i.e., waterproof) bound logbook. The field crew leader is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct field activity without relying on the memory of the field crew. All entries must be made in indelible ink, with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by a single-line cross-out of the error, entering the correct information, dating and initialing the change. Upon return to the office, all field notes must be photocopied and placed in the appropriate project files.

Entries in the field logbook must include:

- Purpose of proposed sampling effort.
- Date and time (24 hour clock) of sampling.

- Names of field crew leader and team members.
- Description of each sampling site, including information on any photographs that may be taken.
- Location of each sampling site, name and number, applicable navigational coordinates, waterbody name/segment number.
- Details of sampling method and effort, particularly deviations from Specific Work Instructions.
- Clear identification of site names and sample numbers.
- Field observations.
- Field measurements taken (e.g., pH, temperature, flow, dissolved oxygen, secchi, weather conditions).
- Sample shipping information.

The field logbook should also be used to document any additional information on sample collection activities, hydrologic conditions, boat or equipment operations, or any unusual activities observed or problems encountered that would be useful to the project manager when evaluating the quality of the monitoring data.

A biomarker logbook should also be kept. All pertinent information on fish biomarkers must be recorded in an appropriate (i.e., waterproof) bound logbook. The field crew leader is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct fish biomarker field activity without relying on the memory of the field crew. All entries must be made in indelible ink, with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by a single-line cross-out of the error, entering the correct information, dating and initialing the change. Upon return to the office, all field logbooks and notes must be photocopied and placed in the appropriate project files.

Entries in the fish biomarker field logbook must include:

- Date and time (24 hour clock) of sampling.
- Names of field crew leader and team members.
- Site name and number.
- Secchi, water temperature, conductivity,
- Fish number and Biomarker number.
- Capture time/sacrifice time (24 hour clock)
- Length/ Total Weight.
- Sex and stage
- Liver: total weight, sample weights, sample time (24 hour clock), canister storage number, colour
- Fillet: sample weights
- Bile: color, volume, canister storage number
- Gonads: total weight (testes or ovaries), egg weights, total fecundity count
- Abnormal tissues collected and preserved

- Ageing structures collected

Biomarker Forms, Catch Records, Fish Sample Records, External/Internal Examination Forms and Photo-Log Sheets are to be filled out, dated and signed. All forms should be cross-referenced to the appropriate field record via the fish number and/or composite number.

5.6 Fish Biomarker Number

All fish that are selected for biomarker analysis are to be given an individual biomarker number. This number is to be recorded on all individual sample labels. The biomarker number is an unique number which identifies the fish by project, species type, site, season and year.

The following format is to be used for biomarker numbering:

e.g.,

WLD	95	P	2A	LNSC	013
Project	Year	Season	Site	Species	Fish No.

Project - a unique 3 character code relating to the project.
Year - use the last two numbers of the year e.g., 1986 = 86.
Season - a one character code relating to season.

P - Spring
U - Summer
F - Fall
W - Winter

Site - a one or two alphanumeric code relating to the site the sample was caught.
Species - a four character abbreviation for species, see Section 5.1.
Fish No. - a three digit consecutive number. Individual numbering scheme for each species are to be used.

NOTE: THIS LABELLING SCHEME MAY BE SUPERCEDED BY LABELLING REQUIREMENTS SPECIFIC TO A PROJECT. HOWEVER, A SPECIAL LABELLING SCHEME MAY ONLY BE USED AT THE AUTHORIZATION OF THE PROJECT MANAGER AND QA OFFICER.

5.7 Shipping of Samples

Samples are to be shipped by the fastest possible means to the analytical laboratory. The primary QA consideration in shipping samples is protecting sample integrity. Preserve sample integrity by ensuring adequate ice levels in coolers before shipment to laboratory. Coolers are to remain sealed throughout shipment. Weigh-bill numbers are to be noted on the copies of the Chain-of-Custody form retained after sealing the coolers. Each transfer of custody is to be noted and signed for. The coolers should be labeled as Perishable/Keep Cold/Time-Sensitive. Clearly indicate the analytical laboratory address as well as a Golder contact person and phone number. The crew leader is to telephone the processing laboratory and

inform them of the upcoming delivery. The crew leader is also required to phone the processing laboratory to confirm arrival of the shipment and that analysis instructions are clear.

5.8 Procedure Alteration Checklist

Variations from the established procedure requirements may be necessary due to unique circumstances in the field. All variations from established procedures shall be documented on Procedure Alteration Checklists (Exhibit G) and reviewed by the Project Manager and the QA Manager.

The Project Manager may authorize the individual Field Crew Members to initiate variations as necessary. If practical, the request for variations shall be reviewed by the Project Manager and the QA Manager prior to implementation. If prior review is not possible, the variation may be implemented at the direction of the Field Biologist, provided that the Project Manager is notified of the variation within 24 hours of implementation and the Procedure Alteration Checklist is forwarded to the Project Manager and the QA Manager for review within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be repeated or action shall be taken as indicated in the Comments section of the checklist.

All completed Procedure Alterations Checklists shall be maintained in project records.

6. RESPONSIBILITY

All aquatic field crew members engaged in conducting fish inventories or fish biomarking studies are responsible for compliance with this procedure.

7. EQUIPMENT AND MATERIALS

Boat supplies
Fuel supply (primary and auxiliary supply)
Spare parts repair kit
Life preservers
First aid kit (including emergency phone numbers of local hospitals, family contacts for each crew member)
Spare paddles
Spare key
Floater Coats
Topographical maps of sampling sites
Flagging material
Tool box
Electrical tape
Water pump

Collection Equipment
Seine nets
Electroshocking device (boat and/or backpack unit)
Gill nets (if required)
Rubber gloves
Dip nets
Fish tubs (if required)

Recordkeeping
Field logbook (perfect-bound, waterproof)
Labels
Chain-of-Custody forms
Fish Sample Records
Unique Catch Records (boat, backpack, gillnet, seine net, etc.)
Indelible pens
Pencils
Applicable MSDS sheets and TGD placards

Biomarking Equipment (to be stored in waterproof, sealable equipment containers)
Specific Work Instructions
20 Litre pails for transfer and holding of fish
Fish measuring board (metric)
Balance (metric), calibration weights, balance levels and 9 volt batteries
Stainless steel forceps
Stainless steel filleting knives
Stainless steel dissecting scissors
Stainless steel scalpels
Stainless steel scalpel blades
Centrifuge (if taking blood samples)

Small whirlpacks
Nalgene bottles or small jars for pathology samples
Histology cassettes
Hemostats for clamping off gall bladder
5 ml Cryovials
Blood tubes
Tube rack
Paper towels
0.15 M KCl
Non-chlorinated, non-powdered latex surgical gloves
Aluminum foil (extra heavy duty)
10 ml syringe
18 g needle
5 ml syringe
27 g needle
Pipettes (if taking blood smears or serum samples)
Pipette Bulbs
Goggles for Liquid Nitrogen handling
Gloves for handling dewar racks (to prevent burns from Liquid Nitrogen)
"Sharps" disposal containers
Wash-tubs for field-washing of dissecting equipment in acetone/hexane
Used acetone/hexane containers
Cutting boards (washable)
Fish bonker
Folding tables (for biomarking stations)
Biomarker tent
Teflon wash bottle with distilled water
Medical tape
String
Several sizes of plastic bags including garbage bags
Cage material for holding fish in situ, if live-wells or fish tubs not available or too small

Sample preservation and shipping supplies
Ice (wet ice and/or dry ice)
Dewar (charged with liquid nitrogen if taking MFO samples)
Dry shipper (if taking MFO samples)
10% neutral buffered formalin
0.15% KCl
Scale envelopes
Ice chests
Duct tape
Clear shipping tape for Chain-of-Custody forms
Pesticide grade Hexane
Acetone
Pre-printed labels

Table 1. Sexual Maturity Codes to be Used For Fish

Males		Stage of reproductive development
IM	1	**Immature:** Gonads have yet to develop into mature condition. The testes are small, string like organs at this stage which are usually located ventral (but in close proximity) to the air bladder. In suckers and percids, immature male testes can be identified by position of testicular artery. The artery is usually totally or partially imbedded in the organ.
MA	2	**Maturing:** This condition refers to a fish which is a first year spawner. This fish has nver spawned before, but will spawn in the coming season. The testes are translucent; length half, or slightly more than half, the length of the ventral cavity.
DV	3	**Developing (Non-spawning gonad development stage):** Stage in which the sexually mature testes are in their development phase. This is the longest of the sexually mature stages as it extends from just after the post-spawning period until the next pre-spawning period. For spring spawning fish (ex: walleye, northern pike, longnose sucker), this stage would last from late May to early April of the next year. The testes will vary greatly in size and color within this stage depending on the time of year they are sampled. Early in development, the testes will be small and yellow to light orange in color. By early fall, they will have grown to nearly mature size and be white in color. Note: Suckers have a black colored testicular membrane which may mask the white color of the testes.
GR	4	**Gravid (Pre-spawning (green) condition):** Externally the abdomen will be slightly distended. Semen can be extruded with light pressure to the abdomen. Small amounts of loose semen will be produced followed by more viscous semen if pressure is re-applied. Internally, the testes will be large and white. Pre-spawning condition can also be determined by the relative position of the male. Males will usually only enter spawning condition once they are on the spawning grounds and around mature females. Thus a male caught away from the spawning grounds is most likely still in pre-spawning condition, even if some sexual products can be extruded. Note: Semen can be extruded from sexually mature males as early as February in spring spawning species.
RP	5	**Ripe (Spawning condition):** Externally the abdomen will be slightly distended. Semen can be extruded with light pressure to the abdomen. Large amounts of loose semen will be produced if pressure is applied. Internally, the testes will be large and white. Spawning condition can also be determined by the relative position of the male. Males will usually only enter spawning condition once they are on the spawning grounds and

around mature females. Thus a male caught on the spawning grounds, in the presence of spawning females, is most likely still in spawning condition.

SP 6 **Spent (Post-spawning condition):** Externally, the abdomen will be slightly flaccid, especially ventrally. Some semen can still be extruded with pressure but it will most likely be watery (i.e. not as intense a white color as in spawning males). Internally, the testes will be reduced in size and gray to creamy-white in color. Hemorrhaging and distended blood vessels on the surface of the organ are common. Post-spawning males are known to stay on the spawning grounds for some time (up to 2 weeks) so position is not always reliable.

RB 7 **Reabsorbing (applies primarily to females):** This condition is extremely rare in males. It can **only** be used as an alternative to the post-spawning stage as reabsorbtion of the semen by the testes is usually a rapid process. This researcher has observed only one case of a male actually retaining the entire contents of the testes for re-absorbtion. Should you suspect this condition, please have it verified by a qualified biologist.

RS 8 **Resting (applies primarily to females):** This condition is extremely rare in males. It can **only** be used as an alternative to the gonad development stage (#2). Resting males are most common in northern latitudes where the growing season is short or in ultra-oligotrophic lakes. Testes will appear flaccid and dirty-white to yellow in color. They will be larger in size than the testes of immature fish. A good indication is the size of the testicular artery in relation to the organ. In immature fish this artery is very thin whereas in resting males the testicular artery is much larger because of prior testicular development. Should you suspect this condition, please have it verified by a qualified biologist.

UN 9 **Unknown:** external examination, condition cannot be determined.

Females **Stage of reproductive development**

IM 1 **Immature:** Gonads have yet to develop into mature condition. The ovaries are small, string like organs at this stage which are usually located ventral (but in close proximity) to the air bladder. In suckers and percids, immature male testes can be identified by position of ovarian artery. The artery is usually completely outside the organ, resting on top of the surface tissue and attached with connective tissue.

MA 2 **Maturing:** This condition refers to a fish which is a first year spawner. This fish has never spawned before, but will spawn in the coming season. The ovaries are translucent, grey-red, length half, or slightly more than half,

of the ventral cavity. Single eggs can be seen. The gonad is developed primarily in the anterior body cavity. In some species, the anterior portion of the ovary will be gravid with eggs (in the later stage of development) while the posterior portion will resemble an immature female.

DV	3	**Developing (non-spawning gonad development stage):** Stage in which the sexually mature testes are in their development phase. This is the longest of the sexually mature stages as it extends from just after the post-spawning period until the next pre-spawning period. For spring spawning fish (ex: walleye, northern pike, longnose sucker), this stage would last from late May to early April of the next year. The ovaries will vary greatly in size and color within this stage depending on the time of year they are sampled. Early in development, the ovaries will be small and yellow to light orange in color. Developing oocytes will be small and dark orange in color. By early fall, the ovaries will have grown considerably to nearly mature size and be bright yellow to orange in color.
GR	4	**Gravid (pre-spawning (green) condition):** Externally the abdomen will be noticeably distended. A few eggs can be extruded with strong pressure to the abdomen. Care must be taken when applying pressure as the eggs are difficult to extrude and injury to the female (broken ribs) can occur. The abdomen will feel tight and hard. Internally, the ovaries will be large and bright yellow to bright orange in color. The size can be up to 25% of the total body weight. Pre-spawning condition can also be determined by the relative position of the female. Females will usually only enter spawning condition once they are on the spawning grounds and around mature males. Thus a female caught away from the spawning grounds is most likely still in pre-spawning condition, even if some sexual products can be extruded.
RP	5	**Ripe (spawning condition):** Externally the abdomen will be greatly distended. Eggs immersed in ovarian fluid can be extruded with light pressure to the abdomen. Large amounts of loose eggs will be produced if pressure is applied. Internally, the ovaries will be large and yellow or orange. The ovarian sac will be transparent and thin. Eggs will be loose inside the sac as they will be immersed in ovarian fluid which is clear. Spawning condition can also be determined by the relative position of the female. Females will usually only enter spawning condition once they are on the spawning grounds and around mature spawning males. Thus a male caught on the spawning grounds, in the presence of spawning males, is most likely still in spawning condition.
SP	6	**Spent (post-spawning condition):** Externally, the abdomen will be noticeably flaccid, especially ventrally. Some eggs can still be extruded with pressure but it will be few and they will be associated with watery

ovarian fluid. Internally, the ovaries will be greatly reduced in size and dark orange to brown in color. Hemorrhaging and distended blood vessels on the surface of the organ and well as within are very common and normal. Some residual eggs (up to 25% of the ovary volume) are common. Post-spawning females are not known to stay on the spawning grounds so position is not always reliable. Female most often spawn and leave the area immediately.

RB 7 **Reabsorbing (applies primarily to females):** This condition is common in females and the product of an interrupted spawning effort.. Thus this stage can **only** be used as an alternative to the gonad development stage. Reabsorbtion of the eggs by the ovary is usually a lengthy process which can take up to a full year. Identification is not always easy. Externally, the female will still have a distended abdomen if caught within a few months of the spawning season. The abdomen will feel usually hard as compared to normally developing females. Later in the season, it will be impossible to distinguish a normally developing female from a reabsorbing one without an internal examination. Internally, reabsorbing ovaries go through a series of distinct stages. Early in the reabsorbtion process, the ovary is dark orange to brown in color. The eggs are dark and flaccid. Heavy amounts of watery ovarian fluid collect at the posterior of the ovary. This fluid most often is ejected readily if the fish is handled. Later, the ovary becomes smaller and hard. The color becomes darker and the eggs become atritic. Atritic eggs are easily identified as they are small, hard and white. Ovaries in the later stages of eggs reabsorbtion have few new oocytes. The remnants of the old eggs collect in the middle of the organ. New oocytes production is restricted to the periphery of the ovary. Should you suspect this condition, please have it verified by a qualified biologist.

RS 8 **Resting (applies primarily to females):** This condition infrequent in females, affecting usually only 0.5 to 1% of the population. This stage can **only** be used as an alternative to the gonad development stage (#2). Resting females are most common in northern latitudes where the growing season is short or in ultra-oligotrophic lakes. The ovaries will appear to have some oocytes but they will be few in number and arrested in their development. The color of resting ovaries varies greatly with fish species but most often they are a light orange. They will be larger in size than the ovaries of immature fish. A good indication is the size of the ovarian artery in relation to the organ. In immature fish this artery is very thin whereas in resting females the ovarian artery is much larger because of prior egg development. Should you suspect this condition, please have it verified by a qualified biologist.

UN 9 **Unknown:** external examination, condition cannot be determined.

TABLE 2

RECOMMENDED FISH AGEING STRUCTURES
(From Mackay et al. 1990 - Fish ageing methods for Alberta)

SPECIES	AGEING STRUCTURE (most preferred structure in bold)			
	LETHAL		NON-LETHAL	
	Preferred	Secondary	Preferred	Secondary
lake sturgeon	otoliths	none	**first pectoral fin ray**[A]	none
Arctic grayling	sagittal otoliths	none	**scales**[B]	pectoral fin rays
cisco	**sagittal otoliths**	none	**scales**[B] **(if fast growing)**	none
lake whitefish	**sagittal otoliths**	undetermined	**scales**[B] **(if fast growing)**	pelvic fin rays
mountain whitefish	sagittal otoliths	none	**scales**[C]	undetermined
lake trout	**sagittal otoliths**	none	**first three pelvic fin rays**[A]	scales (for immature fish)
bull trout	**sagittal otoliths**	none	none (scales not suitable)	none
brook trout	**sagittal otoliths**	none	scales[C] (if < 3 yrs. old)	none
brown trout	**sagittal otoliths**	none	scales[D] (if < 3 yrs. old)	none
rainbow trout	**sagittal otoliths**	none	**scales**[E] **(if fast growing)**	none
cutthroat trout	**sagittal otoliths**	none	scales (unreliable)	none
northern pike	**cleithrum (freeze)**	opercular bones and vertebrae	**first three pelvic fin rays**[A]	scales[D] (fish up to 3 yrs. old)
goldeye	**operculum**	none	first three pelvic fin rays[A]	scales[C] (fish up to 5 yrs.)
mooneye	**operculum**	none	first three pelvic fin rays[A]	scales[C] (fish up to 5 yrs.)
yellow perch	opercular bone	none	**pelvic spine and first two fin rays**[A]	two anal spines[A]
walleye	opercular bones	otoliths	**pelvic spine and first two fin rays**[A]	dorsal spine
sauger	opercular bones	otoliths	**pelvic spine and first two fin rays**[A]	dorsal spine
burbot	**sagittal otoliths**	none	none	none
suckers spp.	none	none	**pectoral fin rays**[A]	scales (if <5 yrs.)
trout-perch	**otoliths**	none	none	none
sculpin spp.	**otoliths**	none	length-freq. analysis	none
cyprinids	**otoliths**	none	**scales**	length-freq. analysis
flathead chub	otoliths	none	**pectoral fin ray**[A]	scales
sticklebacks	**otoliths**	none	length-freq. analysis	none

[A] proximal end
[B] collect 10-15 scales from the left side between the front edge of the dorsal fin and the lateral line
[C] collected between the dorsal fin and the lateral line
[D] collected from above the lateral line just posterior to the dorsal fin
[E] collected from immediately dorsal to the lateral line, between the posterior edge of the dorsal fin and origin of the anal fin

Exhibit A
BIOMARKER DATA Project No. _____ CUTTER: _____

Waterbody: _____ Site: _____ Fish #: _____

Weather: _____ pH: _____

Date: _____ Species: _____ Sex/Maturity: _____ Length: _____

Weight: _____ g Sample Method: _____ Conductivity: _____

Capture Time: Date _____ Hr. _____ Water Temp: _____ °C

Sacrifice Time: Date _____ Hr. _____ Secchi: _____

SAMPLES COLLECTED FOR (check off)

HORMONES: _____ Serum
BIOMARKERS: _____ Liver MFO
_____ Intestine MFO
_____ Other

CONTAMINANTS:
_____ Liver
_____ Flesh
_____ Gonads
_____ Bile
_____ Other

GENERAL FISH HEALTH DEVELOPMENT:
Gonads: _____ Fecundity (1 g of eggs)
_____ Egg Diameter
_____ Histology/Staging

General Organ Histology:
_____ Liver
_____ Spleen
_____ Heart
_____ Gill
_____ Kidney
_____ Other

Stomach/Intestine Content:
_____ Observed
_____ Collected

Ageing Structures: _____ Pectoral Fin
_____ Pelvic Fin
_____ Operculum
_____ Dorsal Spine
_____ Otolith
_____ Scale
_____ Other
_____ Cleithrum

COLLECTION DETAILS

BLOOD: Volume: _____ mL
Serum Volume: _____ mL
Serum Colour: _____

LIVER: MFO: _____ g
MFO Canister No.: _____
Contaminants: _____ g
Histology: _____ g
Other: _____ g
Total Liver Weight: _____ g

FILLETS: Contaminant: _____ g
Tainting: _____ g
Metals: _____ g
Other: _____ g

BILE: Colour: _____
Gall Bladder Fullness: _____
Volume Collected: _____ mL
Canister No.: _____

GONADS: Total Weight _____ g
Contaminants: _____ g

Histology: _____
Region Collected From: _____

Fecundity: _____
Fecundity Subsample Weight _____ g
Region Collected From: _____
Testis Weight: _____ g
Total Gonad Weight: _____ g

RECORDER: _____

Exhibit B

BIOMARKER - INTERNAL EXAMINATION OF FISH

Project # _____

Sampled For: (Check off)

_____ Liver MFO
_____ Intestine MFO
_____ Gonadal Histology
_____ Egg Staging
_____ Contaminants
_____ Fecundity
_____ Stomach/Intestine
_____ Steroid Hormones
_____ Egg Diameters
_____ Other _____

BLOOD
_____ Total Collected
_____ Serum Volume (m)
_____ Serum Colour
_____ Time Taken

BODY CAVITY
_____ Other Obs.
_____ Fluid - clear
_____ Fluid - bloody
_____ Fluid - cloudy
_____ Adhesions

MESENTERIC FAT
_____ None
_____ 50% of cecum covered
_____ <50% of cecum covered
_____ Ceca completely covered

LIVER
_____ (g) archive weight
_____ (g) MFO Sample Weight
_____ (g) Contaminant Sample
_____ (g) Total Weight
_____ Discolored
_____ Yellow
_____ Pale
_____ Enlarged
_____ Growths
_____ Parasites
_____ Time Taken

GALL BLADDER
_____ Empty
_____ Half Full
_____ Full
_____ Yellow
_____ Light Green to Grass Green
_____ Dark Green to Dark Blue Green
_____ Enlarged
_____ Parasites
_____ (ml) Bile Volume Preserved

HIND GUT

_____ No Inflammation
_____ Mild Inflammation
_____ Severe Inflammation

STOMACH CONTENTS:

OTHER OBSERVATIONS:

STOMACH
_____ Empty
_____ Mucus (Chyme)
_____ Fluid
_____ Hemorrhagic

PYLORIC CAECA
_____ Other Obs.
_____ Parasites

INTESTINES
_____ Other Obs.
_____ Flaccid
_____ Mucus
_____ Feces
_____ Fluid
_____ Hemorrhagic
_____ Parasites
_____ (g) MFO Sample Weight

SPLEEN
_____ Other Obs.
_____ Enlarged
_____ Granular
_____ Black
_____ Red
_____ Nodular

GAS BLADDER
_____ Other Obs.
_____ Fluid
_____ Growths

KIDNEY
_____ Other Obs.
_____ Pale
_____ Swollen
_____ Soft
_____ Hemorrhagic
_____ Stones
_____ Growths
_____ Cysts
_____ Parasites (urinary bladder)

TESTIS
_____ Immature
_____ Maturing
_____ Mature (green)
_____ Ripe
_____ Constricted
_____ Resting
_____ Spent
_____ Post-Spawning
_____ Total Gonad Weight (g)

OVARIES
_____ Immature
_____ Maturing
_____ Mature (Green)
_____ Ripe
_____ Reabsorbing
_____ Resting
_____ Spent
_____ Post-Spawning
_____(g)Fecundity Sub-sample Weight
_____(g) Total Ovary Weight

MUSCLE
_____ Other Obs.
_____ Soft
_____ Parasites
_____ (g) Contaminant Sample Weight
_____ (g) Archive weight

HISTOLOGY: (Tissue Preserved)

Exhibit C

BIOMARKER - EXTERNAL EXAMINATION OF FISH

Project # _____

Date: _____ Waterbody: _____ Site #: _____ Cutter: _____ Recorder: _____

Species: _____ Specimen #: _____ Sex/Maturity: _____ Length (mm): _____ Weight (g): _____

Capture Method: _____ Sampling: (Check one) _____ Lethal _____ Non-Lethal Ageing Structures: _____ Tag #: _____

BODY FORM
_____ Other Obs.
_____ Emaciated
_____ Truncate
_____ Scoliosis
_____ Lordosis

BODY SURFACE
_____Other Obs.
_____Raised and/or missing scales
_____ Swollen
_____ Lesions
_____ Excess mucus
_____ Reoriented scales
_____ Growths
_____ Parasites
_____ Wound(s) - Lamprey

LIPS AND JAWS
_____ Other Obs.
_____ Deformed
_____ Growths

SNOUT
_____ Other Obs.
_____ Pugnose (Pughead)
_____ Growths
_____ Abrasions

BARBELS
_____ Other Obs.
_____ Deformed
_____ Missing

OPERCLE
_____ No shortening
_____ Mild shortening
_____ Severe shortening

ISTHMUS
_____ Other Obs.
_____ Enlarged
_____ Hemorrhagic

EYES
_____ Other Obs.
_____ Popeye
_____ Cloudy cornea
_____ Missing
_____ Lens deformed
_____ Lens parasites
_____ Lens cataract

FINS
_____ Other Obs.
_____ Frayed-eroded
_____ Parasites
_____ Hemorrhagic
_____ Gas bubbles

FINS - ERODED
_____ Dorsal
_____ Pectoral
_____ Pelvic
_____ Anal
_____ Adipose
_____ Caudal

GILLS
_____ Clubbed
_____ Other Obs.
_____ Discolored
_____ Gas bubbles
_____ Parasites
_____ Frayed

PSEUDOBRANCH
_____ Other Obs.
_____ Enlarged
_____ Inflamed
_____ Lithic
_____ Swollen & Lithic

BRANCHIAL CAVITY
_____ Other Obs.
_____ Growth
_____ Parasites

ANUS
_____ Inflamed

UROGENITAL OPENING
_____ Other Obs.
_____ Inflamed

LESION-ABRASION
_____ Fins
_____ Head
_____ Eyes
_____ Mouth
_____ Peduncle
_____ Ventral
_____ Dorsal
_____ Lateral

BEHAVIOUR
_____ Normal
_____ Other Obs.

STATE OF MATURITY
Male:
_____ Green
_____ Expressing
_____ Ripe
_____ Spent
Female:
_____ Green
_____ Expressing
_____ Ripe
_____ Spent

OTHER OBSERVATIONS:

_____

_____

_____

_____

_____

Exhibit D

GOLDER ASSOCIATES LTD.
CHAIN-OF-CUSTODY RECORD

Page ___ of ___

Field Sampler: (Signature) _____

Phone No._____

Shipment Date:_____

Carrier: _____

Weigh Bill No.: _____

Ship To:

Send Results To:

Project Name: _____

Project No. _____

P.O. No.: _____

Relinquished by: (Signature)	Received at lab by: (Signature)	Date	Time
Relinquished by: (Signature)	Received at lab by: (Signature)	Date	Time
Relinquished by: (Signature)	Received at lab by: (Signature)	Date	Time
Relinquished from lab by: (Signature)	Received by: (Signature)	Date	Time

ANALYSIS REQUEST

Sample ID No.	Sample Description	Date/Time Sampled	Analysis Requested	Sample Condition Upon Receipt

Special Instructions/Comments:

Rush (surcharge): _____ Standard Turnaround Time: _____

PLEASE RETURN WHITE COPY TO GOLDER ASSOCIATES LTD.

Exhibit E

BOAT ELECTROFISHING CATCH RECORD

Page ____ of ____

Proj. No._____ Proj. Title_____ Task_____ Personnel_____
Date (d/m/y)_____ Stream/Waterbody_____
Location (Reach/Site/Station)_____

	Map UTM Coordinates	GPS Location/File	
Point Location:	_____	_____	
Reach: Start	_____	_____	Portion of Channel Sampled:
Finish	_____	_____	(LDB/RDB/Centre)_____

Length of Stream Sampled (m)_____ Time of Sampling: Start_____ Finish_____
Equipment_____ Effort(sec)_____
Settings: Pulse Rate(AC/DC)_____PPS Range_____ % of Range_____ Output current_____amps
Support Data: Air Temp(°C)_____ Cloud Cover(%)_____ Wind(dir/rate)_____
Water Temp(°C)_____ D.O.(mg/L)_____ Cond.(*u*mhos)_____ pH_____
Secchi Depth(m)_____ Turbidity (NTU)_____

Species Code	Captured				Observed (not captured)				Total			
	Fry	Juv	Ad	Unk	Fry	Juv	Ad	Unk	Fry	Juv	Ad	Unk

Number of fish is in addition to those on Fish Sample Record _____ Photo Reference: Roll No.____
Number of fish includes those on Fish Sample Record _____ Photo No.____

FISH SAMPLE RECORD

Project No._____ Personnel_____ Task_____

Stream/Waterbody_____ Location (Reach/Site/Station)_____

Tag/Mark Description: Type (Floy/VI)_____ Color_____ Number Series_____

Date d/m/y	Capture Method	Fish No.	Species Code	Fork Length(mm)	Weight (g)	Stage Code	Sex	Maturity Code	Age Material	TAG Type	TAG Number	Capt/Rel Code	COMMENTS

1. PURPOSE

This technical procedure describes the methodology to be used for the manual sampling of surface water. Contained within are detailed sampling instructions.

2. APPLICABILITY

This technical procedure is applicable to any persons involved in the manual collection of surface water.

3. DEFINITIONS

3.1 Chain-of-Custody Forms

Standardized forms which are used as a means of keeping close track of samples which are taken from their field and transported to laboratories for analysis. Whenever the samples are transported from the field, the custody is relinquished from the delivery person to the receiver by signatures on the forms. These forms substantially decrease the risk of losing samples because they provide a clear record of the chain of transport and handling of the samples.

3.2 Surface water

Refers to any water either flowing or still that exists above ground level..

4. REFERENCES AND SUGGESTED READING

Environment Canada. 1993. Quality Assurance in Water Quality Monitoring. Ecosystem Sciences and Evaluation Directorate Conservation and Protection. Ottawa, Ontario.

5. DISCUSSION

5.1 General Safety

Refer to Golder Associates Ltd. Safety Manual.

5.2 Methods

To ensure the contaminant free collection of surface water quality samples, the following points in the selection of a sampling location must be observed:

- select actual field sampling site based on program design and access logistics.

Once the general location has been determined, the specific sampling site needs to be located. When locating the specific site the following is to be considered:

- for lotic systems, collect water samples using appropriate sampling device cleaned consistently with the specific requirements of the sampling program (refer to Specific Work Instructions for specific project requirements). Sample collection should be carried out before any disruptions of the water column;
- sample containers (usually provided precleaned by the analytical laboratory) should be rinsed a minimum of two times with ambient water. Rinse the bottles by partially filling, loosely attaching the cap and the shaking the bottles. Drain water and rinse again;
- in flowing water collect as representative a sample as possible based on the local flow conditions and safety of access
- avoid obvious sources of contamination when collecting samples, keep hands and fingers downstream of bottle opening, sample upstream of bridges, boats and yourself.

5.3 Site Location

Once the sampling location has been determined it must be accurately located relative to permanent landmarks such as groundwater wells, outfalls or distinctive landscape features. Actual measurements with long tape measures or electronic distance measuring devices and compass headings are recommended as a minimum to accurately determine position. Locations can be easily recorded as the perpendicular distance from the shoreline and the distance upstream or downstream of a permanent landmark or by global positioning system.

5.4 Sample Handling

The surface water samples should be treated in a manner specific to the parameters that are to be analysed for. In the case of toxicity samples, the vials should be kept cool, either on ice or in a refrigerator. They should be kept from freezing. Each sampling container should be permanently and uniquely marked to avoid confusion. The sample bottles should be submitted to the laboratory with the appropriate documentation (Chain-of-Custody form and Analytical Request Form). Included in the documentation should be the date, time, location, sample number, sampler identification and analytical request. Bottles are to be permanently labelled at the time of sampling with pre-printed, waterproof labels containing all of the pertinent sampling information. In some cases, bottles are to be identified by code numbers which are referenced on the sample submission sheets (check Specific Work Instructions). Analytical request forms for all of this information are provided with the empty sample bottles.

Storage and shipping times must comply with the specific laboratory time frame for analysis to ensure sample integrity. As an example, BOD samples must be to the analytical laboratory within 24 hours of sampling. Toxicity samples should be sent to the laboratory within 2 days of being sampled. Contact the associated laboratory in advance to secure recommended sample storage and transportation times specific to the analytical parameters. The crew leader to is confirm shipment arrival at the laboratory and to explain analysis requests if needed

Samples for water quality analysis need to be treated or preserved according to their specific handling protocols as prescribed by the laboratory. All samples should be kept at 4°C, where this is not possible then maintain unpreserved samples at 4°C.

5.5 Cleaning Sampling Equipment

In some cases, refer to Specific Work Instructions for project requirements, it may be necessary to clean sampling equipment between sampling locations. If this is the case, equipment should be cleaned using cleaning agents such as distilled water or solvents depending on the specific project and parameter requirements. At a minimum, before sampling rinse the sampling equipment thoroughly with ambient water. In general, sample in an upstream direction and start at the clean sites first (i.e.: background).

5.6 Field Records and Logbook

For proper interpretation of field survey results, thorough documentation of all field sample collection and processing activities is required. All logbooks should be perfect-bound and waterproof, forms should be preprinted on waterproof paper, and only indelible ink and pencil (if form or paper is wet) should be used.

All pertinent information on field activities and sampling efforts must be recorded in an appropriate (i.e., waterproof) bound logbook. The field crew leader is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct field activity without relying on the memory of the field crew. All entries must be made in indelible ink, with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by a single-line cross-out of the error, entering the correct information, dating and initialing the change. Upon return to the office, all field notes must be photocopied and placed in the appropriate project files.

Entries in the field logbook must include:

- Purpose of proposed sampling effort.
- Date and time (24 hour clock) of sampling.
- Names of field crew leader and team members.
- Description of each sampling site, including information on any photographs that may be taken.
- Location of each sampling site, name and number, applicable navigational coordinates, waterbody name/segment number.
- Details of sampling method and effort, particularly deviations from Specific Work Instructions.
- Clear identification of site names and sample numbers.
- Field observations.
- Field measurements taken (e.g., pH, temperature, flow, dissolved oxygen, secchi, weather conditions).
- Sample shipping information.

The field logbook should also be used to document any additional information on sample collection activities, hydrologic conditions, boat or equipment operations, or any unusual activities observed or problems encountered that would be useful to the project manager when evaluating the quality of the monitoring data.

The field crew leader is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct field activity without relying on the memory of the field crew. All entries must be made in indelible ink, with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by a single-line cross-out of the error, entering the correct information, dating and initialing the change.

Upon return to the office, all field logbooks and notes must be photocopied and placed in the appropriate project files.

To document field activities, sample identification labels, Chain-of-Custody forms, field logbooks, field record sheets (Appendix A) should be used. This will serve as an overall "Chain-of-Custody" documenting all field samples and field events beginning with sample collection through, preservation and shipment to the laboratory.

6. EQUIPMENT

6.1 Sampling Equipment

The following is a list of the equipment recommended for surface water sampling:

- precleaned sample bottles from analytical laboratory with necessary preservatives,
- sampling protocol specific sampling equipment,
- coolers and ice,

6.2 Field Location Equipment and Logs

The following is required for the complete documentation of surface water samples:

- perfect bound, water-proof field logbook
- field record sheets (sample included in this section)
- maps of area for site locations
- indelible ink pens and felt tip markers and pencils
- 50 metre long tape measure
- survey flagging tape
- survey lathe
- Analytical Request forms
- Chain-of-Custody forms

6.4 Health and Safety Equipment

- waders and water proof gloves,
- suitable clothing for prolonged water work: heavy socks, warm pants, rain gear, etc.,
- approved personal floatation device for deep water or boat work.

1. PURPOSE

This protocol establishes the technical procedure to be used for the sampling of porewater by mini-piezometer. Contained within are detailed sampling instructions, an equipment list and a detailed diagram specifying the design of the mini-piezometers.

The intent of porewater sampling with mini-piezometers is to monitor groundwater inflow quality at the groundwater-surface water interface. The mini-piezometers are designed (see Figure 1) to allow for easy installation to this active interface. The perforated well point allows "porewater", the water contained in the spaces between the sands, gravels and cobbles in the river bottom, to enter the piezometer pipe. The infiltrating water is then sampled and can be tested in any number of ways.

2. APPLICABILITY

This technical procedure is applicable to any persons involved in the collection of porewater using mini-piezometers.

3. DEFINITIONS

3.1 Chain-of-Custody Forms

Standardized forms which are used as a means of keeping close track of samples which are taken from their field and transported to laboratories for analysis. Whenever the samples are transported from the field, the custody is relinquished from the delivery person to the receiver by signatures on the forms. These forms substantially decrease the risk of losing samples because they provide a clear record of the chain of transport and handling of the samples.

3.2 Porewater

This is the water that is contained within the spaces between the substrate particles in the bottom of a river.

3.3 Mini-piezometer pipe

The stainless steel pipe that is threaded at one end to join to the well point.

3.4 Mini-piezometer well point

The stainless steel, perforated fitting that is installed between the pipe and the solid tip on a mini-piezometer.

3.5 Mini-piezometer tip

The stainless steel, solid tip that joins to the well point.

3.6 Mini-piezometer

A metal pipe that has a removable tip assembly. Used in the sampling of the porewater in a river bed.

4. REFERENCES AND SUGGESTED READING

5. DISCUSSION

5.1 General Safety

Refer to Golder Associates Ltd. Safety Manual.

5.2 Site Selection

There are several criteria upon which to base the selection of a porewater sampling site. The gross position of the site is determined by:

- any specifications that may have been received;
- relevant landmarks (i.e. ground water wells or outfalls); and,
- previous porewater sampling sites.

Once the general location has been arrived at, then the specific sampling site needs to be located. When locating the specific site consider the following:

- water depth, generally limited to less than the height of one's waders;
- substrate type, avoid obvious depositional zones;
- current velocity, moderate to fast following water is usually the most productive as these areas generally have less fine sediment and greater porewater inflow rates;
- proximity to other mini-piezometers, if doing an array of mini-piezometers then the distance between the other piezometers needs to be considered.

5.3 Methods

Once the sampling location has been determined, it must be accurately located relative to permanent landmarks such as groundwater wells, outfalls or distinctive landscape features. Actual measurements with long tape measures or electronic distance measuring devices and compass headings are recommended as a minimum to accurately determine position. Locations can be easily recorded as the perpendicular distance from the shoreline and the distance upstream or downstream of a permanent landmark.

At the site, select a clean piezometer and ensure that the threaded connections are tight. Place the piezometer tip on the river substrate and hold the pipe vertical. Measure the depth of the water and the distance from the water surface to the top of the piezometer pipe. Record these two numbers in the field logbook and if applicable, field record sheet. Hammer the piezometer 50 centimetres into the substrate, checking the distance from the water surface to the top of the pipe regularly. When the piezometer has been hammered to the correct depth, the sampling procedure can begin.

The first step, once the piezometer is installed, is to purge the pipe and well point. Wash the vacuum hose and flask with river water before the purge. Purge by sliding the vacuum hose down the open top end of the piezometer pipe. When the hose hits the bottom of the pipe connect the outside end of the hose to the vacuum flask and begin pumping. Extract purge water until either the well goes dry or a 500 ml volume of purge water has been extracted.

The purge water should be completely described by measuring its conductivity, temperature, colour, volume, sediment load, time and location. After the purge, allow the well a period of time to recover. The length of the rest period is largely dependent on the rate of porewater infiltration to the piezometer. This is indicated by the amount of water attained during the purge. If 500 ml of purge water were extracted then the sampling can commence after 5 minutes. If only 100 ml of purge water were obtained then wait 15 minutes. Less than 100 ml of purge water usually suggests a plugged well point. While the well is resting install another well or complete field notes.

Once the piezometer has been purged and has had a period to recover, it is time to sample. Before sampling, wash the vacuum hose and flask well with river water. Insert the hose back down the pipe and pump until 500 ml has been sampled or the well goes dry, whichever is less sample volume. If the required sample volume exceeds that of the vacuum flask then several samples should be collected and composited in an appropriate container. Fill pre-labelled, river water rinsed sample vials or bottles with sample water. Describe remaining sample water by measuring conductivity and temperature and noting the sample colour, volume and sediment load. Also record the time and sample bottle number for each sample. Mark the site using lathe and or survey flagging tape if necessary. Remove the mini-piezometer and clean the equipment.

5.4 Sample Handling

The porewater samples should be treated in a manner specific to the parameters that are to be analysed for (refer to Specific Work Instructions for project requirements). In all cases, whether preserved or unpreserved, the samples should be kept cool, either on ice or in a refrigerator. Protect from freezing. Each bottle must be permanently and uniquely marked. It is recommended that preprinted, waterproof labels be used for this. The sample bottles must be submitted to the laboratory with the appropriate documentation consisting of Chain-of-Custody forms and Analytical Request Forms. Included in the documentation should be the date, time, location, project number, sample number, sampler identification and analytical request. Analytical request forms for all of this information should be provided with the empty sample bottles.

Storage and shipping times must be considered as many water quality parameters must be in the laboratory for analysis within specific time frames to ensure sample integrity. As an example, BOD samples must be to the analytical laboratory within 24 hours of sampling. Toxicity samples should be sent to the laboratory so that they arrive within 2 days of being sampled. Contact the associated laboratory in advance to secure recommended sample storage and transportation times specific to the analytical parameters. The crew leader to is confirm shipment arrival at the laboratory and to explain analysis requests if needed

Samples for water quality analysis need to be treated or preserved according to their specific handling protocols as prescribed by the laboratory. All samples should be kept at 4°C, where this is not possible then maintain unpreserved samples at 4°C.

5.5 Cleaning Equipment

Remove the well point and tip from the piezometer pipe. Clean all three pieces in river water. The well point may require cleaning with the bottle washing brush to remove clay from the perforations. Sometimes it is necessary to use something sharp, like a knife, to effectively clean stubborn clay from the well point slots. Wash the vacuum hose and flask by drawing river water up through the hose into the flask. In some cases, depending on specific sampling protocols, it may be necessary to use other cleaning agents such as distilled water or solvents to clean all equipment.

5.6 Trouble-Shooting

1. The well purges dry after less than 100 ml are pumped up:

    - this is generally a strong indication that the well point is blocked, the easiest solution is to remove the piezometer, clean and reinstall.

2. The piezometer is not going down when it is hit by the hammer:

    - the tip is likely up against a large stone, remove the piezometer, clean and reinstall.

3. Bent piezometer pipe:

    - straighten on a hard, flat surface by rolling and striking the high points with a sledge hammer;
    - make sure the well point and tip are screwed on for this procedure.

4. Piezometer stuck in substrate:

    - use clamped on visegrips to turn the piezometer in a clockwise direction while pulling up.

5. No water coming up when vacuuming:

- either the well is dry, in which case it should be abandoned, or the vacuum hose is plugged, usually at the bottom end of the pipe;
- raise the vacuum hose up and down in the piezometer, the water flow usually starts when the end of the hose is lifted out of the sediments that accumulate in the well point during installation.

6. Piezometer not going into the substrate vertically:

- let it follow its own course, if the angle from vertical exceeds 30 degrees then remove the piezometer.

5.7 Field Records and Logbook

For proper interpretation of field survey results, thorough documentation of all field sample collection and processing activities is required. All logbooks should be perfect-bound and waterproof, forms should be preprinted on waterproof paper, and only indelible ink and pencil (if form or paper is wet) should be used.

All pertinent information on field activities and sampling efforts must be recorded in an appropriate (i.e., waterproof) bound logbook. The field crew leader is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct field activity without relying on the memory of the field crew. All entries must be made in indelible ink, with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by a single-line cross-out of the error, entering the correct information, dating and initialing the change. Upon return to the office, all field notes must be photocopied and placed in the appropriate project files.

Entries in the field logbook must include:

- Purpose of proposed sampling effort.
- Date and time (24 hour clock) of sampling.
- Names of field crew leader and team members.
- Description of each sampling site, including information on any photographs that may be taken.
- Location of each sampling site, name and number, applicable navigational coordinates, waterbody name/segment number.
- Details of sampling method and effort, particularly deviations from Specific Work Instructions.
- Clear identification of site names and sample numbers.
- Field observations.

- Field measurements taken (e.g., pH, temperature, flow, dissolved oxygen, secchi, weather conditions).
- Sample shipping information.

The field logbook should also be used to document any additional information on sample collection activities, hydrologic conditions, boat or equipment operations, or any unusual activities observed or problems encountered that would be useful to the project manager when evaluating the quality of the monitoring data.

The field crew leader is responsible for ensuring that sufficient detail is recorded in the logbook. The logbook must be complete enough to enable someone unfamiliar with the project to completely reconstruct field activity without relying on the memory of the field crew. All entries must be made in indelible ink, with each page numbered, signed and dated by the author, and a line drawn through the remainder of any partly used page. All corrections are made by a single-line cross-out of the error, entering the correct information, dating and initialing the change. Upon return to the office, all field logbooks and notes must be photocopied and placed in the appropriate project files.

To document field activities, sample identification labels, Chain-of-Custody forms, field logbooks, field record sheets should be used. This will serve as an overall "Chain-of-Custody" documenting all field samples and field events beginning with sample collection through, preservation and shipment to the laboratory.

6. EQUIPMENT

6.1 Installation Equipment

The following is a list of the equipment recommended for mini-piezometer installation:

- mini-piezometers, straight and clean;
- extra well points and tips;
- slide hammers;
- tools (pipewrenchs, visegrips, sledge hammer);
- meter stick or tape measure.

6.2 Sampling Equipment

The following is a listing of the recommended equipment for collecting samples from mini-piezometers:

- vacuum flasks (minimum 2);
- vacuum sampling hose (5 x 3-4 metre sections);
- handheld, electrical or gas powered vacuum pumps (depending upon availability);
- battery for electric vacuum pump (only if electric pump used);
- gas and oil for gas power vacuum pump (only if gas powered vacuum pump used);
- sample bottles for toxicity or regular water quality sampling;
- bottle washing brush for well point;
- pocket knife for cleaning clay from well point perforations;
- marking pen and scribe (to etch plastic lids on glass or plastic bottles).

6.3 Field Location Equipment and Logs

The following is recommended for the complete documentation of mini-piezometer sampling:

- field record sheets (sample included in this section);
- maps of area for site locations;
- indelible ink pens and felt tip markers and pencils
- Chain-of-Custody Forms
- Analytical Request Forms
- perfect bound, water-proof logbooks
- 50 metre long tape measure
- survey flagging tape
- survey lathe

6.4 Health and Safety Equipment

- waders and gloves
- protective eyewear
- hearing protection
- suitable clothing for prolonged water work: heavy socks, warm pants, rain gear, etc.
- first aid kit

1. PURPOSE

This technical procedure details the classification system and map coding system to be used for habitat mapping a watercourse. The habitat mapping system consists of two components; a general system for mapping large mainstem rivers and a more detailed system for mapping discrete channels units which is primarily used for smaller streams.

2. APPLICABILITY

This technical procedure is applicable to all personnel involved in habitat mapping of all sizes of watercourses in Alberta. The technique was developed primarily in Alberta in consultation with Alberta Fish and Wildlife. With respect to describing aquatic habitats it is applicable outside of Alberta but may be superseded by local criteria (eg. B.C. MOE guidelines).

3. DEFINITIONS

The habitat mapping system is divided into a set of habitat types or categories, the definitions of which are included in the classification system. Some more general definitions are presented here.

3.1 Channel

A natural or artificial waterway which periodically or continuously contains moving water. It has a definite bed and banks which normally confine the water, and which display evidence of fluvial processes.

3.2 Channel Form

The shape of river confinement.

3.3 Channel Unit

Hydraulic and morphological features of a stream channel. A channel unit is a section of channel which exhibits homogeneity with respect to water depth and velocity and is separated from other channel units by gradients in these parameters. The most common channel units are pool, riffle and run.

3.4 Cover

Aspects of the physical environment which provide cover for fish. Cover consists of two categories: 1) instream cover - any feature which provides a velocity shelter (eg. large substrate particles, submerged debris, etc.); 2) overhead cover - any feature which provides visual isolation for the fish (eg. overhanging vegetation, undercut bank, turbulence, etc).

3.5 Discharge

A measurement of the volume of water flowing in the stream channel, measured as the volume flowing past a specific point over a given time (i.e. m^3/s).

3.6 Stream Habitat

The physical stream environment which provides a place for aquatic biota (fish, invertebrates, plants, etc.) to live, grow and reproduce. Several types of fish habitat should be considered when habitat mapping and include spawning habitat, nursery/rearing habitat, feeding habitat and overwintering habitat.

3.7 Stream Gradient

The slope of the streambed over which the stream runs. Velocity of the water flow is directly related to the gradient; i.e. the steeper the gradient, the greater the velocity of the stream or channel unit.

4. REFERENCES AND SUGGESTED READING

Hawkins C.P., J.L. Kershner, P.A. Bison, M.D. Bryant, L.M. Decker, S.V. Gregory, D.A. McCullough, C.K. Overton, G.H. Reeves, R.J. Steedman, and M.K. Young. 1993. A hierarchial approach to classifying stream habitat features. Fisheries 18(6):3-12.

R.L.& L Environmental Services Ltd. 1986. Fisheries resources upstream of the Oldman Dam: Prepared for Alberta Environment Planning Division, Edmonton. 131 pp. + App.

Northern River Basins Study. 1994. A general fish and riverine habitat inventory; Athabasca River, October 1993. Prepared by R.L.& L. Environmental Services Ltd. for the NRBS, Edmonton. Northern River Basins Study Project Report No. 40. 129 pp. + App.

5. DISCUSSION

The habitat mapping and classification system is used to provide an ecologically relevant inventory of stream habitats within a designated study area. The mapping procedure is meant to describe the habitats available within the stream and to detail the location and extent of each habitat type/class. The habitat classification system is intended to be ecologically meaningful with respect to describing and cataloguing physical habitats in relation to the requirements of fish species and their various life stages (spawning, incubation, nursery, rearing, summer feeding, holding, overwintering, migration); and also to a lesser extent the relationship between physical habitat and benthic invertebrate productivity, at least with respect to fish food production. Researchers have determined that fish distinguish between the habitat types and sub-classes of habitat types that have been used to map streams and it is intended that this classification system provide an ecological association of habitat characteristics and fish use/abundance.

Streams are habitat mapped to provide an inventory of the available habitats and to show the locations of critical habitats, that is habitats that are of importance to a fish population such as migration routes,

spawning habitat, rearing habitat etc. Habitat maps are used in several applications. A habitat map can be used to show the habitat types present at a specific site that may be impacted by a proposed point disturbance such as a pipeline crossing or bridge construction. A habitat map of a length of stream can be used to evaluate optional locations for such a disturbance to minimize the impacts to the fisheries resource. Habitat maps may be used to document changes to a stream environment over time, such as impacts from a disturbance or improvements due to habitat rehabilitation or improvement programs. Habitat maps can provide an inventory of habitat types present downstream of a discharge/effluent which has a continual impact on those habitats. A primary use of the habitat mapping procedure is to provide an inventory of the habitats present in a stream that is subject to a proposed impact in order to ensure compliance with the Federal Regulations stating that "No Net Loss" of productive fish habitat is to occur as a result of a proposed disturbance or alteration of the stream.

The habitat mapping and classification system is composed of two components. The first is a general system called the "Large River Habitat Classification System" which is used to map large mainstem rivers such as the Peace or Athabasca rivers where habitat heterogeneity is less than for smaller streams, and use of a more detailed system may not be appropriate or required by the project. The second component is a the more detailed "Stream Habitat Classification and Rating System", which itself consists of more than one component depending on the level of detailed required by the project.

The habitat map is produced by delineating on a base map the location and extent of each of the habitat features. The features to be included, the definitions of these features, and the abbreviations (map symbols) used to label each feature on the habitat map are detailed in Tables 1 and 2. Also to be recorded during the habitat mapping process is the location of the stream or section of stream being mapped, the project number, the date and, if possible, the discharge at the time of mapping.

Whether the large river classification system (Table 1) is used or the stream classification and rating system (Table 2) is used will depend on the size of the watercourse and the level of mapping detail required to meet the objectives of the project. For medium to large sized watercourses it may be possible to apply both systems to the same mapping program.

In addition to the two habitat classification systems, additional detail can be recorded on the habitat maps which describe, in qualitative terms, the general substrate conditions. Typically, this process would be applied during use of the stream habitat classification and rating system to describe the substrate conditions for specific areas, such as potential spawning habitats, or to describe the substrate type within each individual channel unit. Substrate composition is presented as the percent occurrence (visual estimation) of each substrate size category. Substrate particle sizes are presented on Table 3.

5.1 Large River Habitat Classification System

This is a general system based on gross morphology, surficial and hydraulic characteristics and consists of two primary components. These are: 1) "major habitat type", which defines the type of channel present, and; 2) "bank habitat type", which details the structure of the bank and near shore habitats. Also included on the map are "special habitat features" which are significant to fish distribution/use in these large rivers. Table 1 presents the details of the large river habitat classification system.

5.2 Stream Habitat Classification and Rating System

This is a detailed mapping system based on individual channel units, which are sections of stream of homogenous character with respect to depth, velocity and cover. The extent of each habitat unit is delineated on the map, as is the class rating for each unit (where appropriate). Some of the channel units also have modifiers (types) which should also be recorded. Table 2 presents the details of the stream habitat classification and rating system.

TABLE 1:

LARGE RIVER HABITAT CLASSIFICATION SYSTEM

(From R.L.&L. 1992 - General Habitat Inventory for the NRBS)

MAJOR HABITAT TYPES

Type	Abbreviation	Description
Unobstructed channel	U	single main channel, no permanent islands, side bars occasionally present, limited development of exposed mid-channel bars at low flow
Singular island	S	two channels around single, permanent island, side and mid-channel bars often present at low flow
Multiple island	M	more than two channels and permanent islands, generally extensive side and mid-channel bars at low flow

SPECIAL HABITAT FEATURES

Tributary confluences	TC	confluence area of tributary entering mainstem
[sub-classified according	TC1	intermittent flow, ephemeral stream
to tributary flow and	TC2	flowing, width <5m
wetted width at mouth at	TC3	flowing, width 5-15m
the time of the survey]	TC4	flowing, width 16-30m
	TC5	flowing, width 31-60m
	TC6	flowing, width >60m
Shoal	SH	shallow (<1m deep), submerged areas in mid-channel or associated with depositional areas around islands/side bars
	SHC	submerged area of coarse substrates
	SHF	submerged area of fine substrates
Backwater	BW	discrete, localized area exhibiting reverse flow direction and, generally, lower velocity than main current; substrate similar to adjacent channel with more fines
Rapid	RA	area with turbulent flow, broken surface (standing waves, chutes etc.), high velocity (>1 m/s), armoured substrate (large boulder/bedrock) with low fines
Snye	SN	discrete section of non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula (bar)
Slough	SL	non-flowing water body isolated from flowing waters except during flood events; oxbows
Log jam	LJ	accumulation of woody debris; generally located on island tips, heads of sidechannels, stream meanders; provide excellent instream cover

BANK HABITAT TYPES

Armoured/Stable	A1	largely stable and at repose; cobble/s.boulder/gravel predominant; uniform shoreline configuration; bank velocities low-moderate; instream/overhead cover limited to substrate and turbidity
	A2	cobble/s.-l.boulder predominant; irregular shoreline due to cob/boulder outcrops producing BW habitats; bank velocity low (BW)-mod; instream/overhead cover from depth, substrate and turbidity
	A3	similar to A2 with more l.boulder/bedrock; very irregular shoreline; bank velocities mod-high with low velocity BW/eddy pools providing instream cover; overhead cover from depth/turbidity
	A4	rip-rap substrates consisting of angular boulder sized fill; often associated with high velocity areas; shoreline usually regular; instream cover from substrate; overhead cover from depth/turbulence
Canyon	C1	banks formed by valley walls; l.cobble/boulder bedrock; stable at bank-water interface; typically deep/high velocity water offshore; abundant velocity cover from substrate/bank irregularities
	C2	steep, stable bedrock banks; regular shoreline; mod-deep/mod-fast water offshore; occasional velocity cover from bedrock fractures
	C3	banks formed by valley walls, primarily fines with some gravel/cobble at base; moderately eroded at bank-water interface; mod-high velocities; no instream cover
Depositional	D1	low relief, gently sloping bank; shallow/slow offshore; primarily fines; instream cover absent or consisting of shallow depressions or embedded cobble/boulder; generally associated with bars
	D2	similar to D1 with gravel/cobble substrate; some areas of higher velocities producing riffles; instream/overhead cover provided by substrate/turbulence; often associated with bars/shoals
	D3	similar to D2 with coarser substrates (cobble/boulder); boulders often imbedded; mod-high velocities offshore; instream cover abundant from substrate; overhead cover from turbulence
Erosional	E1	high, steep eroded banks with terraced profile; unstable; fines; mod-high offshore velocity; deep immediately offshore; instream/overhead cover from submerged bank materials/vegetation/depth
	E2	similar to E1 without the large amount of instream vegetative debris; offshore depths shallower
	E3	high, steep eroding banks; loose till deposits (gravel/cobble/sand); mod-high velocities and depths; instream cover limited to substrate roughness; overhead cover provided by turbidity
	E4	steep, eroding/slumping highwall bank; primarily fines; mod-high depths/velocities; instream cover limited to occasional BW formed by bank irregularities; overhead cover from depth/turbidity
	E5	low, steep banks, often terraced; fines; low velocity; shallow-moderate; no instream cover; overhead cover from turbidity
	E6	low slumping/eroding bank; substrate either cobble/gravel or silt with cobble/gravel patches; moderate depths; mod-high velocities; instream cover from abundant debris/boulder; overhead cover from depth/turbidity/overhanging vegetation

TABLE 2:

STREAM HABITAT CLASSIFICATION AND RATING SYSTEM

(Adapted from R.L.&L. 1992 - General Habitat Inventory for the NRBS)

Channel Unit	Type	Class	Symbol	Description
Falls			FA	highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade			CA	extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections, but overall is passable to fish; armoured substrate; may be assoc. with chute (RA/CH)
Chute			CH	area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids			RA	extremely high velocity; deeper than riffle; substrate extremely coarse (l.cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle			RF	high velocity/gradient relative to run habitat; surface broken; relatively shallow; coarse substrate; limited instream or overhead cover
Run				moderate to high velocity; surface largely unbroken; deeper than RF; substrate size dependent on hydraulics
	Depth/Velocity Type			run habitat is differentiated into 4 types; deep/slow, deep/fast, shallow/slow, shallow/fast
		Class 1	R1	highest quality/deepest run habitat; generally deep/slow type; coarse substrate; high instream cover from substrate/depth
		Class 2	R2	moderate quality/depth; high instream cover except at low flow; generally deep/fast or moderately deep/slow type
		Class 3	R3	lowest quality/depth; generally shallow/slow or shallow/fast type; low instream cover in all but high flows
Flat			FL	area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than RU3 habitat
Pool				discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
		Class 1	P1	highest quality pool habitat based on size and depth; high instream cover due to instream features and depth; suitable holding water for adults and for overwintering
		Class 2	P2	moderate quality; shallower than P1 with high instream cover except during low flow conditions
		Class 3	P3	low quality pool habitat; shallow and/or small; low instream cover at all but high flow events
	Pool Type			several types of pool are specified, depending on the hydraulic factors which formed them, they include; eddy, trench, lateral, mid-channel, plunge and convergence
Impoundment		Class 1-3	IP (1-3)	includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools
	Dam Type			four types of impoundments have been identified based on dam type; debris, beaver, landslide and abandoned channel
Backwater			BW	discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but generally lower than main flow; substrate similar to adjacent channel with higher percentage of fines
Snye			SN	discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder Garden			BG	significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle (RF/BG) or run (eg. R1/BG)

TABLE 3: SUBSTRATE CRITERIA

SUBSTRATE DEFINITIONS, CODES AND SIZE-RANGE CATEGORIES

CLASS NAME	SIZE RANGE	
	MM	INCHES
Clay/Silt	<0.06	<0.0024
Sand	0.06-2.0	0.0024-0.08
Small Gravel	2-8	0.08-0.3
Medium Gravel	8-32	0.3-1.3
Large Gravel	32-64	1.3-2.5
Small Cobble	64-128	2.5-5
Large Cobble	128-256	5-10
Small Boulder	256-762	10-30
Large Boulder	>762	>30
Bedrock	-	-

ATTENTION USERS!

STANDARD OPERATING PROCEDURE
CHARGING OF LIQUID NITROGEN DRY SHIPPER

This dry shipper is NOT charged will liquid nitrogen on receipt from Enviro-Test Laboratories.

It is the clients' responsibility to ensure that the dry shipper is fully charged (See below for instructions)

IMPORTANT: ENVIRO-TEST LABORATORIES WILL NOT CLAIM ANY RESPONSIBILITY FOR SAMPLE LOSS DUE TO FAULTY OR INSUFFICIENTLY FILLED DRY SHIPPERS.

Instruction on Charging Dry Shippers:

1. The dry shipper is taken by the user to either Prax Air in Calgary, Liquid Carbonic in Edmonton, or Western Breeders in Balzac to be charged with liquid nitrogen. The user should accompany the gas company employee to ensure the canister is charged properly.

2. The entire canister & shipping container must be tared on a scale at the gas company prior to charging. To fill the canister to capacity, it takes approximately 20-30 minutes. The liquid nitrogen has to be added repeatedly until all bubbling action in the canister has ceased. At this point, you can be sure the canister is fully charged. The canister and shipping container must be weighed immediately after charging. Record the weight, inventory number and user name. A completely charged canister should weigh approximately 7-9 lbs when fully charged. A receipt from either Prax Air, Liquid Carbonic or Western Breeders must be retained for user records.

3. Specifications for SC 4/V2 canisters indicate the liquid nitrogen capacity is 3.9 litres with a static evaporation rate of 0.2 litres /day. Normal working duration of a fully charged canister is 12 days and 19 days for static holding time.

REF#: MSOP105.01 (June 29, 1995)

Enviro-Test Laboratories

APPENDIX VIII

SOIL SURVEY QA/QC PROGRAM

Soil Survey Quality and Quantity Control Program

Precision: $\frac{\text{measured value + measured duplicate value}}{2}$

Precision will be used in soil correlation among team surveyors. As part of our correlation of soil and site descriptions, soil surveyors will describe a minimum of twenty profiles and capability ratings in duplicate (or triplicate for three crews) to measure precision. The capability ratings are assigned numerical values thereby permitting simple, meaningful calculations.

Accuracy: Laboratory to use accredited procedures and acceptable level of accuracy.

Representativeness : Sample modal profiles that are typical of extensive (>5% of area or unique and important type) soil and landform types. Sample sites will correspond to *ecosites* used to characterize vegetation communities. Sites will be selected jointly by soils and vegetation specialists. In addition we propose to use the *Transect Method* to statistically quantify ranges of parameters within map units. This approach permits charactization of mapping units in terms of purity with respect to key parameters relating to soil and landscape features (e.g. depth of litter, texture, drainage, stoniness), to reclamation (e.g. surface soil depth, equivalent capability), and to tree growth (e.g. moisture regime, nutrient regime). A minimum of two tansects (10 sites/transect at regular intervals, for example, 100 m spacing) for each main soil unit, aiming at 16 to 18 main units. The literature will be used to relate findings from several previous studies in the region to this study area, using *soil series* as a basis for cross referencing analytical data, capability, tree growth, reclamation , soil handling procedures, etc.

Comparability: Soil series will be used as a basis for comparing soils of this study to those of others undertaken previously in this region. The characterization described above will permit us to assign levels of confidence to our assessments, taking into account spatial and operator variation. There is considerable analytical data available at the soil series level for natural soils in the general region, therefore, our costs for collecting new data are minimal.

Completeness: $\frac{\text{number of valid measurements}}{\text{number of data points planned}} \times 100$

The objective is to attain an overall average of 100% completion and a minimum of 80% completion in each specific area as follows:

- 400 inspections in detailed mapping areas, including sites within transects (as per attached field sheet, which is input to computer program, thereby providing all data in electronic format). The survey will be free style (traverses along access routes, with checks at more or less regular intervals characterizing similarities/differences in soils/landforms). The survey will concentrate on trails and cutlines with bush walks where necessary (ensuring 1 mile or less between traverses). The rate of progress is set at 30 sites/mapper/10 h day.
- 300 inspections in remainder of area, also including transects. This will also be a free style survey approach, with traverses at one to two mile intervals along cutlines. Mapping rate is also 30 sites/mapper/10 h day.
- sample 16 soils, 2 extensive series in duplicate,

- Conduct soil interpretations relating to agricultural capability, forestry capability, sensitivity to acidification, erodibility, and others that arise as important.
- Identify best/alternative soil handling and soil reclamation procedures for reclaiming to *equivalent capability*, using the capability program as a modelling and planning tool. Identify target surface and subsurface root zone materials and amounts (depths, volumes).

Information Collection:

Preliminary photo-interpretation will be conducted prior to commencing fieldwork. This will be checked by vegetation and forestry mappers to ensure initial integration. Field mapping will focus on ground truthing the units and checking the boundaries. Field logs of all sites will be gathered on paper, for entry on computer. Sample bags will be labelled, sampled sites/horizons will be marked on field sheets, and on lab sheets with copies to be submitted to the lab with samples. All inspection/sampling sites will be marked on air photos (GPS optional).

Samples: Soil samples will be stored in padlocked crates until delivered to the lab.

Budget: As presented previously, with an addition of 8 days @ $300.00 per day totalling $2400.00 for wordprocessing, drafting, and data entry. Our field time is set at 12 to 14 days, leaving about 10 days for report and map preparation. It would be helpful to have quads for the accessible trails, and helicopter drop off/pick up for the inaccessible areas.

SURVEYOR : DATE: M: D: Y: 95 LOCATION:

Site # SX	Subgroup	Series	Topsoil Texture	Subsoil Texture	Parent Material	Slope Class	Slope Position	Stoniness	Drainage	Land Use	Erosion	Wetness	Topsoil Depth	Colour Change	Sod Qual.
						1 2 3 4 5 6 7 8 9 10	C U M L D Level	0 1 2 3 4 5	R W MW I P VP	C H IR M NR P W WT	N S MS VS E	0 1 2 3 4 5 6 7 8		G P	G P

Horiz.	Depth cm.	Colour	dry/moist	Texture	Structure	Size	Consistence	Comments	Samples

Site # SX	Subgroup	Series	Topsoil Texture	Subsoil Texture	Parent Material	Slope Class	Slope Position	Stoniness	Drainage	Land Use	Erosion	Wetness	Topsoil Depth	Colour Change	Sod Qual.
						1 2 3 4 5 6 7 8 9 10	C U M L D Level	0 1 2 3 4 5	R W MW I P VP	C H IR M NR P W WT	N S MS VS E	0 1 2 3 4 5 6 7 8		G P	G P

Horiz.	Depth cm.	Colour	dry/moist	Texture	Structure	Size	Consistence	Comments	Samples

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Site # SX	Subgroup	Series	Topsoil Texture	Subsoil Texture	Parent Material	Slope Class	Slope Position	Stoniness	Drainage	Land Use	Erosion	Wetness	Topsoil Depth	Colour Change	Sod Qual.
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Horiz.	Depth cm.	Colour	dry/moist	Texture	Structure	Size	Consistence	Comments	Samples

Site # SX	Subgroup	Series	Topsoil Texture	Subsoil Texture	Parent Material	Slope Class	Slope Position	Stoniness	Drainage	Land Use	Erosion	Wetness	Topsoil Depth	Colour Change	Sod Qual.
						1 2 3 4 5 6 7 8 9 10	C U M L D Level	0 1 2 3 4 5	R W MW I P VP	C H IR M NR P W WT	N S MS VS E	0 1 2 3 4 5 6 7 8		G P	G P

Horiz.	Depth cm.	Colour	dry/moist	Texture	Structure	Size	Consistence	Comments	Samples

APPENDIX IX

PROPOSED CODE DICTIONARY

CODE_TYPE	CODE	DESCRIPT
ANALYSISTYPE	F	Field observation
ANALYSISTYPE	L	Laboratory analysis
AREA BASIS	K	Per kilometer
AREA BASIS	M	Per square meter
AREA BASIS	S	Per sample
AREA BASIS	T	Per station or transect
AREA UNITS	A	Acres
AREA UNITS	H	Hectares
AREA UNITS	M	Miles
AREA UNITS	S	Square Miles
BASIN TYPE	A	River or Stream
BASIN TYPE	B	Estuary
BASIN TYPE	C	Lake
BASIN TYPE	D	Ocean
BENTHIC SUM	ACARINA	Acarina
BENTHIC SUM	ACMAEIDAE	Acmaeidae
BENTHIC SUM	AMPHIPODS	Abundance of amphipods
BENTHIC SUM	ANOMURANS	Anomurans
BENTHIC SUM	ANTHOZOA	Anthozoa
BENTHIC SUM	ARTHROPODS	Abundance of arthropods
BENTHIC SUM	ASTEROIDEA	Asteroids
BENTHIC SUM	BRACHIOPODS	Brachiopods
BENTHIC SUM	CIRRIPEDS	Cirripeds
BENTHIC SUM	COPEPODS	Copepods
BENTHIC SUM	CRUSTACEANS	Abundance of crustacea
BENTHIC SUM	CUMACEANS	Cumaceans
BENTHIC SUM	DECAPODS	Decapods
BENTHIC SUM	DIVERSITY	Shannon-Weiner diversity
BENTHIC SUM	ECHINODERMS	Abundance of echinoderms
BENTHIC SUM	ECHINOIDS	Echinoids
BENTHIC SUM	ECHIURA	Echiura
BENTHIC SUM	EUPHAUSIACEA	Euphausids
BENTHIC SUM	EVENNESS	Evenness
BENTHIC SUM	GASTROPODS	Gastropods
BENTHIC SUM	HOLOTHUROIDS	Holothurians
BENTHIC SUM	ISOPODS	Isopods
BENTHIC SUM	MISCTAXA	Abundance of miscellaneous taxa
BENTHIC SUM	MOLLUSCS	Abundance of molluscs
BENTHIC SUM	NEBALACIANS	Nebalacians
BENTHIC SUM	NEMATODES	Abundance of nematodes
BENTHIC SUM	NEMERTEA	Nemertea
BENTHIC SUM	NUMBEROFTAXA	Total number of taxa
BENTHIC SUM	OLIGOCHAETES	Oligochaetes
BENTHIC SUM	OPHIUROIDS	Ophiuroids
BENTHIC SUM	OPISTOBRANCH	Opistobranch
BENTHIC SUM	OPPORTUNISTS	Abundance of opportunistics species
BENTHIC SUM	OSTRACODS	Ostracods
BENTHIC SUM	PELECYPODS	Pelecypods
BENTHIC SUM	PHORONIDS	Phoronids
BENTHIC SUM	PLATYHELMNTH	Platyhelminth
BENTHIC SUM	POLYCHAETES	Abundance of polychaetes
BENTHIC SUM	POLYPLACOPHR	Polyplacophora
BENTHIC SUM	PYCNOGONIDS	Pycnogonids
BENTHIC SUM	SENSITIVESP	Abundance of pollution sensitive species
BENTHIC SUM	SIPUNCULIDS	Sipunculids
BENTHIC SUM	TANAIDACEA	Tanaids
BENTHIC SUM	TOLERANTSP	Abundance of pollution tolerant species
BENTHIC SUM	TOTALABUNDAN	Total abundance
BIOASSAY	001	Amphipod 10-day bioassay
BIOASSAY	002	Bivalve Larvae 48 hour bioassay

CODE_TYPE	CODE	DESCRIPT
BIOASSAY	004	Microtox
BIOASSAY	005	Amphipod dilution bioassay
BIOASSAY	006	Echinoderm Larvae 72 hour bioassay
BIOASSAY	007	Juvenile Infauna 20-day bioassay
BIOASSAY	008	Echinoderm Larvae 7 day bioassay
BIOASSAY	009	Copepod 4-week reproductive success bioassay
BIOASSAY	010	Clam reburial 48 hour bioassay
BIOASSAY	011	Daphnia pulex 48-hour acute bioassay
BIOASSAY	012	Hyalella azteca 48-hour acute bioassay
BIOASSAY	013	Juvenile infauna 10-day bioassay
BIOASSAY	014	Adult clam survival bioassay
BIOASSAY	015	Polychaete survival bioassay
CODES	FRWT STDTYPE	Type of standard for freshwater fish tissue
CODES	ITI_GROUP	Infaunal Trophic Index species groupings
CODES	TOLERANCE	Taxa classifications (e.g., pollution tolerant)
COMMUN BASIS	A	Abundance (numbers of organisms)
COMMUN BASIS	B	Biomass (grams)
COMMUN BASIS	C	Percent cover
COORD UNITS	L	Latitude/Longitude
COORD UNITS	S	State Plane Coordinates
ECOLQUAL		No qualifier - data is useable without qualification
ECOLQUAL	B	Value is blank-corrected down to detection limit
ECOLQUAL	C	Compound is reported elsewhere as part of a combination
ECOLQUAL	E	Quantity listed is an estimated value
ECOLQUAL	G	Estimated value is greater than the minimum shown
ECOLQUAL	K	Detected at less than detection limit shown
ECOLQUAL	L	Estimated value is less than the maximum shown
ECOLQUAL	M	Value is a mean
ECOLQUAL	N	Results based on presumptive evidence
ECOLQUAL	O	Data value was lost or rejected
ECOLQUAL	Q	Questionable value
ECOLQUAL	R	Data value rejected and not reported
ECOLQUAL	T	Substance detected below quantification limit shown
ECOLQUAL	U	Substance undetected at the detection limit shown
ECOLQUAL	X	Substance was measured in a sample with <10% recovery
ECOLQUAL	Z	Value is blank-corrected and still above detection limit
EXTRACTION	O	Organic extraction
EXTRACTION	S	Saline extraction
F APPEARANCE	1	Normal
F APPEARANCE	2	Emaciated
F REPRODUCT	1	Immature
F REPRODUCT	2	Mature, not ripe
F REPRODUCT	3	Not ripe.
F REPRODUCT	4	Mature, ripe
F REPRODUCT	5	Spent
FIS STDTYPE	FDA	FDA standards for seafood consumption
GEARTYPE	01	Net (plankton,trummel,bongo)
GEARTYPE	02	Seine (beach, purse, etc)
GEARTYPE	02A	Purse seine
GEARTYPE	03	Trawl (otter, beam, eastern)
GEARTYPE	03A	Otter trawl
GEARTYPE	03B	400 meter eastern otter trawl
GEARTYPE	03C	25 meter otter trawl
GEARTYPE	04	Hook and line
GEARTYPE	05	Bottle(nisken, rosette, etc)
GEARTYPE	06	Grab (Van Veen,etc)
GEARTYPE	06A	0.1 m2 modified Van Veen grab
GEARTYPE	07	Core (piston,gravity,box,etc)
GEARTYPE	07A	0.06m2 box corer
GEARTYPE	07V	Vibra-corer

CODE_TYPE	CODE	DESCRIPT
GEARTYPE	08	Dredge (clam,pipe,anchor,etc)
GEARTYPE	09	Pump (plankton,midwater, etc.)
GEARTYPE	10	Compositer, hand or automatic aliquots
GEARTYPE	99	Misc (hand-gathered,traps,etc)
GEARTYPE	99A	Scoop
GEARTYPE	99B	Scuba (spear etc.)
GEARTYPE	99C	Crab pot
INDICATOR	ABDM	Ampelisca abdita (amphipod) bioassay Mortality
INDICATOR	AMPT	Amphipod 10-day bioassay Mortality
INDICATOR	BENA	Benthic community structure Difference
INDICATOR	BIVA	Bivalve larvae bioassay Abnormality
INDICATOR	CLAMM	Clam species bioassay Mortality
INDICATOR	CLAMR	Clam species bioassay Reburial
INDICATOR	ECHA	Echinoderm species bioassay Abnormality
INDICATOR	LUMN	Microtox bioassay change in Luminescence
INDICATOR	NEAB	Neanthes (polychaete) species bioassay change in Biomass
INDICATOR	NEAM	Neanthes (polychaete) species bioassay Mortality
INDICATOR	NEPB	Nephthys (polychaete) species bioassay Mortality
INDICATOR	RHPM	Rhepoyxnius abronius (amphipod) bioassay Mortality
ITI_GROUP	1	ITI Group I. Suspended detrital feeders
ITI_GROUP	2	ITI Group II. Surface detrital feeders
ITI_GROUP	3	ITI Group III. Surface deposit feeders
ITI_GROUP	4	ITI Group IV. Sub-surface deposit feeders
LES DISTRIB	1	Focal
LES DISTRIB	2	Multifocal
LES DISTRIB	3	Diffuse
LES SEVERITY	1	Mild
LES SEVERITY	2	Moderate
LES SEVERITY	3	Severe
METHODS	30A	Photograph
METHODS	31A	Direct count
METHODS	31B	Estimated count by extrapolation
METHODS	85SM417B	Ammonia-Nesslerization-Standard Methods-1985
METHODS	85SM417C	Ammonia-Phenate Method-Standard Methods-1985
METHODS	85SM417E	Ammonia-Electrode Method-Standard Methods-1985
METHODS	85SM417G	Ammonia-Automated Phenate Method-Stnd Meth-1985
METHODS	A1	Otolith reading
METHODS	A2	Scale reading
METHODS	A3	Otolith and scale reading
METHODS	A4	Length
METHODS	A5	Interopercle reading
METHODS	APHA-PSP	Amer. Pub. Health Assoc. Paralytic Shellfish Poisoning method
METHODS	ASA-KW82	Amer Soc of Agronomy-Methods of Soil Analysis
METHODS	CLP68016866	EPA Contract Number 68-01-6866 analysis method for volatiles
METHODS	CLP84	U.S. EPA Contract Lab Program Methods (1984 publication)
METHODS	CLP86	U.S. EPA Contract Lab Program Methods (1986 revision)
METHODS	DFAA	Direct Flame Atomic Absorption Spectrometry
METHODS	EPA 350.3	EPA Ammonia
METHODS	F1	Fork length of fish.
METHODS	F2	Standard fish length
METHODS	F3	Whole - total fish length
METHODS	FAA	Flame atomic absorption spectometry
METHODS	GFAA	Graphite furnace atomic absorption spectrometry (GFAA)
METHODS	OA	Winkler titration/Carpenter method
METHODS	OB	Probe/Electrode
METHODS	OTHER	Methods other than Puget Sound Protocols
METHODS	P301H	EPA 301h Program analytical protocols
METHODS	P8603CS	Recommended methods for analysis of sediment conventionals
METHODS	P8608M-CVAA	Cold vapor atomic absorption spectrometry
METHODS	P8608M-GFAA	Graphite furnace atomic absorption spectrometry

CODE_TYPE	CODE	DESCRIPT
METHODS	P8608M-HGAA	Hydride generation atomic absorption
METHODS	P8608M-ICP	Inductively coupled plasma emission spectroscopy
METHODS	P8610F-SW	Recommended methods for fecal coliform analysis in water/sed.
METHODS	P8610F-T	Recommended methods for fecal coliform analysis in tissue
METHODS	P8612O-HPT	Heated purge and trap
METHODS	P8612O-VPT	Vacuum purge and trap
METHODS	P8612OSL	Recommended low level analysis for sediments
METHODS	P8612OSS	Recommended screening level analysis for sediments
METHODS	P8612OTL	Recommended low level analysis for tissues
METHODS	P8612OTS	Recommended screening level analysis for tissues
METHODS	PL81AM	Plumb-1981-COE/EPA standard ammonia procedure
METHODS	SA	Analysis of sample
METHODS	SB	CTD Probe
METHODS	SM85CW	Standard Methods (APHA, 1985) for water column analysis
METHODS	SW7471	EPA SW846-MANUAL COLD VAPOR TECHNIQUE - MERCURY
METHODS	SW8010	GC-HALL-Purgeables Halogenated
METHODS	SW8015	GC-FID-Purgeables
METHODS	SW8020	GC-FID-Aromatic Volatile Organics
METHODS	SW8030	GC-FID-Acrolein, Acrylonitrite, Acetonitrile
METHODS	SW8040	GC-FID-Phenols
METHODS	SW8060	GC-ECD-Phthalate Esters
METHODS	SW8080	GC-ECD-Organochlorine Pesticides, PCBs
METHODS	SW8090	GC-FID or ECD-Nitroaromatics and Cyclic Ketones
METHODS	SW8100	GC-FID-Polynuclear Aromatic Hydrocarbons
METHODS	SW8120	GC-ECD-Chlorinated Hydrocarbons
METHODS	SW8140	GC-FPD or NPD-Organophosphorus Pesticides
METHODS	SW8150	GC-ECD or HALL-Chlorinated Herbicides
METHODS	SW8240	GCMS-Volatile Organics
METHODS	SW8270	GCMS Capillary-Semi-Volatile Organics
METHODS	SW8290	Dioxins and Furans
METHODS	SW8310	HPLC UV and Flour-Polynuclear Aromatic Hydrocarbons
METHODS	T1	Turbidometer
METHODS	T2	Transmissometer (1 cm path)
METHODS	T3	Fluoremeter
METHODS	T6	Transmissometer (10 cm path)
METHODS	VW611	GC-HALL-Haloethers
METHODS	WW601	GC-HALL-Purgeable Halocarbons
METHODS	WW602	GC-PID-Purgeable Aromatics
METHODS	WW603	GC-FID-Acrolein,Acrylonitrile
METHODS	WW604	GC-FID-Phenols
METHODS	WW605	HPLC-Electrochem-Benzidines
METHODS	WW606	GC-ECD-Phthalate Esters
METHODS	WW607	GC-NPD-Nitrosamines
METHODS	WW608	GC-ECD-Pesticides, PCB's Organchlorine
METHODS	WW609	GC-FID + ECD-Nitroaromatics,Isophorone
METHODS	WW610	HPLC-UV/Flour/Hydrocarbons-Polynuclear Aromatic Hydrocarbons
METHODS	WW612	GC-ECD-Chlorinated Hydrocarbons
METHODS	WW613	GCMS-2,3,7,8-Tetrachlorodibenzo-p-dioxin
METHODS	WW614	GC-FPD or NPD-Organophosphate Pesticides
METHODS	WW617	GC-ECD-Organohalide Pesticides, PCBs
METHODS	WW619	GC-NPD-Triazine Pesticides
METHODS	WW622	GC-FPD-Organophosphate Pesticides
METHODS	WW624	GCMS-Purgeables
METHODS	WW625	GCMS-Base/Neutrals, Acids and Pesticides
METHODS	WW630	Colorimetric-Dithiocarbamate Pesticides
METHODS	WW632	HPLC-UV-Carbamates and Urea Pesticides
METHODS	XFS	X-ray Flourescence
ORGAN	01	Muscle
ORGAN	02	Liver
ORGAN	03	Digestive Gland

CODE_TYPE	CODE	DESCRIPT
ORGAN	04	Gonad
ORGAN	05	Gills
ORGAN	10	Blood
ORGAN	15	Whole organism
ORGAN	30	Whole organism (less shell)
ORGAN	EXT	Externally visible portions of organism
QA TYPE	F	Field replicate
QUALIFIERS		No qualifier - data is useable without qualification
QUALIFIERS	B	Blank-corrected down to detection limit.
QUALIFIERS	C	Compound is reported as part of a combination of compounds
QUALIFIERS	E	Quantity listed is an estimated value
QUALIFIERS	G	Estimated value is greater than the minimum shown
QUALIFIERS	K	Detected at less than det. limit shown.
QUALIFIERS	L	Estimated value is less than the maximum shown
QUALIFIERS	M	Value is a mean.
QUALIFIERS	Q	Questionable value.
QUALIFIERS	R	Data value rejected and not reported
QUALIFIERS	T	Detected below quantific'n limit shown.
QUALIFIERS	U	Substance undetected at the detection limit shown
QUALIFIERS	W	Post Digestion Spike outside Control Lim
QUALIFIERS	X	Recovery less than 10%.
QUALIFIERS	Z	Blank-corrected, still above det. limit.
QUALITY	A	Data were subject to QA/QC
QUALITY	B	Data were not subject to QA/QC
QUALITY	C	Unknown if data were subject to QA/QC
RESPONSE	1	Mortality
RESPONSE	2	Abnormality
RESPONSE	3	Emergence
RESPONSE	4	Luminescence
SA PURPOSE	B	Bioassay
SA PURPOSE	C	Chemistry/Conventionals/Nutrients
SA PURPOSE	P	Pathology
SA PURPOSE	S	Benthic Species Identification
SA TREATMENT	F4	Filtered - 0.45 micron filter
SA TREATMENT	FR	Frozen
SA TREATMENT	FX	Fixed
SA TREATMENT	S	Strong Acid digestion
SA TREATMENT	S1	Seived - 1.0 mm seive
SA TREATMENT	S5	Seived - 0.5mm seive
SA TREATMENT	ST	Stained
SA TREATMENT	T	Total Acid digestion
SAMPLE TYPE	2	Surface-floating
SAMPLE TYPE	3	Whole Water
SAMPLE TYPE	4	Bottom Sediment
SAMPLE TYPE	6	Biota
SAMPLE TYPE	7	Interstitial water
SAMPLE TYPE	8	Suspended particulate matter
SAMPLE TYPE	9	Re-suspended sediment
SAMPLE TYPE	A	Suspended solids
SAMPLE TYPE	I	Dissolved fraction - water sample
SAMPLE TYPE	M	Particulate fraction - water sample
SEX	0	Indeterminable
SEX	1	Male
SEX	2	Female
SEX	3	Hermaphrodite
SEX	4	Transitional
SEX	5	Grouped, both sexes present
SEX	6	Hermaphroditic, func. female
SEX	7	Hermaphroditic, func. male
SHLT STDTYPE	FDA	FDA standards for shellfish consumption

CODE_TYPE	CODE	DESCRIPT
SP-BIVALVE	SSCLM	soft shell clam
SP-FINFISH	ALW	alewife
SP-FINFISH	AMEL	American eel
SP-FINFISH	ANED	Atlantic needlefish
SP-FINFISH	AS	American shad
SP-FINFISH	AST	Atlantic sturgeon
SP-FINFISH	ATMHD	Atlantic menhaden
SP-FINFISH	ATS	Atlantic sturgeon
SP-FINFISH	ATSI	Atlantic silverside
SP-FINFISH	ATTC	Atlantic tomcod
SP-FINFISH	BB	brown bullhead
SP-FINFISH	BBH	blueback herring
SP-FINFISH	BLC	black crappie
SP-FINFISH	BLG	bluegill
SP-FINFISH	BLUE	bluefish
SP-FINFISH	BRSI	brook silverside
SP-FINFISH	BT	brown trout
SP-FINFISH	CARP	carp
SP-FINFISH	CHP	chain pickerel
SP-FINFISH	GLDF	goldfish
SP-FINFISH	GOSH	golden shiner
SP-FINFISH	KILLI	killifish
SP-FINFISH	LDAC	longnose dace
SP-FINFISH	LMB	largemouth bass
SP-FINFISH	MUMCH	mummichog
SP-FINFISH	NOP	northern pike
SP-FINFISH	PICK	chain pickerel
SP-FINFISH	PKSD	pumpkinseed
SP-FINFISH	RB	rock bass
SP-FINFISH	RBRS	redbreast sunfish
SP-FINFISH	RS	rainbow smelt
SP-FINFISH	SKSP	sucker spp.
SP-FINFISH	SMB	smallmouth bass
SP-FINFISH	SNS	shortnose sturgeon
SP-FINFISH	SPSH	spottail shiner
SP-FINFISH	STB	striped bass
SP-FINFISH	SUN	sunfish spp.
SP-FINFISH	TESS	tesselated darter
SP-FINFISH	TML	tiger muskellunge
SP-FINFISH	WC	white catfish
SP-FINFISH	WEAKF	weakfish
SP-FINFISH	WEYE	walleye
SP-FINFISH	WP	white perch
SP-FINFISH	WS	white sucker
SP-FINFISH	YB	yellow bullhead
SP-FINFISH	YP	yellow perch
SP-SHFISH	BCCRB	blue claw crab
SP-SHFISH	BCRB	blue crab
SP-SHFISH	CRB	crab
SP-SHFISH	GSHR	grass shrimp
SP-SHFISH	LOBST	lobster
SP-SHFISH	MCRB	mud crab
SP-SHFISH	UMCRB	fiddler crab
SP-SHFISH	UPCRB	fiddler crab
STATION TYPE	A	Area
STATION TYPE	P	Point
STATION TYPE	T	Transect
STATUS	C	Continuous
STATUS	D	Discontinued
STATUS	I	Intermittent

CODE_TYPE	CODE	DESCRIPT
STATUS	P	Planned
SUCCESS	N	Unsuccessful completion of activity (e.g., trawl)
SUCCESS	Y	Successful completion of activity (e.g., trawl)
TIDE STAGE	1	Ebb
TIDE STAGE	2	Ebb slack
TIDE STAGE	3	Flood
TIDE STAGE	4	Flood slack
TOLERANCE	S	Pollution-sensitive taxa
TOLERANCE	T	Pollution-tolerant taxa
UNITS	AL	Microgram atoms per liter (ppb)
UNITS	BL	ppb (ug/l)
UNITS	BS	ppb (ug/kg)
UNITS	CF	Cubic feet per second
UNITS	CP	Colonies per gram
UNITS	DC	degrees C
UNITS	DG	degrees (direction)
UNITS	EC	uEinsteins/cm
UNITS	GR	grams
UNITS	MC	meters/sec
UNITS	ML	ppm (mg/l)
UNITS	MM	Millimeters of mercury (for barometric pressure)
UNITS	MS	ppm (mg/kg)
UNITS	MT	meters
UNITS	NT	ntu (Turbidity Units)
UNITS	OT	most probable number of organisms per 100g tissue or sediment
UNITS	OW	most probable number of organisms per 100ml of water
UNITS	PC	percent
UNITS	PH	pH units
UNITS	PS	ug toxin/ 100 g meat
UNITS	TL	ppt
UNITS	UC	umhos/cm
VAR CATEGORY	MICROBIAL	Microbial variables
VAR CATEGORY	NUTRIENTS	Nutrient variables
WCL STDTYPE	CLASS A	Ecology Water Quality standards for Class A marine waters
WET/DRY WGHT	D	Dry weight
WET/DRY WGHT	W	Wet weight

APPENDIX X

PROPOSED GIS LAYERS

GIS LAYERS - BASELINE

Discipline	Layer	Source
Base	hydrology	Alberta government
	contours	Alberta government
	roads	Alberta government
	lease boundaries	Suncor
	digital elevation model	derived
	slope	derived
	aspect	derived
	political boundaries	
Aquatics	study areas	
	historical data	
	reach breakouts	
	sampling sites	
	habitat mapping	
Geology	bedrock geology	AOSERP
	surficial geology	AOSERP
	isopach maps	Suncor
Hydrology	sampling sites	
Hydrogeology	monitoring wells	
	water table maps	
	groundwater chemistry maps	
	groundwater flow maps	
Air	sampling sites	
Biophysical	sampling sites	
	forestry	
	vegetation/ELC	
	existing soils mapping	AOSERP
	soils	
	sensitive areas	
	VEC Mapping	
Wildlife	study areas	
	historical data	
	ungulate observations	
	winter track counts	
	winter bird surveys	
	browse/pellet group surveys	
	avifauna surveys	
	reptile/amphibian surveys	
	beaver surveys	
	insect surveys	
	rare and endangered species	
	HSI variable sample sites	
	HEP mapping	
	sensitivity mapping: noise/visual	
	sensitivity mapping: habitat loss	
	species distribution maping	
	special features mapping	
	registered trapline map	
Socio-economics	communities	
	municipal boundaries	
	infrastructure	
Archaeology	historical data	
	sample sites	
	drainage	
	traditional land use	
	sensitivity mapping	