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ECOTOXICOLOGY AND MARINE ECOLOGY STUDIES IN POST WAR KUWAIT

DP/KUW/92/003

KUWAIT

Technical report: Findings and recommendations\*

Prepared for the Government of Kuwait  
by the United Nations Industrial Development Organization,  
acting as Executing Agency for the United Nations Development Programme

Based on the work of R.R. Stephenson,  
expert in ecotoxicology

Backstopping officer: B. Sugavanam, Chemical Industries Branch

United Nations Industrial Development Organization  
Vienna

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\* This document has not been edited.

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## ABSTRACT

This is a report of a 3 week assignment of Dr. R.R. Stephenson as an expert in ecotoxicology to the Kuwait Institute for Scientific Research, Kuwait (KISR). Project Number DP/KUW/92/003/11-01.

The aim of the assignment was to assist KISR to upgrade their ecotoxicology facilities and expertise; in particular to prepare for a longer mission for an expert to assist KISR to study the long term effects of the pollution resulting from the Gulf War.

The main conclusions are:

- KISR has, by a remarkable effort, repaired much of the damage to facilities and equipment caused in the Gulf War
- UNIDO should support the proposed longer term mission to KISR of an expert in marine ecotoxicology
- KISR has within the Environmental Sciences Department (ESD) and the Mariculture and Fisheries Department (MFD) a good basis for the development of marine ecotoxicology. Particular strengths are the analytical chemistry and mariculture expertise. The construction of new Bioassay Laboratory, to be available in September 1994, will provide an ideal "meeting point" for these resources; located on the MFD site but staffed by ESD personnel.
- Principal objectives of the longer term mission should be:
  - provision of further advice on equipping and start-up of the new Bioassay Laboratory
  - development/establishment of algal, invertebrate and fish bioassays suitable for the acute and chronic assessment of effluents from industry and pollution incidents
  - to initiate and establish a research programme, involving laboratory, field model ecosystems and ultimately field monitoring studies to determine the potential for chronic effects of petroleum hydrocarbons in the Gulf region, with a view to providing understanding of the apparent limited effects of the Gulf War (and earlier) oil spills in the sub-tidal environment
  - to provide on-the-job training of ESD staff in ecotoxicology
  - there should be close linkage between the proposed Marine Ecology project and the Marine Ecotoxicology project

(ii)  
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## INTRODUCTION

The marine environment is a key resource for Kuwait and other Gulf states. For Kuwait it is the principal source of drinking water and supports important fisheries.

Potential major threats to the marine environment of Kuwait are the introduction of petroleum hydrocarbons, via spills or chronic inputs from land-based sources or offshore activities, including transport, or other contaminants from industrial or urban developments in the region. The Gulf War resulted in the release of large quantities of crude oil to the environment, both on land and directly to the sea. Despite considerable investigation of the impact of the oil spilled to the Gulf no major effects have been detected other than in the intertidal region and this was limited in Kuwait. Nor has significant residual contamination of the seawater or sediments been detected offshore.

The Kuwait Institute for Scientific Research (KISR) suffered the total loss of its equipment and significant structural damage during the Iraqi occupation; along with the departure of significant numbers of staff. By a remarkable effort KISR has re-established itself and is now re-equipped and operating.

In 1989 the Environmental and Earth Sciences Division (EESD) of KISR produced a 5 year Strategic Plan, the implementation of which was interrupted by the war. Subsequent to the war a Transitional Strategic Plan was developed for the EESD. The Plan defined three programme areas for research:

- (i) Atmospheric and terrestrial
- (ii) Marine and coastal
- (iii) Environmental risk assessment

In the 1989 Strategic Plan a research programme entitled "Oil pollution in the marine environment" was proposed, within which it was planned to develop a Bioassay Laboratory. The requirement for this facility was maintained in the Transitional Strategic Plan in which it was envisaged that this laboratory would provide support to the Marine and Coastal and Environmental Risk Assessment programmes.

The purpose of this 3 week assignment was to assist KISR to establish ecotoxicological expertise so as to be able to investigate the long term effects of the Gulf War, and in particular to review equipment, facilities (existing and proposed), capabilities and plans for dealing with this issue. In addition, the expert was to prepare a preliminary job description and work plan for an 11 month UNIDO assignment in ecotoxicology. (see Annex I for a job description of the current assignment).

The period of the present assignment, 10th October 1993 - 31st October 1993, overlapped with that of a UNIDO expert in Marine Ecology (Prof. Peter Saenger, DP/KUW/92/003/11-06) who was at KISR from 23rd September 1993 - 17th October 1993. The report of the Marine Ecology assignment provides some information of relevance to the present report.

I ASSIGNMENT ITINERY

11th October	:	Arrival Kuwait
12th-27th October	:	Discussion with: KISR staff ROPME
25th October	:	Debrief UNDP Kuwait
29th October	:	To Vienna
29th October	:	Debrief Vienna
30th October	:	To UK.

## II ENVIRONMENTAL AND EARTH SCIENCES DIVISION

### A. Background

The Environmental and Earth Sciences Division (EESD) contains three Departments, Environmental Science Department (ESD), Hydraulics and Coastal Engineering and Geological Survey Group. The assignment reported here was located in the Environmental Sciences Department.

The EESD has the objective of, assessing the various environmental and natural resources of the deserts of Kuwait, to understand the dispersion of air pollutants, to assess natural processes in coastal and marine environments, to provide environmental planning for coastal development, to assess municipal and industrial wastes, to assess the fate and effects of pollutants in the environment including risk assessment for man and the environment.

A Transitional Strategic Plan for EESD was developed following the Gulf War and is now in-place. The programme includes the following elements.

- a) Atmospheric and Terrestrial Environment
  - (i) Micrometeorology
  - (ii) Transport and fate of pollutants
  - (iii) Desertification and remote sensing
- b) Marine and Coastal Environment
  - (i) Coastal zone development - hydraulics
  - (ii) Environmental toxicology and chemistry
  - (iii) Waste assessment and technology
- c) Environmental Risk Assessment
  - (i) Exposure assessment
  - (ii) Effects assessment
  - (iii) Statistical analysis

Three "support units" will be set-up in addition to the above serving across the groups.

- (i) Remote sensing
- (ii) Wind tunnel
- (iii) Bioassay Laboratory

There is an, as yet unimplemented, proposal to re-organise the EESD along the above lines.

### B. Staff

ESD has a staff of 7 researchers (PhD level) and some 20 professionals (BSc. MSc level) Annex II lists research staff and their expertise. The staff, along with those in other Divisions of EESD and KISR provide a reasonably wide ranging expertise in environmental matters. There is particular strength in environmental chemistry related to hydrocarbon in the marine environment but only limited expertise in environmental biology as related to effects assessment. With a view to correcting this deficiency one researcher (Dr. S. Yakoob) is at present on an assignment at Oregon State University, USA and the UNIDO marine ecotoxicology project has been proposed.

### C. Activities

A list of ongoing research activities is given in Annex III. Of particular relevance to the proposed UNIDO project is the project "Toxicity and Bioaccumulation of Crude Oil and Partially Combusted Oil in Selected Marine Invertebrates" (see Annex IV for abstract). Initial phases of this project are taking place at Oregon State University with a view to them being transferred to KISR once the Bioassay Laboratory is available. Under a broader project proposal more extensive collaborative work with Oregon State University has been considered but it is unclear as to whether, and to what extent, this will take place.

There needs to be care taken that this is no duplication or conflicts between the ongoing OSU activities and the proposed UNIDO project.

### D. Bioassay Laboratory

This facility is planned and construction will commence in January 1994 with a completion date of September 1994. It will be on the M F D Mariculture site at Salmiya. The building will occupy 400 m<sup>2</sup> constituting a wet laboratory, sample room, preparation room and office. Plans of the facility are appended in Annex IV. Sea water and filtered sea water supplies to the laboratory are continuously available in "unlimited" amounts. Supplies are at ambient temperature. The building is air conditioned.

The plans for the facility were reviewed with both ESD staff and planning engineers from the Office of Physical Planning. Some modifications were proposed and accepted in principle (Annex V).

A list of core equipment for the Bioassay Laboratory was assembled (Annex VI).

The issue of safe-handling of carcinogens and potential carcinogens (e.g. Polycyclic aromatic hydrocarbons) in the bioassay laboratory was discussed and the need for full and careful consideration before commencement of experimental work stressed.

It is envisaged that at least one researcher and 3-5 professionals will work at the Bioassay Laboratory on a full-time basis if it is to be fully utilized; assuming the bulk of the chemical analysis takes place at the main KISR Laboratory.

There will be a major requirement for analytical chemistry support in relation to the aquatic toxicity and bioaccumulation studies. On the basis of past experience I would suggest that for toxicity tests the ratio of chemical support to other aspects of the conduct of the tests will be at least 1:1, for bioaccumulation studies, where analysis of tissues is required, the ratio chemistry to other aspects of the conduct of the tests will be at least 5:1 and may be as high as 10:1.

This laboratory when operational will be capable of, and should aim to become a regional centre of expertise in aquatic toxicology. The Regional Organisation for the Protection of the Marine Environment (ROPME), based in Kuwait could provide the basis for extending the role of laboratory to a regional one.



### III OTHER RELEVANT ACTIVITIES AT KISR

#### A. Mariculture and Fisheries Department (MFD)

Only activities directly relevant to the ecotoxicology project are described here. Extensive new (some still under construction) facilities are available at this site. The planned ESD Bioassay Laboratory will be on this site.

Mariculture activities are presently based around 3 fish, gruppia (*Epinephelus travina*), sea bream (*Sporidenta hasta*) and Tilapia (*Oreochromis spilurus*) (the latter having been fully acclimated to sea water). These are reared throughout their life-cycles in the laboratory but as yet without "out-of-season spawning". There is large scale culturing of rotifers (*Brachionus* sp) and algae (*Chlorella* sp) as food for the larval fish, presently on a batch basis but with continuous culture systems in preparation.

The laboratory systems for the culture of these fish species are on a large scale. In addition there are cage-rafts close to the laboratory used for growing-on.

MFD also has experience in the culturing of shrimp/prawns and the maintenance of coral colonies in the laboratory although there is no ongoing research in either of these areas. Four boats are available in MFD (up to 11 m) but no ocean going vessel. SCUBA diving equipment and trained divers are also available.

There is clearly a lot of experience in MFD in operating and conducting experimental work in laboratory and field based marine facilities. This will be of great value to the proposed ESD ecotoxicology project and the maintenance and development of established links with this expertise will be important. MFD should be able to operate as the prime provider of test organisms for the ecotoxicology project. In addition MFD's capability and experience of operating cage-rafts could provide the basis for the development of in-shore mesocosm experiments.

#### B. Central Analytical Laboratory

This is a well equipped modern analytical facility that provides central service in method development and sample analysis to KISR.

Analytical equipment available includes:

GC, GC-IR, GC/MS, HPLC, WM.R, Xray diffraction and fluorescence spectrometers, amino acid analyses, auto analysers, scanning electron microscope, UV/VIS/NIR spectrophotometer, and other general purpose analytical equipment.

There are established Quality Assurance/Quality Control procedures in place in the CAL and it has been involved in inter laboratory ring-tests.

At the present time the bulk of the analyses required in support of ESD activities are conducted within ESD where dedicated analytical facilities are also available.

C. National Science and Technology Information Centre

Good access to information services are provided through NSTIC and library facilities in MFD. All books, technical reports and journals were removed or destroyed during the Gulf War, but much has been done to correct for these losses.

Currently some 800 periodicals are subscribed to and 25 CD-ROM data bases are available. Back issues of 183 journals have been purchased. Most of the major journals in Environmental Sciences are subscribed to. Access to literature past or current will not be an impediment to the development of ecotoxicology research at KISR.

### RECOMMENDATIONS

1. That the proposed 11 month UNIDO assignment of an expert in marine ecotoxicology go ahead with a start date of August/September 1994, coinciding with the completion of the Bioassay Laboratory. (see Annex VI for job description).
2. Initial activities in the Bioassay Laboratory should focus on establishing of:
  - acute and chronic toxicity tests for effluent monitoring and incident assessment
  - research into the fate and effects of petroleum hydrocarbons in the Gulf environment. Linkage with the proposed marine ecology project on corals should be considered. These studies should involve assessment of fate and effects and laboratory and field studies, the latter using model ecosystems.
3. The proposed UNIDO project should be designed to ensure there is no duplication of work that might be carried out in proposed collaborative research with Oregon State University.
4. That note be taken of the manpower requirements to staff and operate the Bioassay Laboratory, in particular the heavy demands that will be placed on analytical chemistry, especially if bioaccumulation studies are undertaken.
5. Safety aspects of working with carcinogens and potential carcinogens in the Bioassay Laboratory need to be fully addressed in advance of work commencing.
6. Where possible and relevant OECD Guidelines for Ecotoxicology should be the basis for the conduct of laboratory toxicity tests.

ANNEX I

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

DP/KUW/92/003/11-01

Post title                      Expery in ecotoxicology

Duration                        1.0 m/m

Date required                  As soon as possible

Duty station                    Kuwait city with travel within the country

Purpose of project                To assist the Kuwait Institute of Scientific Research (KISR) in their aim to up-grade their laboratory to study the long term ecotoxicological effects due to the chemical pollution caused during Gulf War.

Duties                            The expert is expected to undertake duties related to preparing for a longer mission of an expert to assist the Kuwait Institute of Scientific Research (KISR) in tackling the ecological disaster caused by damages to the country's industrial infrastructure. In this he is expected to review current plans, programmes and capabilities within Kuwait to tackle these problems. In particular, he will be, in association with the National Project Director:

- review the equipment, laboratories and analytical practices of the Environment Science Division to determine their capability to study various ecological problems related to pollution by toxic/hazardous pollutants;
- review current capabilities for studying the fate of chemicals and their break-down products in the ecosystem, for mapping out zones of contamination, and for developing model systems in the laboratory to follow the movement of such chemicals in the eco-system;

- review all other aspects related to setting up health related issues due to pollutants in the environment;
- review current plans and programmes in the country for dealing with these issues, and the capability and expertise of the multi-disciplinary team in KISR looking at these.

The expert will write a report summarizing the above findings, and based on this will determine the most critical areas where ecotoxicology expertise is required. From this he will prepare a preliminary work plan for this, and a detailed job description for the expert for the main part of this project.

**Qualifications:**

An ecotoxicology specialist or analytical chemist qualified in analysis of biological materials with extensive experience in problems associated with man-made chemicals in the environment affecting the food chain, aquatic life and soil micro-organisms. Must have a high level educational qualification, with experience at senior level in organizing research work, leading research groups, conducting model systems in laboratories to follow fate of chemicals and their metabolites in the eco-system. Experience with developing countries would be an advantage.

**Language:**

English

**Background Information:**

The country, immediately following the Gulf war, took all necessary steps to mitigate the short term direct effect of war and the burning oil wells. However, having taken the immediate action, the Government is planning long term action plan to study effect of chemical residue in the ecological system. For this the Kuwait Institute of Scientific Research (KISR) is taking R&D studies to monitor the effects to human health, eco-system and aquatic life.

In line with the Government's programme, the KISR is requesting UNIDO to provide the necessary technical assistance in setting up of a well equipped laboratory and in carrying out R&D projects to upgrade the capabilities of the institute.

ANNEX II

Name	Degree	Special Field of Study
Dr. Saleh Al-Muzaini	Ph.D. in Environmental Engineering	Industrial & Sanitary Wastewater, Solid waste
Dr. Hosny Khordagui	Ph.D. in Environmental Chemistry	Environmental Quality Management Chemistry of Water Pollution
Dr. Abdul Nabi Al-Ghadban	Ph.D. in Oceanography	<ul style="list-style-type: none"> <li>- Sediment Transport in Marine Environment</li> <li>- Geological Oceanography</li> </ul>
Dr. Mohammed Metwally	Ph.D. in Analytical Chemistry	<ul style="list-style-type: none"> <li>- Applied Marine Sciences</li> <li>- Environmental Chemistry</li> <li>- Analysis of Environmental Samples</li> </ul>
Dr. Fatima Abdali	Ph.D. in Environmental Health Sciences	Environmental Chemistry, Exposure Assessment and Risk Assessment (Marine Pollution and Air Pollution)
Dr. Talat Saced	Ph.D. in Analytical Chemistry	Analysis of Environmental Samples of Water, Biota, and Sediments
Dr. S. Al Yakoob*	Ph.D. in Environmental Health Sciences	Environmental Chemistry, Exposure Assessment and Risk Assessment (Marine Pollution and Air Pollution)

\* Currently on 7 month ecotoxicology training assignment at Oregon State University, USA.

ANNEX III

ENV ONGOING PROJECTS JULY 93 - JUNE 94

TITLE	LEADER/CODE	DURATION	CLIENT
An Air Pollution Index for Shuaiba Indu. Area	H. Khordagui EES-171 126404	1/11/92 - 31/8/93	SAA
Study of the Chemical Composition of the Oil Lakes and Effects of Weathering on Aromatics	T. Saeed VR-001K	1/9/92 - 31/8/93	KISR
Distribution of Pollutants in Soil, Sediment and Marine Water in the <i>SAA Shuaiba Industrial Area.</i>	S. Al-Muzaini VR-002C 126405	1/03/93 - 30/8/94	SAA
Degradation Kinetics and Assessment of Pesticides on Vegetables Grown in Kuwait	M. Metwally VR-003C 126407	1/06/93 - 31/5/95	PAAF
Toxicity and Uptake of Crude Oil and Partially Combusted oil by Selected Marine Organisms in Kuwait	M. Metwally VR-004K	1/6/93 - 31/5/95	KISR
Estimation of Risk Associated with Consumption of Oil-Contaminated Seafood by Kuwait's Population	S. Al-Yakoob EES-121 126409	1/4/93 - 31/5/95	KFAS
Preliminary Toxicity Assessment of Industrial Effluents in the Marine Environment of the Shuaiba Industrial Area using Microtox Bioassay	S. Al-Muzaini EES-155 126406	1/03/93 - 28/2/94	SAA
Study of the Environmental Pollution from Landfill Sites Receiving Wastes Generated during Iraqi Invasion	S. Al-Muzaini VR-008C 126408	1/06/93 - 31/7/94	KFAS
Distribution of Volatile Liquid Hydrocarbons in Kuwait Marine Environment	H. Khordagui EES-152	1/11/93 - 31/10/94	EPC

ANNEX IV

PUBLICATION TITLE		اسم المنشور	AUTHORS(S)	المؤلف / المؤلفين
Toxicity and Bioaccumulation of Crude Oil and Partially Combusted Oil in Selected Marine Organisms in Kuwait			Dr. M. Metwally	
PROJECT CODE VR004P	رمز المشروع	PROJECT TITLE	As above	اسم المشروع
DEPARTMENT/PROGRAM ENV	الدائرة/البرنامج	DIVISION	EES	الإدارة
TYPE OF PUBLICATION		نوع المنشور		
<input checked="" type="checkbox"/> Preproposal		<input type="checkbox"/> PERIODICAL ARTICLE		
<input type="checkbox"/> PROPOSAL		<input type="checkbox"/> CONFERENCE PAPER		
<input type="checkbox"/> INTERIM REPORT		<input type="checkbox"/> PROGRESS REPORT		
<input type="checkbox"/> FINAL REPORT				
SECURITY CLASSIFICATION		تصنيف أمني		
<input type="checkbox"/> GENERAL		<input checked="" type="checkbox"/> RESTRICTED		
<input type="checkbox"/> CONFIDENTIAL				
ABSTRACT (SUMMARY OF NOT MORE THAN 300 WORDS)		المستخلص (ملخص لا يزيد عن ٣٠٠ كلمة)		

This study will increase our understanding of the toxicity of crude oil and partially combusted oil (PCO) to aquatic life and the potential for bioaccumulation, an important determinant of food chain transfer from fish to humans. It will also assess techniques suitable for monitoring biological responses of natural and cultured fish populations to oil and PCO.

Because laboratory facilities at KISR are in the process of reconstruction, the initial testing will take place at Oregon State University (OSU), U.S.A., as a part of a cooperative agreement with OSU. KISR scientists and OSU scientists will work together for the first year. Upon completion of the KISR facilities, the KISR research team will continue the studies in Kuwait.

This project will:

- (1) Conduct laboratory research to provide specific benefits for assessing risks posed by oil-derived contaminants.
- (2) Transfer the technology of bioassay technique and toxicity testing employed in studies of oil and PCO on marine species.
- (3) Assist in preparing the EES aquatic bioassay laboratory at KISR.

The project will last for three years with an estimated budget of K.D. 190,000.

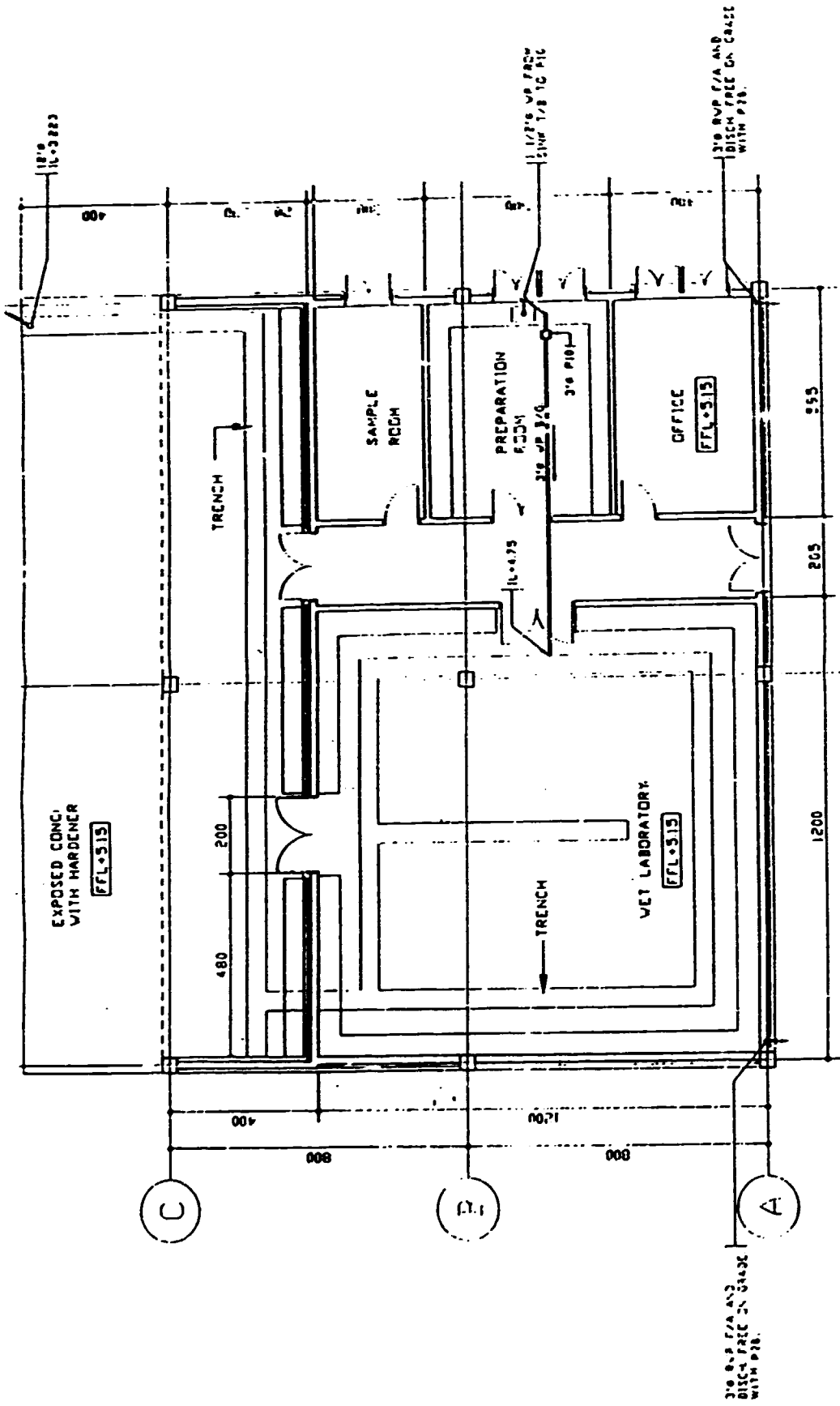


ANNEX V

Plans for Bioassay Laboratory and Proposed Modifications

1. Extend open drains (trenches) into Sample Room, Preparation Room and to edges of Wet Laboratory.
2. Increase number of sea water lines to provide adequate supplies to centre of Wet Laboratory and into Preparation Room.
3. Install 2 sinks in Wet Laboratory with hot and cold water supply.
4. Provide for fume cupboards in Preparation Room (2) and Wet Laboratory (1).
5. Reduce cold water supply points to one per sea water supply point.

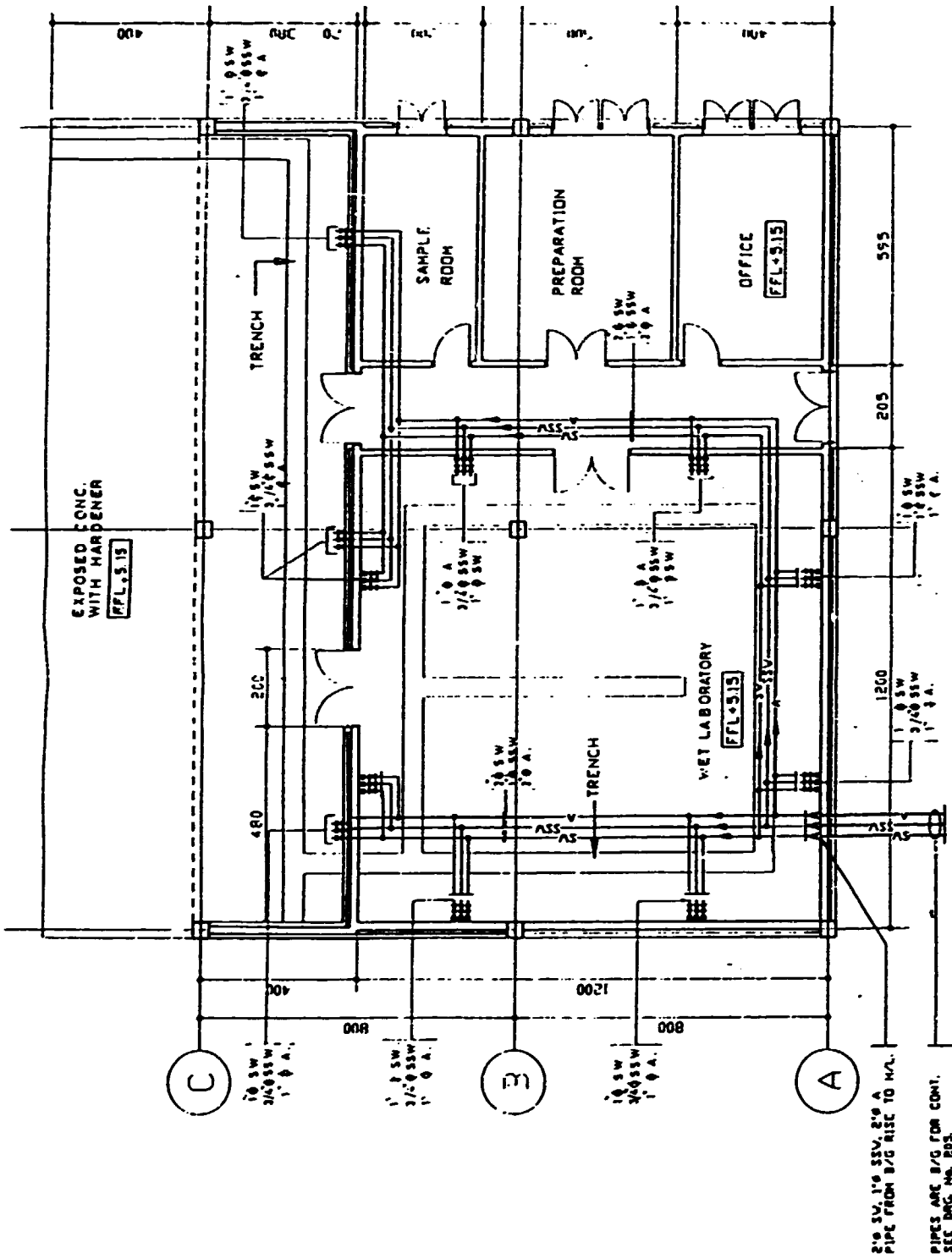
(NB. Plans indicating modifications proposed were left at KISR).



GROUND FLOOR PLAN

MARINE POLLUTION ANALYTICAL LAB. 1:100

Y



# GROUND FLOOR PLAN

MARINE POLLUTION ANALYTICAL LAB.

1100

Y

2" SW, 1" SSW, 2" SW  
PIPE FROM B/G RISE TO H.A.  
PIPES ARE B/G FOR CONT.  
SEE DRG. NO. 103.





## ANNEX VII

### Proposed Job Description for Marine Ecotoxicology Expert

The appointee will take up an 11 month assignment to the Kuwait Institute for Scientific Research, where in an established and well equipped Environmental Sciences Department they will:

- provide advice on the equipping and start-up of a recently built Bioassay Laboratory
- initiate and establish "routine" acute and chronic bioassays with algae, invertebrates and fish suitable for assessment of effluents and pollution incidents
- initiate a research programme, involving laboratory, model ecosystem and ultimately field monitoring studies to determine the potential for chronic toxic effects of petroleum hydrocarbons in the Gulf region. Particular emphasis should be placed on the use of model ecosystems and field studies as a means of developing further understanding of the apparent limited impact of the recent large oil spills into the sea off Kuwait
- train KISR staff in the field of aquatic toxicology and aquatic hazard assessment

**Qualifications:** A marine ecotoxicologist with at least 5 years experience of working in a multidisciplinary research environment where they have had a significant supervisory role. Should have experience of organising and preferably initiating research programmes in a matrix environment. Practical experience and ability in setting up and running laboratory and outdoor model ecosystem studies in the marine environment is very desirable.

Some experience of developing countries would be an advantage.

**Language:** English

UNIDO Comments

The report gives a brief review of the existing situation in Kuwait regarding various actions taken by the Kuwait Institute for Scientific Research (KISR) to monitor Xenobiotics in the environment. While exhaustive measures have been taken to establish the Institute by providing with new buildings, sophisticated equipment, the Institute needs long term planning, selection of projects avoiding duplication and above all carrying out full sequence of analytical procedures according to the international standards. In this connection proper sampling, storage of samples, handling of samples, carrying out analysis, collection of data, interpretation of data, storage/retrieval of data are of vital importance to monitor the fate of chemical in soil, air, aquatic and marine environment.

The most important aspect is to make the Institute, a Centre of Excellence in the Gulf region so that many countries in the region could be benefitted since monitoring and exchanging of transboundary pollution is vital for the overall safety in the region which has a major share in upstream petroleum processing and moving towards downstream processing. Therefore UNIDO's role, apart from this on-going project, should be broadened to give a regional character to the ecotoxicology centre. UNIDO is already involved in the Republic of Korea, Pakistan and Bangladesh. In this, regional approach would be valuable.