Antarctic Environmental Officers Network

Environmental Monitoring
and
Environmental Impact Assessment

Workshop

20-22 September 1999

Goa, India

Table of Contents

Section 1: AEON Workshop

Section 2: Annexes

Section 1
AEON Workshop

Section 1.1: Terms of Reference for AEON Workshop

ANTARCTIC ENVIRONMENT OFFICERS WORKSHOP
20-22 September 1999, Goa, India

Environmental Monitoring and Environmental Impact Assessment

Terms of Reference
5 February 1999

Background

At the first meeting of the Committee for Environmental Protection, environmental impact assessment and environmental monitoring were recognised as two of the priority areas of work for the committee. These issues have also been prominent in the work of COMNAP. Most recently COMNAP have assigned AEON the task of developing a practical handbook on environmental monitoring techniques and the COMNAP EIA guidelines were used as the basis for CEP intersessional work on EIA which many EOs have been involved in.

The COMNAP meeting in September 1999 provides a timely opportunity for members of AEON to come together to provide coordinated input on the draft monitoring handbook, discuss common issues with monitoring, particularly at multiple operator sites and to examine the EIA guidelines to be discussed and (possibly) adopted at ATCM XXIII, with an emphasis on their practical implementation.

Purpose of the Workshop

The purpose of the workshop is to facilitate discussion on the issues of environmental monitoring and EIA, taking advantage of the combined experience and expertise of EOs. The focus will be to increase awareness and understanding among EOs of the current issues surrounding Antarctic environmental monitoring and EIA and to identify ways to improve coordination within the context of these two issues

Specific Objectives

1. To review the status of the COMNAP Monitoring Handbook and provide feedback to the Project Team.

2. To consider ways in which monitoring activities and information at multiple operator sites can be effectively coordinated.

3. To consider how to decide what monitoring activities should be initiated.

4. To discuss practical implementation of the EIA guidelines. Particular emphasis will be placed on:
    - EIA for joint activities;
    - comparison of EIAs for similar activities in different programmes;
    - use of EIA to assist in analysis of cumulative impacts, and;
    - improvements in the process of developing EIAs.

Anticipated Outcomes

- Comprehensive feedback and comments from EOs on the draft COMNAP monitoring handbook.
- An interim report of the workshop, to be presented during the COMNAP XI Forum on Environmental Monitoring and EIAs programmed for Wednesday 22 September.
- A final report of the workshop including recommendations for further AEON and COMNAP action on these issues.

Section 1.2: Workshop Agenda

COMNAP XI Meeting
Goa, India

Antarctic Environmental Officers Network
Workshop on Monitoring and Environmental Impact Assessment

20-22 September 1999

PROGRAMME

Facilitator: Emma Waterhouse Antarctica New Zealand, AEON Chair
Chief Rapporteur: Birgit Njaastad, Norwegian Polar Institute

Monday 20 September	
1400	**Welcome and introductions**
1445	**Setting the framework for Antarctic environmental monitoring - an overview of initiatives and progress** *Emma Waterhouse*
1530	**Coffee Break**
1600	**Designing a monitoring programme for a large scale operation - McMurdo Station as an example** *Mahlon C. Kennicutt II, Geochemical and Environmental Research Group (GERG), Texas A&M University, USA*
1645	**Designing a monitoring program for a small scale operation – Wasa Station as an example** *Anders Modig, Swedish Polar Research Secretariat*
1715	**Identification of key monitoring issues to be discussed during workshop's second day including:** • What monitoring should be initiated, and how • Monitoring at multiple operator sites • Setting monitoring priorities • Data management
1800	**Close**

Tuesday 21 September	
0900	**Welcome and recap**
0905	**Discussion in small groups** ***1. How to decide what monitoring should be initiated, and how*** • what guidance is available, and is it sufficient? • what are the key questions that should be addressed when developing a monitoring programme? ***2. Monitoring at multiple operator sites*** • what questions need to be answered at multiple operator sites coordination issues • data management/exchange of information • station vs. field site • priority of sites
1005	**Initial presentation of conclusions from discussion groups**
1030	**Coffee Break**
1100	**Discussion in small groups continues**
1200	**Presentation of conclusions from discussion groups**
1230	**Lunch**
1400	**Developing recommendations on discussion group topics**
1430	**COMNAP Technical Handbook of Monitoring Techniques** *Mahlon C. Kennicutt II, Handbook Project Manager*
1530	**Coffee Break**
1600	**Open discussion and questions on draft handbook including:** • technical and practical issues related to methods • layout and use of handbook • data management issues
1730	**Summary and close**

Wednesday 22 September	
0900	**Welcome and recap**
0905	**The Environmental Impact Assessment Guidelines – practical implementation issues** *Tito Acero, Instituto Antarctico Argentino*
0935	**Discussion focused on the following points:** • coordination and planning of EIA at multiple operator sites • role of EIA in identifying cumulative impacts • value and methods of comparison of EIA for similar activities
1030	**Coffee Break**
1100	**Further discussion**
1130	**Consideration of draft workshop report and preparation for presentation at COMNAP forum**
1230	**Close of Workshop and Lunch**
1400	**COMNAP forum on Environmental Monitoring and EIA and presentation of interim AEON Workshop report**

<u>Additional Activities:</u>

Wednesday 22 September
COMNAP Environmental Coordinating Group Meeting (coordinator to attend)

Thursday 23 September
- Report preparation and finalisation with discussion group leaders and rapporteurs.
- AEON meeting (0900-1030)
- Presentation of ECG report to COMNAP meeting.

Section 1.3: Report from the AEON Workshop discussions

Report of the AEON Workshop on Environmental Monitoring and EIA

Goa, India
20-22 September 1999

Background

Environmental monitoring and environmental impact assessment (EIA) have been important focuses of COMNAP work over the last decade. Recent initiatives within the Antarctic Treaty system and within SCAR and COMNAP as well as ongoing experience in the practical implementation of the Environmental Protocol have advanced the understanding of both issues.

Two workshops, organised by SCAR and COMNAP, on environmental monitoring were held in 1995 and 1996. The outcomes of the workshops were published in the workshop report *Monitoring of Environmental Impacts from Science and Operations in Antarctica*. In 1997 SCAR and COMNAP reported on the outcomes of the workshops to ATCM XXI and identified four specific recommendations for further work that were subsequently endorsed by the meeting. The recommendations included :

- development of a technical handbook for standardised monitoring techniques;
- a review of existing data and key research areas;
- development of a process for data management; and
- methods of coordination of monitoring activities.

A summary of existing monitoring activities from 15 countries was also published by COMNAP in May 1998 and COMNAP reported back on progress with the four recommendations at ATCM XXIII earlier this year. The Committee for Environmental Protection (CEP) subsequently endorsed the monitoring work and requested that COMNAP report back to CEP III on further progress. At the same meeting, the CEP agreed to guidelines for the EIA process which COMNAP has published in both hard copy and on its web site.

COMNAP XI provided a timely opportunity for members of AEON (who are often responsible for the practical implementation of monitoring and EIA) to come together to follow up in recent initiatives and to facilitate discussion on the issues of environmental monitoring and EIA. The Workshop would also provide a forum for the provision of coordinated input on the draft handbook of monitoring techniques.

Consequently Environmental Officers from 10 countries participated in the Workshop (this represents over half the current membership of AEON). Other experts and observers joined the meeting at various stages.

Purpose and Objectives of the Workshop

The Terms of Reference for the Workshop were agreed by the COMNAP Executive at their last meeting (see Section 1.1) and included the following purpose and objectives:

> *The **purpose** of the Workshop is to facilitate discussions on the issues of environmental monitoring and EIA taking advantage of the combined experience and expertise of EOs. The focus will be to increase awareness and understanding among EOs of the current issues surrounding Antarctic environmental monitoring and EIA and to identify ways to improve coordination within the context of these two issues.*
>
> ***Specific Objectives***
>
> 1. *To review the status of the COMNAP Monitoring Handbook and provide feedback to the Project Team.*
> 2. *To consider ways in which monitoring activities and information at multiple operator sites can be effectively coordinated.*
> 3. *To consider how to decide what monitoring activities should be initiated.*
> 4. *To discuss practical implementation of the EIA guidelines. Particular emphasis will be placed on:*
>   - *EIA for joint activities*
>   - *comparison of EIAs for similar activities in different programs*
>   - *use of EIA to assist in analysis of cumulative impacts, and*
>   - *improvements in the process of developing EIAs*

Summary of Workshop Outcomes

1. Environmental Monitoring

Monitoring activities from three different operators were presented, and focused on issues associated with developing and designing monitoring programs. These included recent work by the United States on designing a monitoring program for McMurdo Station, an overview of monitoring activities at Wasa Station (Sweden) and plans for monitoring at Maitri Station (India). Copies of the presentation transparancies are reproduced in Section 2.2, 2.3 and 2.4.

Participants discussed the differences between the monitoring programs presented, in particular between a large scale operation like McMurdo Station and smaller scale operations. However, the Workshop recognised that the basic approach to developing a monitoring program has many common elements regardless of size.

The Workshop then identified two of the key outstanding issues with respect to monitoring as follows:

- *how to decide what monitoring should be initiated (see Section 1.4); and*
- *monitoring issues at multiple operator sites (see Section 1.5).*

The main outcomes of the discussions are presented below together with some recommendations for the consideration of COMNAP.

How to decide what monitoring should be initiated

The Workshop identified that there are several steps in the process of developing, designing and implementing environmental monitoring programs and noted that these have been identified and elaborated on in the report of the SCAR/COMNAP workshops. However, the SCAR/COMNAP report did identify some gaps in the process, in particular the need for standard technical methods for monitoring in Antarctica, which has lead to the current work of developing a technical handbook.

The Workshop looked at other areas where there may be gaps in the documentation and information available to operators. The issues of how to develop and design a monitoring programme, in particular on the process for deciding what monitoring to carry out were a focus for discussion.

The Workshop recognised that there is already useful information in the SCAR/COMNAP workshop report that could be elaborated on, and noted that the four reports on the McMurdo monitoring programme (US Antarctic Program) provide an example of a process for developing a monitoring program. However, the Workshop further noted that the information contained in the SCAR/COMNAP report was not widely available, and was not written as practical guidelines, readily understandable to those who did not attend the workshop.

Another gap identified by the Workshop in the overall monitoring regime was coordination of monitoring data, including current information on what monitoring is done and the actual results or data arising from monitoring programmes. Participants discussed the summary of monitoring activities in Antarctica prepared by COMNAP in 1998 and discussed whether this summary could form the basic framework from which to link monitoring data.

The Workshop considered this to be an especially important issue given the importance that has been placed on comparability of monitoring data and the need for data to be readily accessible. The Workshop furthermore recognised that there are several groups of experts considering Antarctic data management issues, where this issue could be taken up.

Following the discussion on the above issues, the Workshop developed the following recommendations for the consideration of COMNAP:

Recommendations

1. **That existing monitoring documents be more readily available through the COMNAP web site or through links to other sites. These could include:**
   - **the SCAR/COMNAP workshop report;**
   - **the summary of monitoring activities;**
   - **the technical handbook of monitoring techniques monitoring (when completed); and**
   - **a link to the four US monitoring reports (and others as they become available).**

2. **That consideration be given to the value of preparing practical guidelines for developing and designing an environmental monitoring program. Any guidelines would need to provide a process for assessing and selecting appropriate indicators and should take into account the following:**

- **goals of monitoring**
- **identification of values**

- **existing monitoring data**
- **available resources and practical issues**

- **environmental and geographic setting**
- **types and outputs of activity carried out**
- **location of activities**
- **size of operations**

Monitoring Issues at Multiple Operator Sites

At the XXIII ATCM it was recommended that methods of coordination of environmental monitoring activities be developed to avoid duplication and ensure effective use of resources. To this end, COMNAP asked AEON to consider the role of monitoring at multiple operator sites.

The Workshop identified a number of issues related to monitoring at multiple operator sites including:

- The need to further define what is meant by a multiple operator site. The Workshop suggested the following definition*: Any locality that is also potentially impacted by other activities in the area.* The Workshop also identified that there were different types of multiple operator sites, including overlapping "footprints" of station operations causing impact (e.g. King George Island), conducting scientific activities in common areas (e.g. Dry Valleys), and specialised circumstances that warrant careful consideration (e.g. sites where special activities such as electromagnetic interference or air emissions might impact on scientific activities).

- Given that implementing environmental monitoring is still in an early stage of development, the Workshop acknowledged that at most sites the first step should be to understand the monitoring needs specific to the activities of each operator.

- The need to determine whether joint monitoring is needed at a multiple operator site and at what level. The Workshop considered that one way to do this was to answer several basic questions, including:
  - who is operating in the area?
  - what is the extent, intensity and type of activities at stations in that area?

- what is the potential for one station's activities to impact adjacent stations?
- what is the extent of the footprint of each station, i.e. do they overlap?
- what monitoring has been, or is, carried out?

It was recognised that a key issue is to determine how significant any overlap is, and determine whether this warrants a joint monitoring program or some other management response.

The Workshop identified some ways in which issues at multiple operator sites could be addressed. These include:

- exchange of basic information about the activities at the same site
- improved coordination of activities to minimise concerns, in particular minimise interference or potential cumulative impacts. In some cases establishing an Antarctic Specially Managed Area (ASMA) might provide a suitable framework for achieving this (monitoring might be included as part of an ASMA management plan in particular to assist in reviewing the effectiveness of the plan)
- initiating joint monitoring programmes, including approved monitoring designs, methods and implementation phase

Following discussions on the above issues and potential responses, the Workshop developed the following recommendations for the consideration of COMNAP on monitoring at multiple operator sites:

Recommendations

3. **That consideration be given to whether the operational information an operator needed to assess whether joint monitoring is required is readily available.**

4. **As a first priority, that individual operators concentrate on developing monitoring programs for their own activities and communicate this information to other operators in the same area. While developing and implementing the monitoring program operators should continuously evaluate whether a cooperative monitoring effort is required. This could range from sharing laboratory sources to shared sampling design to integrated data management systems.**

5. **Where stations are located in very close proximity (e.g. within a few hundred meters of each other) or on exactly the same site then operators should consider developing joint monitoring programs from the outset.**

6. **That when reviewing monitoring requirements operators should take into account significant changes in activities or operations and whether these changes might trigger the need for joint monitoring programs.**

2. Technical Monitoring Handbook

The need for a technical handbook was identified during the SCAR/COMNAP monitoring workshops and was one of the four recommendations endorsed by the ATCM XXI for further work. COMNAP, with assistance from SCAR, initiated the development of a handbook for standardised monitoring techniques for use in Antarctica. The first draft of the handbook was presented to the Workshop.

The focus of discussions was on the practical use of the handbook, ensuring that it covers relevant issues and to provide direct feedback to the contractor. Several formatting and general use issues were highlighted, such as the importance of the description of sampling, sample preservation and transport methods, the need to focus on techniques that are unique for Antarctica (e.g. sampling through sea ice, lake ice) and data management.

A recurring issue throughout the discussion was that the handbook does currently not consider biological indicators. The Workshop participants were aware that the contractor (at least for the time being) had been charged with developing techniques only for a specified set of physical and chemical indicators. Participants also noted that biological monitoring is carried out in Antarctica now, is likely to continue in the future and should not be overlooked. The Workshop stressed the importance of continuing work on providing information and guidance on biological monitoring methods.

3. Environmental Impact Assessments

EIA Guidelines

The Workshop discussed the EIA guidelines adopted at CEP II and considered their usefulness in assisting in the practical implementation of the EIA requirements of the Protocol.

Participants agreed that the guidelines were useful for implementing the EIA process, and noted that the guidelines were being used by some countries either as national procedures or as a guide.

The Workshop noted that it would be important to link the EIA guidelines on the COMNAP web site with the AEON web site as soon as it is fully operative.

There was some discussion on the preliminary stage evaluation of activities, noting that this process differed between countries. The Workshop considered that it would be valuable for those countries with written procedures to make these available, e.g. by a link to AEON web site or posting directly onto this site.

Coordination and planning EIA at multiple operator sites

It was noted that EIA processes at sites where more than one operator was carrying out activities were not always coordinated. Two examples of this were discussed, including the issue of research on Weddell seals in McMurdo Sound and the issue of multiple tourist visits to the same site. Participants agreed that the first essential step in the coordination of EIAs in these situations was timely and targeted exchange of information between operators. Any exchange of information needed to be available in advance of an activity taking place to enable potential impacts to be considered in the EIA process of each country. As a minimum information on the project title, contact point, locations and dates could be exchanged which would allow for assessment of whether multiple activities are occurring on a site.

Role of EIA in identifying cumulative impacts

The Workshop discussed the definition of cumulative impacts and focused on the information provided in the EIA guidelines. However, there still appears to be different understandings of the concept of cumulative impacts.

It was noted that activities are often considered as isolated events when preparing an EIA. By addressing cumulative impacts operators are, however, encouraged to consider other activities in the area over space and time.

Value of comparison of EIAs

The Workshop considered the value of comparing EIAs for similar activities in similar types of environments, and noted that such a comparison could probably only be done for IEEs due to the low number of CEEs so far prepared. It was suggested that a number of IEEs for similar activities could be compared to enable a better understanding of how the EIA process is being implemented. This could include a comparison of the impacts identified, the methodologies used, the level of information and detail about activities provided, and the conclusions reached.
Types of activities that this could be based on include station rebuilds, decommissioning or clean up activities and research activities. Such analysis could be carried out through e-mail in the AEON network.

Following discussion on the above issues, the Workshop developed the following recommendations for the consideration of COMNAP:

Recommendations

7. That COMNAP consider how the issue of coordination and planning of EIA might be advanced, in particular the issue of timely advance exchange of information.

8. That COMNAP consider initiating an analysis of existing IEEs for two or three specified types of activities with the aim to achieve a better understanding of how the EIA process is being implemented by different operators.

Section 1.4: Notes from Discussion Group 1

AEON Workshop - Discussion Group 1
How to decide when and what to monitor

21 September 1999

Group Members

Anders Modig (facilitator)
Paula Kankaanpää (rapporteur)
Viktor Pomolov
Birgit Njåstad
In-Young Ahn
Heinz Miller (part)

Initially the discussion concentrated on how to start to develop a monitoring program. It was agreed that the idea of the monitoring work is to assess the environmental conditions and assess changes caused by human activities.

As a first step in the development of a monitoring program, it is important to choose the goals to which answers are looked for. Environmental values at the site of the activity should be assessed and it should be pointed out what kind of values the activity may damage. The next step is to define the parameters and indicators, which are dependent on the goals and values. However, the intention of this discussion was not to identify parameters, but to discuss how to choose them and which factors affect on the choosing process.

The monitoring program should be related to the type of the activity and the environmental setting around it. It also should be realistic as well as plausible based on careful planning process, which means e.g. good selection of parameters and indicators.

In the Protocol of Environmental Protection it is required to monitor physical environment and the related ecosystems. It was agreed that in addition to physical and chemical parameters also biological parameters might be useful. It was also pointed out that it is often unclear what biological indicators tell, and that there is lack of base line studies about natural variability. However, biological parameters (e.g. birds, lichens) can in certain conditions be easily measured and add important values in physical and chemical measurements.

It was also noted that recommendations for monitoring programs are extensively described in the SCAR/COMNAP report. However, it was noted that as a workshop report it is not written in format of guidelines and important information is lacking which is urgently needed for guidance in the starting phase of a development of a monitoring program and how to use existing documents about monitoring activities.

It was emphasized that monitoring should be made from already existing regular activities as well as related to CEEs. It is important that all stations develop at least a minimum monitoring program. This kind of monitoring program would collect information about e.g. fuel consumption, controlling of wastewater, etc.

Monitoring can also be used to detect reduced impacts due to activity changes. It was discussed if improvements of environmental conditions and decrease of the effect of human activities should be monitored. In regions, which are totally affected by humans e.g. close surroundings of big stations it may be useless to implement monitoring. However, detection of good changes in environment may stimulate further improvements in activities.

Although, it was concluded that all stations should have a minimum monitoring program, it was also agreed that it is not possible to develop a single harmonized minimum monitoring program for all various stations and activities because they differ from each other considerably. However, it should be possible to prepare guidelines about planning process for monitoring program by classifying different types of stations and activities and different environmental settings in a few common types. The classification could follow the lines as follows:

SIZE	**LOCATION**	**ENVIRONMENTAL SETTING**
Big	Continental	Ice free
Medium	Shore based	Ice
Small		

Therefore the group agreed that it would be useful to develop guidelines for development monitoring programs which take into account different categories of the activities. The guidelines should give instructions for developing basic monitoring programs, which are realistic and easily implemented. The guidelines should be brief and refer to more detailed monitoring documents.

Section 1.5: Notes from Discussion Group 2

AEON Workshop - Discussion Group 2
Monitoring at Multiple Operator Sites

21 September 1999

Group Members

Emma Waterhouse (facilitator)
Chuck Kennicutt (rapporteur)
Jose Acero
R. Sarin
Guy Gutheridge (part)

Background

The group discussed the issue of environmental monitoring at multiple operator sites in the Antarctica and noted that at ATCM XXIII it was recommended that methods of coordination of monitoring be developed to avoid duplication and ensure effective use of resources. The group focused on the definition of a multiple operator sites and some of the ways in which issues associated with monitoring activities in these areas could be addressed.

The group discussed the importance of each operator having a well-defined monitoring programme in place first ie before monitoring could be effectively coordinated at multiple operator sites. It was felt that monitoring in Antarctica was still at a generally undeveloped stage. Therefore in order to facilitate cooperative efforts each party must be able to understand their individual monitoring program's design, goals and implementation issues to develop a common vision of a coordinated effort.

However the group did acknowledge that there would be well-defined instances where a joint monitoring programme may be sensible from the outset. An example would be where two stations are within a few hundred metres of each other or where science activities are planned at the same site either spatially or temporally. In these cases the most effective approach would be for cooperation in developing a joint monitoring programme.

Definition of a Multiple Operator Site

The group thought that it was important to first define the circumstances under which an area could be considered a "multiple operator site". A suggested working definition was proposed as follows:

> *Any locality that is potentially impacted by other activities in the area.*

The group noted that there may be different types of multiple operator areaa and discussed the potential situations where these might occur. Three "types" were identified as follows:

- Overlapping footprints based on station operations causing impact e.g. at King George Island. Consideration of cumulative and possibly additive effects of operations may also become important in these situations and should be taken into account in any monitoring programme.

- Conducting scientific activities in common areas e.g. McMurdo Dry Valleys. Scientific activities may be impacted by either station operations and/or by other scientific activities in a common area.

- Special circumstances where certain activities e.g. air monitoring may be subject to very specific perturbations caused by other activities in the areas i.e. emissions.

The group discussed how to determine whether a multiple operator site existed and identified several key questions that might provide information to allow a closer assessment of potential overlap of activities and impacts. Information needs include the following:

- who is operating in the area?
- what is the extent, intensity and type of activities at stations in the area?
- what is the potential for one station's activities to impact adjacent stations?
- what is the extent of the footprint of each station and do they overlap?
- what monitoring has already been carried out in the area?
- how significant is any overlap and can this be determined?

Methods to Address Issues at Multiple Operator Sites

The group discussed ways in which the issues at multiple operator sites could be addressed generally. It noted that in some cases a joint monitoring programme may not be needed but that issues could be addressed through management means.

As a minimum it was felt that many issues at multiple operator sites could be addressed though exchange of information that addressed the questions posed above. The group discussed whether this information was currently available in an accessible form. It was felt that although some was, that there were gaps in the system. It was also noted that information exchange could be an adequate response if no specific concerns are identified.

Identifiable concerns could lead to consideration of coordination of activities to minimise interference or cumulative impacts. Monitoring by each individual operator and review of monitoring data would be important to ensure that activities did not change and create unforeseen issues.

However where there was more than one operator in an area with multiple activities and there were serious concerns re overlap of activities and impacts, that more formal coordination and management may be appropriate.
This could include a joint monitoring approach and a coordinated effort through agreed programme design, methods and implementation plans. It may be that only one aspect of each operator's activities would require a joint monitoring plan and any monitoring programme should be designed appropriately.

The group discussed the role of Antarctic Specially Managed Areas (ASMAs) in the coordination of activities and the potential for limiting adverse impacts at multiple operator sites. In many cases an ASMA might ensure that impacts are minimised and that extensive joint monitoring is not required. However monitoring activities could serve to provide information for assessing the effectiveness of the plan and its goals and objectives.

Conclusions

1. The group noted that basic operational information should be widely available in order for each operator to determine the existence of a multiple operator site where further action was required.

2. The group considered that as a first priority operators should concentrate on developing monitoring programmes for their own activities and communicate this information to other operators. The summary of monitoring activities prepared by COMNAP could provide a mechanism for achieving this provided it could be readily updated.

3. In situations where stations or activities were very close together ie within a few hundred metres it was felt that consideration should be given to joint monitoring approaches from the outset.

4. The group considered that where there were significant changes to activities that a review of whether joint monitoring was required should be undertaken i.e. that review of monitoring activities should be an ongoing process.

Section 1.6: List of participants at the AEON Workshop

Antarctic Environmental Officers Network Workshop
Goa, India 20-22 September 1999-09-30

WORKSHOP PARTICIPANTS

Name	Position/Title	Address	Fax	Phone
José Maria Acero	Environmental Officer	*Instituto Antartico Argentino* Cerrito 1248 1010 Buenos Aires ARGENTINA	00 541 14 812 2039	00 541 14
In-Young Ahn	Principal Research Scientist	*Polar Research Center* *KORDI* ANSAN P.O. Box 29 Seoul 425-600 KOREA	00 82 345 408 5825	00 82 345
Paula Kankaanpää	Senior Adviser	*Ministry of Environment* P.O. Box 380 00131 Helsinki FINLAND	00 358 9 1991 9603	00 358 9
Mahlon C. Kennicutt II	Director	*Geochemical and Environmental Research Group* 833 Graham Rd. College Station, Tx 77845 USA	00 1 409 862 2311	00 1 409 Ext. 111
Anders Modig	Environmental Officer	*Swedish Polar Research Secretariat* Box 50005 104 05 Stockholm SWEDEN	00 46 8 152057	00 46 8 6

Name	Position/Title	Address	Fax	Phone
Birgit Njaastad	Environmental Officer	*Norwegian Polar Institute* Polar Environmental Centre 9296 Tromsø NORWAY	00 47 77 75 05 01	00 47 77
Joachim Ploetz	Environmental Officer Seal researcher	*Alfred Wegener Institute* Postfach 120161 D-27515 Bremerhaven GERMANY	00 49 471 4831 149	00 49 471
Victor Pomelov	Environmental Manager	*Arctic and Antarctic Research Institute, RAE* Bering Str. 38 St. Petersburg RUSSIA 199397	00 812 352 2930	00 812 35
Dr. R. Sarin	Deputy Director	*National Environmental Engineering Research Institute* Nehru Mang Nagpur 440020 INDIA	00 91 712 222725 00 91 712 231529	00 91 712
Emma Waterhouse	Environmental Manager	*Antarctica New Zealand* Private Bag 4745 Christchurch NEW ZEALAND	00 64 3 358 0211	00 64 3 3

Section 2

Annexes

Section 2.1: Monitoring in Antarctica - a historical overview

Presented by Emma Waterhouse (New Zealand)

ATCM XV (1989)	**Recommendation XV 5** Called for monitoring of: • waste disposal • oil and hazardous contamination • logistic support facilities • scientific programmes • recreation activities Group of experts to be convened.
ATCM XVI (1991)	**SCAR/COMNAP Paper** Meeting discussed: • lack of agreed principles • specialised meeting required TOR for 1st Meeting of Experts agreed.
Experts Meeting (June 1992)	**Reported to ATCM XVII (1992)** Nine recommendations including: • Representative facilities for monitoring • Data management and exchange • Antarctic Data Directory • Formats for long term monitoring • Further meeting to discuss design, protocols, standardisation, etc

SCAR/COMNAP workshops (1995/1996)	**Workshop 1** Options for monitoring impacts of human activities associated with research and logistics operations. **Workshop 2** Priorities examined and assessed methodologies, technologies, study design and data management.
Workshop Report July 1996	**Comprehensive record of the outcomes of both workshops** Conclusions included: • monitoring fundamental part of environmental management • need standardised approaches • sharing experiences essential • need coordination on methodologies, study design, data interpretation

Workshop Report Cont…	**Identified the following:** • Protocol requirements • framework for monitoring • prioritisation issues • chemical and physical impacts including potential indicators • local impacts on biota • design issues • data management • performance criteria
SCAR/COMNAP WP 20 ATCM XXI 1997	**Monitoring of Environmental Impacts** Identified five key conclusions and four recommendations: • technical handbook of standardised monitoring techniques • review of exiting data and key research areas • process of data management developed through SCAR/COMNAP • methods of coordination of monitoring be developed

Monitoring Summary (1998)	**Summary of Env. Monitoring in Antarctica (AEON)** Summary of monitoring activities from 15 countries including relevant publications and baseline research.
Monitoring Handbook (1999/2000)	**COMNAP Technical Handbook** Technical handbook of standardised methods for the parameters and key indicators identified in the SCAR/COMNAP workshops. First draft available at this workshop.
COMNAP WP 4 ATCM XXIII 1999	**Monitoring of Environmental Impacts** Status report of work completed on the four recommendations from 1997. CEP endorsed the work. COMNAP will report to CEP III on further progress.

Section 2.2: Monitoring programs for small scale operations - Wasa and Svea as examples

Presented by Anders Modig (Sweden)

Designing a monitoring program for a small scale operation - Wasa station

Wasa station

- 120 km inland, on a nunatak
- Possible to use as a year round station
- Beds for twelve people
- Washing machine
- ShowersSauna
- Dry toilet
- Modern kitchen

Electricity and heating

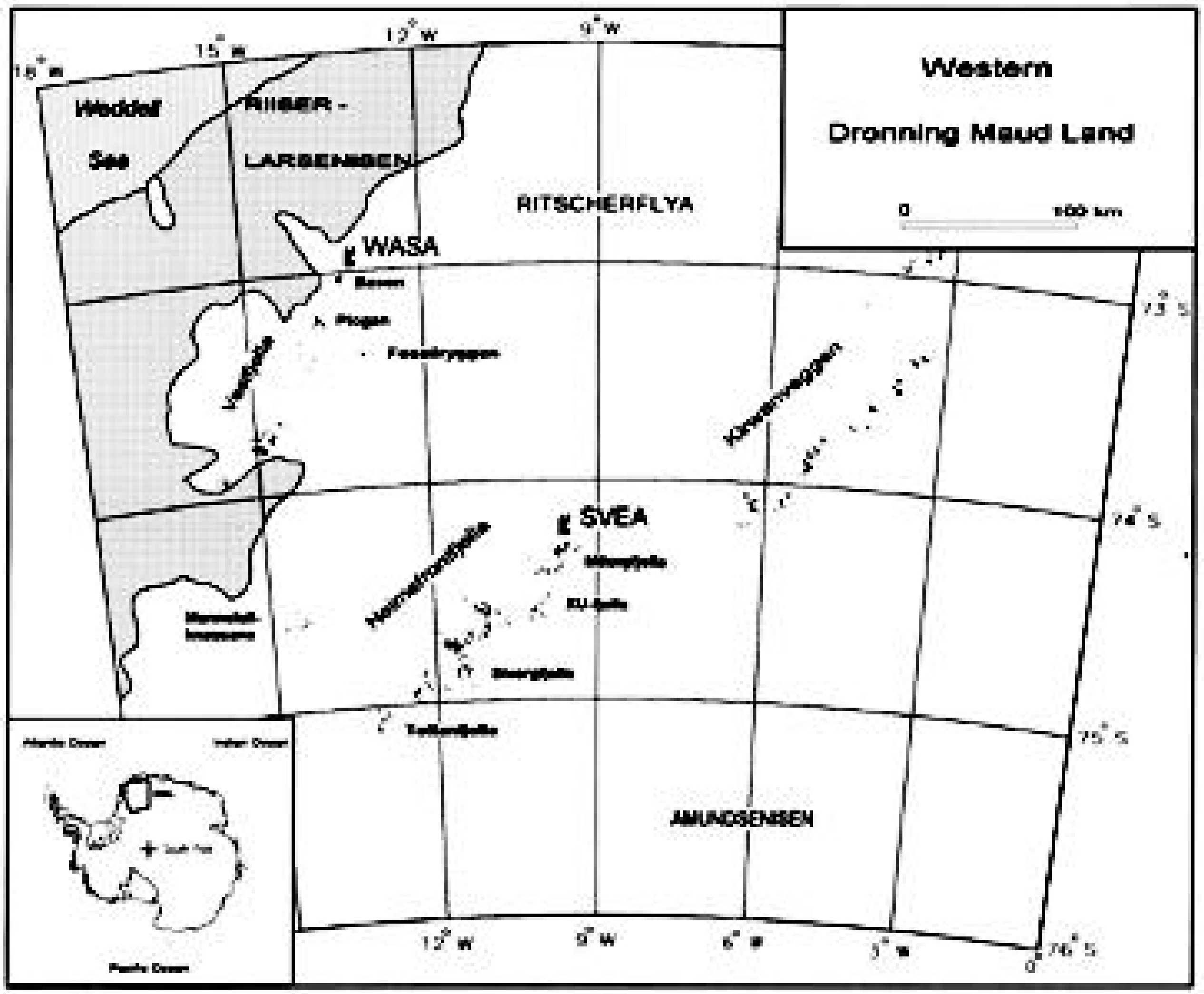
- 32 solar panels, will be extended to 48 (sufficient amount of electricity)
- Heated by LPG heaters (100% efficiency)
- Heat exchanger system (85% efficiency)
- LPG-generators (Liquefied Petroleum Gas), consume 24 kg per day
- Diesel-generators, 120 litres per day (without load), used as back up

Svea station

- 300 km inland, on a nunatak
- Small station (four beds)
- LPG heater and stove
- Toilet tent

Vehicles

- Hägglund TL4 (new concept)
- Modified Toyota Landcruiser
- Snow scooters with PFI



Environmental monitoring program

- Snow sampling: Down-wind emission load as a result of station activity
- Snow coverage: Aerial photography
- Water chemistry: Different parameters and substances
- Birds: Number and breeding success (south polar skua, snow petrel)
- Lichens, mosses: c. 10 transects
- Fresh water plankton
- Terrestrial meiofauna
- Terrestrial pollutants and substances (future)

Conclusions

- Do not overdo it!
- Be sure to monitor relevant parameters
- It is not necessary to monitor everything every season
- Lichens are hard to recognise – you need a true expert
- Down-wind emission load and snow coverage are hard to evaluate
- ***Concentrate on birds and analysis of pollutants in soil and water – easy and quick!***

Section 2.3: Monitoring programs for large scale operations - McMurdo as an example

Presented by Mahlon C. Kennicutt (USA)

Monitoring of Operations at McMurdo Station

“Monitoring of Operations at McMurdo Station”

NSF-OPP/AFCEE/WPI/TCAT/GERG

Phase I - Design a simple, practical, cost-effective monitoring program.

Phase II - Pilot Project to test design assumptions.

Phase III - Implement a long-term monitoring program.

Phase I Project Objectives

(1) Summarize existing data.

(2) Evaluate models for defining the “footprint” of the station.

(3) Develop an approach for defining heavily impacted area boundaries.

(4) Assess and choose appropriate indicators.

(5) Develop an implementation plan for long-term monitoring.

Phase I
Scope of Work

Task 1 - Scientific Advisory Board

Task 2 - Review the SOW

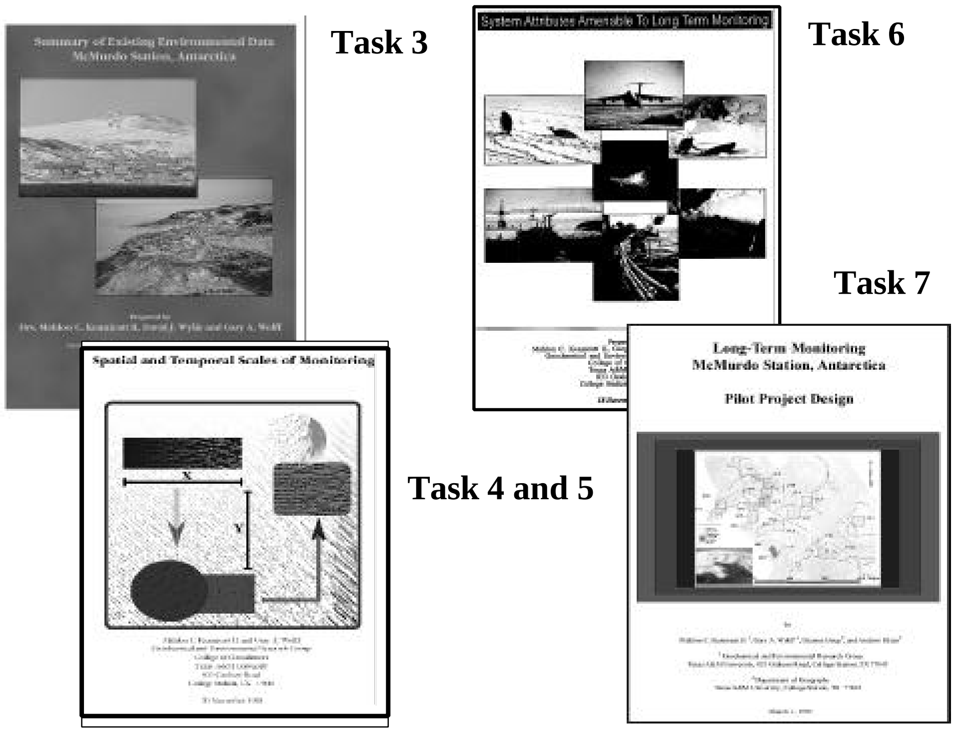
Task 3 - Summary Historical Data

Task 4 - Spatial Scales of Impact Report

Task 5 - Approach to Heavily Impacted Area Monitoring

Task 6 - Assess Indicators

Task 7 - Plan to Implement Phase I Findings



Goals of the Monitoring Program at McMurdo Station

- **The first goal is to establish the "footprint" of the station and determine whether it is increasing or decreasing in size over time and in response to management decisions**.
- **The second goal is to establish whether known areas of "heavy" impact are stable and contained by efforts to date to remediate the sites**.
- **The third goal is to document the impact or effect of specific activities**.
- **Finally, provide an overall assessment of the condition of the system.**

Overarching Strategy

- **A targeted, nested set of sampling grids at multiple spatial scales is the preferred overarching program design.**
- **The design will incorporate two important stratification strategies.**

  - One based on the setting (terrestrial, marine, and ice covered)

  - The second based on the source areas of disturbances and the vectors that propagate the disturbance through the system.

Summary of Monitoring Program Design Elements

Monitoring Program	Indicator	Monitoring Goal Addressed
Terrestrial		
• Aerial Photography	• Alteration of Landscape	• Define physical "footprint" of the station
	- area of disturbance	
	- vegetation coverage	
	- classification of usage areas (buildings, storage tanks, roads, landfills, snow disposal areas, pipelines, excavations)	
	- snow cover (extent, thickness, and density)	
• Point Sampling	• Regional Scale	• Define physical "footprint" of the station, calibration of photodocumentation
	- vegetation coverage	
	- snow/ice coverage	
	- disturbance	
	- soil compaction	
	- water infiltration	
	- permafrost thaw depth	
	- snow thickness	
	- snow density	
	• Local Scale (soils/snow/ice runoff)	• Define the "footprint" of the station, test stability of historical disturbances
	- Petroleum Hydrocarbons - Specific Hydrocarbons (aromatics)	- detect spills and leakage - detect combustion emissions
	- Pb, Hg	- detect disposal of metal wastes, corrosion of pipelines
	- Fe, Al - Particulates, pH	- normalization to recognize anthropogenic sources - ir emissions,

Summary of Monitoring Program Design Elements

Monitoring Program	Indicator	Monitoring Goal Addressed
Marine		
• Benthic Monitoring	• Contaminants (sediments, biota, water)	• Define the marine "footprint" of the station, stability of the historical spill in WQB
	- hydrocarbons	- to detect spills, leaks, runoff;
	- PCBs, PCTs	- test stability of historical spill in WQB
	- Pb, Hg	- plumbing pipes, sewage discharges and stability of the historical spill in WQB
	• Biotic Indicators	
	- benthic infauna (community structure, species diversity, abundance, and biomass)	• resource alteration, stability of historical disturbance
	- benthic epifauna (community structure, species diversity, abundance, and biomass)	• resource alteration, stability of historical disturbance
• Water Quality	• Toxicological measurement • nutrients • BOD, COD • coliform bacteria • dissolved oxygen • salinity and temperature	• detect eutrophication, sewage discharge and disposal effects

Summary of Monitoring Program Design Elements

Monitoring Program	Indicator	Monitoring Goal Addressed
	•	•
Ice Covered Areas	• Petroleum Hydrocarbons	• detect spills and contamination of fossil fuel related to emissions
	• Trace Metals	• detect trace metal waste
Station Performance	• number of people • number of tourists • fuel usage • energy usage • vehicle traffic • aircraft traffic • vessel traffic • construction projects • solid non-hazardous waste disposal • sewage and grey water disposal • hazardous waste disposal • fuel and chemical spills • fire	• correlate human activities with measured change

Regional Design

Aerial Photography
Snow Cover
Thematic Maps

Aerial Photography

Image Analysis Highlights "Footprint" of McMurdo Station

- Vegetation loss
- Snow cover change
- Topsoil Loss
- Land Use/Land Cover change

Orthophotograph of McMurdo Station, Antarctica

Why Use Aerial Photography?

- **Spatial resolution ~ 1- 0.25 m pixel sizes**
  - **produces a high quality map**
- **Precise photogrammetry**
  - **reduce errors in analysis**
- **Comparison of historical and contemporary imagery**
  - **assesses natural variability as opposed to human induced change.**

Why Use Aerial Photography?

- **These data are sufficient to examine the smallest tesserae of interest**
  - **pixel sizes are 2-3 times smaller than grid sizes**

Snowfield Analysis

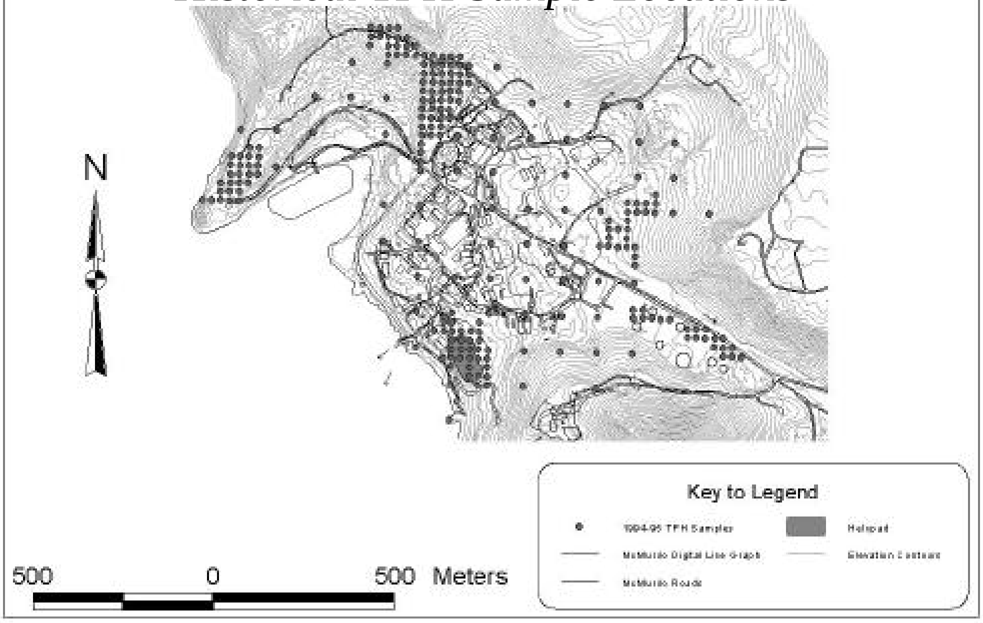
Snow Cover

- **A discontinuous three-dimensional land surface cover.**
- **Affects physical, chemical, and biological processes.**
- **Long-term changes in snow-cover extent potentially impact McMurdo's environment.**

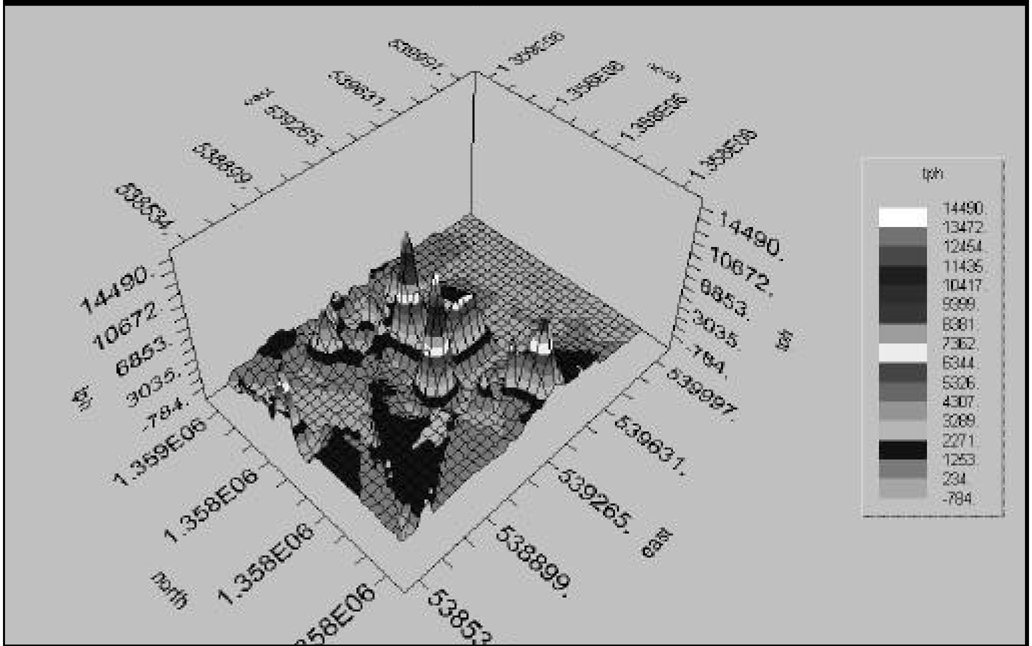
Thematic Maps

- **Distinguish between major land-covers**
  - **soils**
  - **bedrock**
  - **snow**
- **Local and regional scales**

Historical TPH Sample Locations

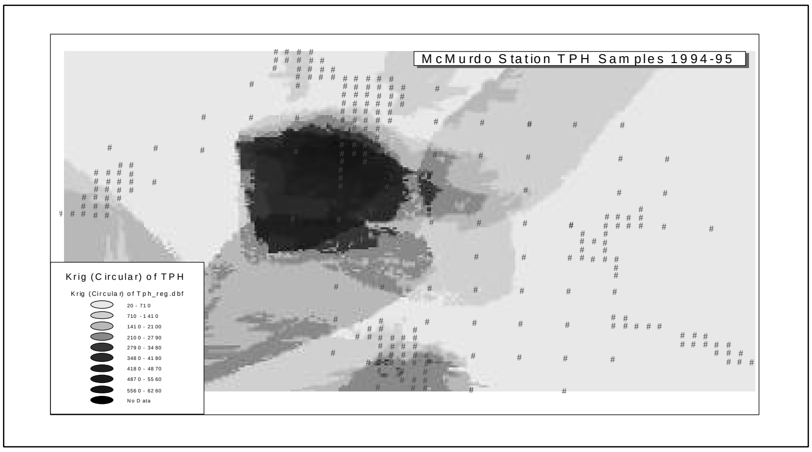


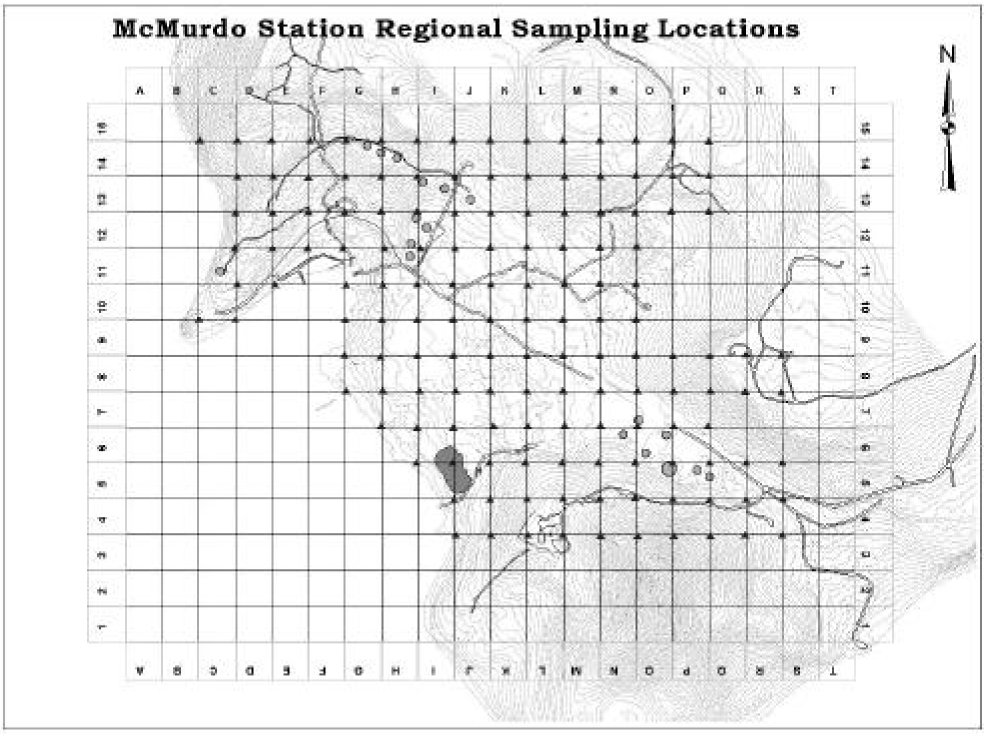
TPH Areal Concentrations

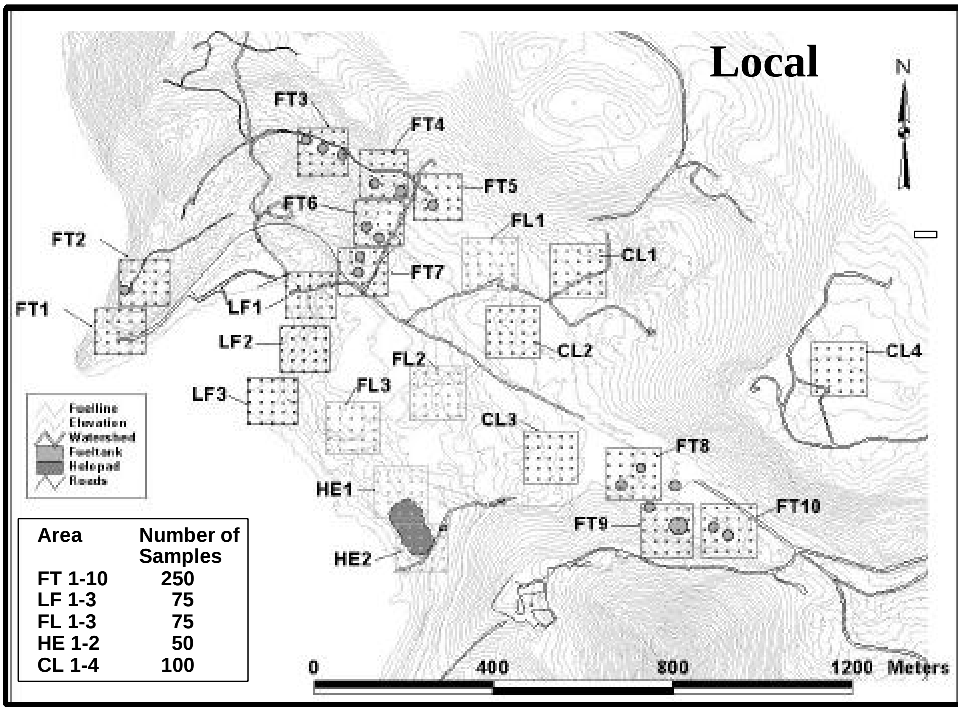


Kriging

- **Weighted combination of the sample values around the point to be estimated.**
- **Uses the variogram parameters to obtain the relationship between the data points.**
- **Provides unbiased estimates of unsampled points.**







Area	Number of Samples
FT 1-10	250
LF 1-3	75
FL 1-3	75
HE 1-2	50
CL 1-4	100

Station Activities

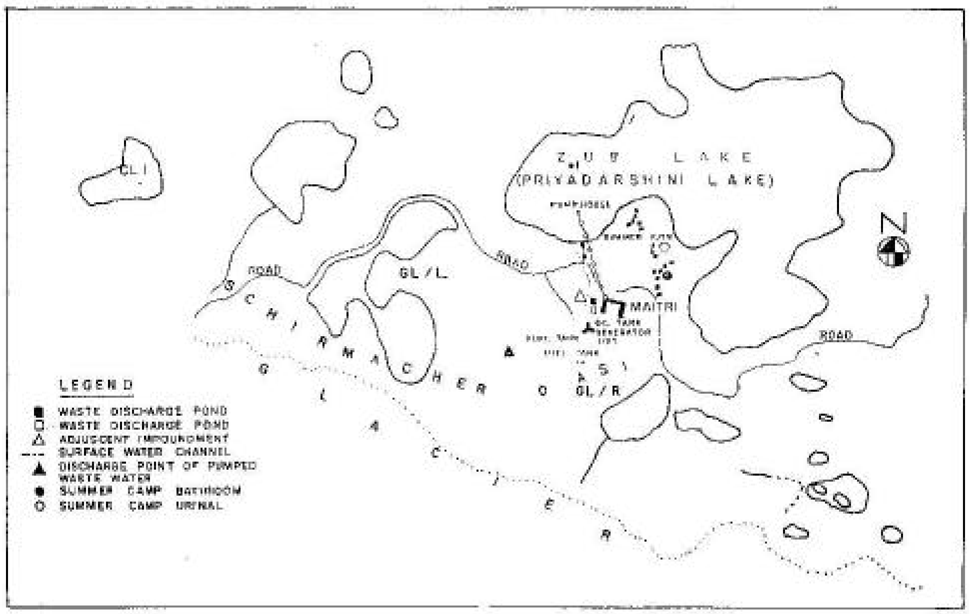
- **Number of people**
- **Number of tourists**
- **Fuel usage**
- **Energy usage**
- **Vehicle traffic**
- **Aircraft traffic**
- **Vessel traffic**
- **Construction Projects**
- **Solid non-hazardous waste disposal**
- **Sewage and grey water disposal**
- **Hazardous waste disposal**
- **Fuel and chemical spills**
- **Fire**

Section 2.4: Monitoring programs for medium scale operations - Maitri as an example

Presented by Dr. Sarin (India)

Maitri Station

Location	-	70°42' 53" E Latitude, 11°44' 3" S longitude in Schirmacher Oasis and close to ice shelf and about 80 km from the ice shelf edge
Research Activities	-	Atmospheric sciences, Geology, Geophysics Meteorology, Biology, Oceanography and Medical research



Location of Activities at Antarctica

Studies carried out during XIII, XIV and XV Expedition to Antarctica aiming EIA

* Source identification under air, noise, water and land environment
* Air quality monitoring at Bhaskara Complex Generator room, Kitchen, Toilet burning etc
* Ambient air quality monitoring
* Noise monitoring close to sources like, Boiler, Generator and Helicopter
* Water sample collection and characterization from Priyadarshini lake and surrounding lake for different physiochemical and biological parameters
* Wastewater sample collection and its characterization from different sources for various constituents of physico-chemical and biological parameters
* Performance Evaluation of biodiscs employed for wastewater treatment
* Assessment of impact of surface water seepage on lake plankton
* Attempt was made to evaluate seepage of wastewater from ponds
* Soil sample collection and its characterization at different depths of contaminated site
* Assessment of solid waste management system

Work Plan for XIX Expedition to Antarctica

A Laboratory Setup:

Instruments required:

High Volume Sampler, Electrometric pH meter, Conductivity Meter, Turbidity Meter, DO Meter, BOD Incubator, Autoclave, Oven, Electronic Balance Spectrophotometer, Hot Plate, Digestion and Distillation unit, Specific Ion Meter

B Environmental Impact Assessment

Air Environment

- Preparation of emission inventory
- Air quality monitoring due to stationary sources for SPM, SO_2, NO_x and HC
- Air quality monitoring due to mobile source for SPM, SO_2, NO_x and HC
- Chemical analysis of pollutants monitored during study period
- Collection of meteorological data from Indian Meteorological Department viz. wind speed, wind direction, temperature, humidity, solar radiation, snowfall and radiosounde data.
- Collection of topographical map of surrounding area from survey of India
- Preparation of windrose during study period

- Location marking of sources and receptors surrounding the station using GPS
- Air quality modeling for predicting ground level concentrations (GLC_s) of air pollutants from major sources

Noise Environment

- Identification of stationary and mobile noise generating sources
- Day-night noise level monitoring
- Aircraft noise level monitoring and its characterization
- Interior noise level monitoring
- Development of noise level contour around Maitri

Water Environment

- Identification of water and wastewater generation sources
- Preparation of water budget/ water balance diagram
- Measurement of water flow, lake depth, elevation and surface area using GPS
- Assessment of distribution system viz., size, age, condition, pressure, storage requirement and capacity
- Analysis of surface water using environmental indicators such as colour, temperature, turbidity, conductivity, hardness, pH, sulphate, chlorides, fluorides, dissolved solids, alkalinity, ammonia, total kjeldahl nitrogen organic nitrogen, phosphate, total coliform, fecal coliform, oil and grease, hydrocarbons, heavy metals (cadmium, copper, chromium, lead, iron, Manganese, Zinc)

- Assessment of wastewater collection system viz., sewer size, age, condition, capacity, current flow, problems encountered (odor, sludge etc.)
- Collection and analysis of wastewater samples
- Flow and pollution load estimation for waste water (average and time variation)
- physico-chemical analysis of raw and treated waste water for temperature, colour, pH, suspended solids, chlorides, sulphate total kyeldahl nitrogen, phosphate, heavy metals (cadmium, copper, chromium, lead, iron, zinc), biochemical oxygen demand and chemical oxygen demand
- Identification of sludge handling system and its characterization of sludge (type, quantity, moisture content, disposition)
- Identification of outfall location for discharge of treated waste water
- Identification of operational difficulties (odor, insects, etc.)

Land Environment

- Soil samples collection at different depth
- Characterization for different constituents like - Particle size distribution, soil texture water holding capacity, available nitrogen, exchangeable cation (Ca, Mg, Na, K) oil and grease hydrocarbon

Biological Environment

- Sample collection for phytoplankton and zooplankton in lakes surrounding Maitri Station
- Collection of water sample for bacteriological study in Priyadarshini lake and surrounding lake to Maitri station

C. Environmental Audit

Environmental Audit (EA) to commensurate with Environmental Management inclusive of

- Emission Audit
- Waste Audit
- Health and Safety Audit
- Energy Audit

Emission Audit

- Review of air pollution control system manual
- Performance evaluation of environmental management system
- Identification and characterization of waste water
- Performance evaluation of wastewater treatment system
- Identification of possibility of reuse, recycle and waste minimization

Water Audit

- Identification of area of water loss
- Planning and suggestions on water conservation measures
- Performance evaluation of existing water treatment facilities

Work Plan for XIX Expedition to Antarctica

A. Scope of Work

- Identification of site-specific contaminants
- Identification of potential pathways of chemical release such as surface water contamination and wind blown dispersal
- Quantification and extent of chemical/oil contamination
- Establishing cause and effect relationship for chemical/oil contamination
- Site evaluation of oil/chemical storage facility
- Evaluation of modes of disposal of solid waste generated (landfill, incineration, recovery)

Energy Audit

- Performance evaluation of energy consuming equipment
- Identification of measures for energy conservation

Health and Safety Audit

- Collection and study of relevant records and safety manuals
- Identification of potential of physical hazards which may trigger loss in different units
- Checking the adequacy and effectiveness of existing fire detection and fire fighting system
- Collection of preliminary information through questionnaire to assess the existing facilities

Environmental Monitoring Programme at Antarctica

WATER ENVIRONMENT

S.No.	Parameter	Analytical Method	Sampling Requirement
Physical Characteristics			
1.	Temperature	Thermometer	100 ml sample in borosilicate glass bottle Refrigeration at 4°C Analysis within 24 hours
2.	pH	pH meter	
3.	Conductivity	Conductometry	
4.	Turbidity	Nephelometry	
Inorganic Characteristics			
5.	Alkalinity	Titrimetry	500 ml sample in borosilicate glass bottle Refrigeration at 4°C Analysis within 24 hours
6.	Hardness	EDTA Complexometry	
7.	Chloride	Titrimetry	
8.	Sulphate	Turbidimetry	
9.	Sodium	Flame photometry	
10.	Potassium	Flame photometry	
Organic, Nutrient and Demand Characteristics			
11.	Nitrate	Spectrophotometry	500 ml sample Preserve with 2 ml conc. H_2SO_4 Analysis within 24 hours
12.	Nitrite	Spectrophotometry	
13.	Ammonia	Spectrophotometry	
14.	Phosphate	Spectrophotometry	100 ml sample in borosilicate glass bottle pre-rinsed with 1:1 HNO_3 Refrigeration at 4°C Analysis within 24 hours
15.	Dissolved Oxygen	Modified Winkler	300 ml sample in BOD bottle. Fix it immediately with alkali azide and $MnSO_4$ Analyze as soon as possible
16.	Biochemical Oxygen Demand	5 days, 20°C Dissolved Oxygen Estimation	300 ml sample in BOD bottle. Refrigeration at 4°C Analysis within 6 hours

Contd...

Contd….

S.No.	Parameter	Analytical Method	Sampling Requirement
17.	Chemical Oxygen Demand	Complexometric Titration	100 ml sample in borosilicate glass bottle Refrigeration at 4°C Analysis within 24 hours
18.	Total Kjeldahl Nitrogen	Digestion/Distillation/ Titrimetry	500 ml sample in borosilicate glass bottle Analyse immediately
19	Oil & Grease	Soxhlet Extraction	1000 ml sample in wide-mouth glass bottle Preserve with 5 ml 1:1 H_2SO_4
20.	Hydrocarbon	Fluorescence Spectrophotometry	
Heavy Metals			
21.	Cadmium, Chromium, Copper, Nickel, Manganese, Lead, Iron, Zinc	Atomic Absorption Spectrophotometry/ ICP	500 ml sample in acid leached glass bottle Preserve at pH = 2 using conc. HNO_3

AIR ENVIRONMENT

S.No.	Parameter	Analytical Method	Sampling Requirement
1.	SPM	Gravimetry	High volume air sampler 24 hourly collection on glass fibre filter paper
2.	SO_2	West & Gaek Spectrophotometry	High volume air sampler 24 hourly sampling in absorbing medium
3.	NOx	Jacob & Hochheiser (Na-Arsenite) Spectrophotometry	High volume air sampler 24 hourly sampling in absorbing medium
4.	Hydrocarbon	Hydrocarbon analyzer	Grab sampling in Mylar bag using squeezer

LAND ENVIRONMENT

Physico-chemical Characteristics

S.No.	Parameters	Analytical Method	Sampling Requirement
1.	Soil Texture	Sedimentation	Air-tight packing in polythene bags for complete soil analysis
2.	Water holding capacity	Gravimetry	
3.	pH	pH meter	
4.	Electrical conductivity	Conductometry	
5.	Cation Exchange Capacity	Titrimetry	
6.	Exchangeable Cations	Complexometry – Flame photometry (from extract)	
7.	Percent Organic Carbon	Titrimetry, Dichromate oxidation	
8.	Oil & Grease	Soxhlet extraction	
9.	Hydrocarbons	Fluorescence spectrophotometry	

Section 2.5: Terms of Reference - Handbook on Standard Techniques for Monitoring in Antarctica

Development of a Technical Handbook of Standardised Monitoring Techniques for use in Antarctica

Terms of Reference

(1) To prepare a technical handbook of standardised monitoring methodologies for a common set of indicators for use by national Antarctic programs and other Antarctic operators, for monitoring the impact of science and operations activities in Antarctica in order to comply with the Protocol requirements for monitoring.

(2) The priority of the first edition of the handbook will be methodologies for monitoring the impacts of stations in Antarctica.

(3) The handbook will include:

- standardised techniques and methodologies for monitoring the principal physical and chemical indicators identified in the SCAR/COMNAP report, 1996 ("Monitoring the Environmental Impacts from Science and Operations in Antarctica");
- standardised techniques and methodologies for biological monitoring based on the recommended options identified in the SCAR/COMNAP report 1996;
- guidelines for data management related to monitoring programmes.

(4) In preparing the handbook, the following shall be taken into account:

- scientific protocols which already exist for monitoring the indicators identified (including those used outside Antarctica);
- experience gained and information available through existing Antarctic monitoring activities (refer in particular to the COMNAP document "Summary of Environmental Monitoring Activities in Antarctica", May 1998);
- relevant conclusions set out in the SCAR/COMNAP report 1996; and
- mechanisms to update monitoring techniques and the contents of the handbook.

Section 2.6: Draft of Handbook on Standard Techniques for Monitoring for Antarctica

Presented by Mahlon C. Kennicutt (USA)

Table of Contents

Table of Contents (Cont.)

Chapter 2. Waste Waters/Sea Water/Fresh Water

Table of Contents (Cont.)

Chapter 3. Snow

Table of Contents (Cont.)

Chapter 4.
Soils/Marine Sediments

Table of Contents (Cont.)

"Apparatus, Materials, and Reagents - Particulate Measurements"

- **Preweighed quartz and polyvinylchloride** (PVC) membranes.
- **Microwave**
- **Photometer** – A spectrophotometer or filter photometer suitable for measurements at 435, 525, 660, 800 nm.
- **Neutral Density Filter**
- **Nucleopore filter**, 25mm, 0.4 µm pore size
- **Pore Filter**, 0.45-tan pore for backup.
- Aluminum oxide, 3 suspensions of aluminum oxide, each having approximately 3mg L^{-1} of aluminum oxide particles, with mean diameters of 0.05, 0.3, ad 1.0 µm.
- Hydrosol- Prepare a 100 mg of Monarch 71(M71) calibration soot (Cabot Corporation) by dissolving in 80 ml filtered water and 20 ml isopropyl alcohol. Disperse soot particles by then placing the hydrosol in an ultrasonic bath for several minutes. Then prefilter hydrosol through a 2.0 µm pore diameter Nucleopore filter to produce soot particles in the same size range as found in atmospheric aerosols. Next, prepare three aliquots of a 1/10 solution of the stock hydrosol with one of these saved as a reference. The one half of the second aliquot needs to be diluted for use in subsequent steps. Filter the third through one of the prepared Nucleopore filters.

PERFORMANCE

The method was tested by 16 laboratories using reagent water, drinking water, surface water, and three industrial wastewaters spiked at six concentrations over the range 0.1 to 425 ug/L. Single operator precision, overall precision, and method accuracy were found to be directly related to the concentration of the analyte and essentially independent of the sample matrix. Linear equations to describe these relationships are presented in Table 4.

This method has been tested for linearity of spike recovery from reagent water and has been demonstrated to be applicable over the concentration range from 8 x MDL to 800 x MDL with the following exception: benzo(ghi)perylene recovery at 80 x and 800 x MDL were low (35% and 45%, respectively). The accuracy and precision obtained will be determined by the sample matrix, sample-preparation technique, and calibration procedures used.

Table 1.1 Development of a Technical Handbook of Standardized Techniques for Use in Antarctica - Draft Terms of Reference (4 June 1998).

Terms of Reference

To prepare a technical handbook of standardized monitoring methodologies for a common set of indicators for use by national Antarctic programs and other Antarctic operations, for monitoring the impact of science and operations activities in Antarctica in order to comply with the Protocol requirements for monitoring.

The priority for the first edition of the handbook will be methodologies for monitoring the impacts of stations in Antarctica.

The handbook will include:

- standardized techniques and methodologies for monitoring the principal physical and chemical indicators identified in the SCAR/COMNAP report, 1996 ("Monitoring the Environmental Impacts from Science and Operations in Antarctica");
- standardized techniques and methodologies for biological monitoring based on the recommended options identified in the SCAR/COMNAP report 1996;
- guidelines for data management related to monitoring programs.

In preparing the handbook, the following shall be taken into account:

- scientific protocols which already exist for monitoring the indicators identified (including those used outside Antarctica);
- experience gained and information available through existing Antarctic monitoring activities (refer in particular to the COMNAP document "Summary of Environmental Monitoring Activities in Antarctica", May 1998);
- relevant conclusions set out in the SCAR/COMNAP report 1996; and
- mechanisms to update monitoring techniques and to extend the contents of the handbook.

Table 1.2. Compilation of methods reviewed during the development of this handbook (EPA-U.S. Environmental Protection Agency, ASTM-American Society for Testing Materials, GERG-Geochemical and Environmental Research Group, NOAA NS&T-National Oceanic and Atmospheric Administration National Status and Trends Mussel Watch Program, APHA-American Public Health Association)

Analyte	Method	Description	Source	Matrix
Acidity	EPA 305.1	Titrimetric	EPA	water, wastewater
	EPA 305.2	Titrimetric	EPA	water
Aromatics	ASTM D5831-96	Screening for fuels	ASTM	soils
	EPA 602	Purge and Trap gas chromatographic	EPA	surface, sea, waste waters, soils, sediments, sludges
(PAH)	EPA 550, 550.1	Liquid-Liquid extraction with HPLC, Coupled Ultraviolet and Fluorescence Detection	EPA	water
	Qian et al, (1998)	Soxhlet extraction with dichloromethane	GERG, NOAA NS&T	soils, sediments
	Qian et al, (1998)	sodium sulfate extraction with dichloromethane; Kuderna-Danish technique	GERG, NOAA NS&T	Tissues
PCB, PAH, TPH	Mudroch et al. (1997)	Recommended extraction procedures		sediment
Hydrocarbons	EPA 5030, 5030a, 5030b	Purge and Trap	EPA	water, wastewater
	EPA 8015, 8015a, 8015b	Gas Chromatography	EPA	water, wastewater
	Denoux et al. (1998)	Gas Chromatography/Mass Spectrometry--selected ion monitoring	GERG, NOAA NS&T	water, sediments, tissue
(Volatiles)	ASTM D4547-91	Sampling for volatile organics	ASTM	soils, sediments, wastes
BOD	EPA 405.1	Incubation, Probe	EPA	water
Characterization	ASTM D2488-93	Visual identification and description	ASTM	soils
COD	EPA 410.1	Titrimetric	EPA	water
	EPA 410.2	Titrimetric	EPA	water
	EPA 410.3		EPA	water
	EPA 410.4	Titrimetric		ground, surface waters
	APHA 5220b	Open Reflux method	APHA	water, wastewater
	APHA 5220c, d	Closed Reflux method	APHA	water, wastewater
DO	360.1	Probe	EPA	water--outfalls, streams
	360.1	Titration, Probe	EPA	water, wastewater
Cadmium (Cd)	EPA CLP 213.1	Atomic absorption, Flame technique	EPA	water, wastewater
	EPA CLP 213.2	Atomic absorption, Flame technique	EPA	water, wastewater

Table 1.3. An Example of the Table of Contents for a Quality Assurance Management Plan (QAMP).

TABLE OF CONTENTS

Table 1.5. Format for an Administrative Standard Operating Procedure (SOP)

The following format is for an Administrative SOP and presents an outline for the general requirements for repetitive administrative or documentation activities. This outline is a suggested format, although the wording should be modified to reflect the content and applicability of each Administrative SOP.

1.0 PURPOSE

1.1 Summary

This procedure [establishes the selection and training requirements] *for personnel involved in the operation, maintenance, and technical support of the monitoring programs.*

1.2 Application

The provisions of this SOP apply to all operations, staff, and management.

2.0 SAFETY

The hazards, toxicity or carcinogenicity of each compound or reagent used in standard operating procedures have not been precisely determined. However, each chemical compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. The laboratory maintains Material Safety Data Sheets (MSDS) which contain information regarding the safe handling of chemicals. A reference file of MSDS is available to all personnel involved with these materials. All laboratory personnel should direct any questions regarding safety issues to their supervisors or the Safety Officer. [This is a U.S. requirement.]

3.0 RESPONSIBILITIES AND AUTHORITIES

4.0 PERSONNEL SELECTION

5.0 TRAINING

- 5.1 Requirements
- 5.2 Primary Training
- 5.3 Supplemental Training
- 5.4 Initial and Continuing Training
- 5.5 Primary Training Instruments
- 5.6 Initial Training
  - 5.6.1 The Personnel Administrator will.....
    - 5.6.1.1 The employee keeps.....
- 5.7 Continuing Training

6.0 Record Requirements

Table 1.8. Standard Reference Materials

Available From	Matrix	Analytes
NIST	All Matrices	Multiple Analytes
NRCC	Fortified Distilled	Trace Elements, Conductivity, Nutrients, Turbidity, pH, Alkalinity
	Near Shore Sea Water (CASS-3)	Trace Elements,
	Open Ocean Seawater (NASS-4)	Trace Elements
BCR	Sea Water (CRM 403)	Trace Elements
SCRC	Sea Water (CSK)	Nutrients
OSI	Standard Seawater (IAPSO)	Conductivity

Sources, Matrices, and Methods for Analytes SRMs (Cont.)

Analyte	Matrix	Name of the Standard	Source
BOD	NA	NA	NA
COD	NA	NA	NA
Conductivity	Ocean water	IAPSO	OSI
DO	NA	NA	NA
Hg	Estuarine sediment	# 1646	NIST
Metals	Sediments	#1646	NBS
Nitrate/Nitrite	CSK	CSK Nutrient Elements	SCRC
PAHs	Mussel tissue	#1974a; HS-3, HS-4, HS-5	NIST; NRC
Particulates	Snow	#1648	NIST
PCBs	River sediment	#1939; HS-1, HS-2	NIST; NRC
pH	Distilled water	NA	NRCC
Phosphate	Fortified distilled; Ocean water	CSK	SCRC
Phytoplankton	NA	NA	NA
TC	NA	NA	NA
Temperature	General Use	Monograph SP 250-23	NIST
TIC	NA	NA	NA
TOC	NA	NA	NA
Trace element	Open ocean water	NASS-4	
Trace elements	Ocean water	CRM 403	BCR
Trace elements, Nutrients	Ocean water	CSK	SCRC
Trace metals	Marine and estuarine sediments	BEST-1	NRCC
Trace metals	Marine sediment	BCSS-1	NRCC
Trace metals	Nearshore waters	CASS-2	NRCC
Trace metals	Marine sediment	MESS-2	NRCC
Trace metals	River water	SLRS-1	NRCC
TSS	NA	NA	NA

NIST-U.S. National Institute of Standards and Technology (formerly the NBS, National Bureau of Standards); BCR-Community Bureau of Reference (Belgium), NBS-National Bureau of Standards, NIST-National Institute of Standards and Technology, NRCC-National Research Council of Canada, OSI-Ocean Scientific International ltd. (UK), SCRC-Sagani Chemical Research (Japan).

Table 1.9. Summary of Preservation and Holding Times

Required Containers, Preservation Techniques and Holding Times for Water and Seawater

Name	Minimum Sample Size	Container[1]	Preservation[2]	Maximum holding time
Biological Tests				
Coliform, total	500 mL	P, G	Cool, 4°C, 0.008% N2S2O3	6 hours
Chlorophylls	100-300 mL	P	Cool, 4°C, 0.008% MgCO4	8 hours before filtering
			Frozen –20°C	Several Weeks for filters
Inorganic Tests				
Chloride	See method	P, G	None required	28 days
Hydrogen ion (pH)	25 mL	P, G	None required	Analyze immediately
Nitrate/Nitrite	200 mL/100 mL	P, G	Cool 4°C	48 hours
Sulfate	50 mL	P, G	Cool 4°C	28 days
Phosphate	50 mL	P, G	Cool 4°C	28 days
Suspended Solids	1-4 L	P, G	Cool 4°C, add zinc acetate	7 days
Dissolved Oxygen	125 mL	BOD Bottle	Cool 4°C, add H2SO4 &	7 days
COD	50 mL	BOD Bottle	See method	See method
BOD	50 mL	COD Bottle	See method	See method
Metals				
Mercury	See method	P, G	HNO_3 to pH<2	38 days in glass; 13 days in plastic
Other Metals		P, G	HNO_3 to pH<2	6 months
Organic Tests				
Oil and grease	500 mL - 1L	G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Organic carbon	See method	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
PAHs	500 mL - 1L	G, Teflon lined cap	Cool, 4°C, H_2SO_4 to pH<2	7 days until extraction

[1]Polyethylene (P) or Glass (G)
[2]Adjust to pH<2 with H_2SO_4, HCL or solid $NaHSO_4$

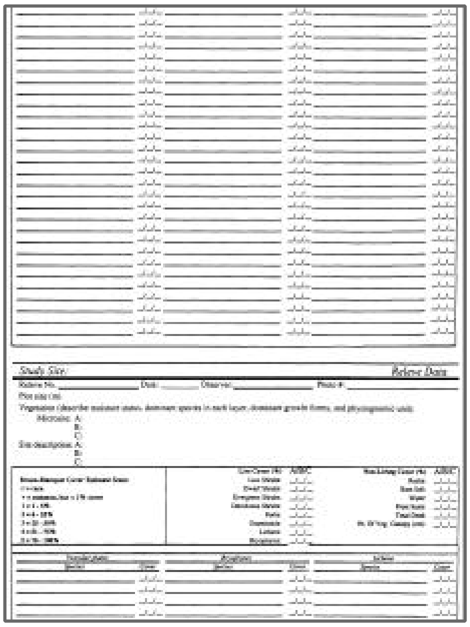


Figure 5.1. The data sheet showing the Braun-Blanquet classifications and site description information.

Table 6.1. Suggested Hazardous Substances Spill Report Format (ASA)

1. Time and Date Spill Occurred/Discovered (HRS, MM/DD/YY)
2. Activity Originating Release: (Enter Agency/Department Responsible for Spill)
3. Spill Location: (Enter Specific Location)
4. Amount Spilled in Gallons: (Round to Nearest Gallon)
5. Material Spilled: (JP-8; MOGAS; Oil, Lubricant; Oil, Hydraulic; etc.)
6. Operation Underway When Spill Occurred: (What was happening when spill occurred?) (i.e., day tank refueling, normal building heating operations, supply movement, etc.)
7. Spill Cause: (Equipment failure or Operator error plus specific cause)
8. Slick Description and Movement: (Describe the spill itself)
9. Areas Damaged or Threatened: (Describe the area damaged or threatened)
10. Telephonic Report to NRC Not Made. (Include this line in all reports)
11. Samples Were Not Taken. (Include this line if true, modify if necessary)
12. Containment Method Used: (Describe how the spill was contained)
13. Removal Method Used: (Describe how the spill was cleaned up)
14. Parties Performing Spill Removal: (List parties that performed spill clean-up)
15. Additional Comments: (Provide narrative detail about spill)
16. Activity Contact for Additional Information: John Hatcher, ASA Spill Coordinator/Manager Hazardous Waste or Duty Spill Team Leader

Table 6.2. Suggested Format for Annual Tracking of Generated and Removed Wastes

Waste Category & Waste Stream	
Nonhazardous Solid Waste Stream	
RECYCLABLES	
Aluminum	
Cardboard	
Cooking Oil/Lard	
Copper, Brass & Wire	
Glass	
Heavy Metal	
Magazines/Newspapers	
Plastics	
White Paper	
	Subtotal
DISPOSABLES	
Construction Debris	
Greywater and Urine (containerized)	
Municipal Solid Waste (mixed solid waste)	
Remediation Waste (mixed solid waste)	
	Subtotal
WASTE TO ENERGY	
Domestic Combustibles	
Food Waste/Food-Contaminated Containers	
Human Solid Waste (containerized)	
Wood	
	Subtotal
SALVAGEABLE MATERIALS	
Resalable Materials	
	Subtotal
Total Nonhazardous Solid Waste	
SEWAGE AND DOMESTIC LIQUID WASTES (liters)	
Sanitary Wastewater (Sewage)	
Brinewater (potable water production)	
Seawater (aquarium)	
Seawater (potable water production)	
	Total Sewage and Domestic Liquid Waste