



# Assistance for Your Environmental and Occupational-Health Concerns



Our mission is twofold: to ensure that our employees and customers understand the safe-handling practices associated with the products that M-I SWACO provides and to secure a safe work environment for all of our employees.

# M-I SWACO provides operators and contractors with world-class environmental and occupational-health support

On land and offshore, operational and discharge practices are being challenged by an increasing number of international agreements as well as federal, state and local regulations.

As environmental and safety controls tighten, concerns mount among operators and contractors as to how to ensure cost-effective compliance with the new regulations and acceptable solutions that are based on sound environmental science and the latest safety practices

As one of the world's largest producers of drilling-fluid systems for use in the oil, gas, waterwell and mining industries, M-I SWACO, a Schlumberger Company, is the only company of its kind with in-house facilities for a full range of environmental testing—from water-quality analysis to acute and chronic ecotoxicity testing of drilling fluids and additives in fresh, marine and on-land applications. Because we are so committed to producing solutions that are safe for the environment as well as for the people who use them, we keep our own people and our customers current with, and often ahead of, international, federal, state and local regulations.

## Environmental Affairs

The Environmental Affairs Section of the QHSE Department offers expertise in assisting its customers, both external and internal, with environmental concerns. We conduct biological testing for onshore and offshore discharges.

We investigate and resolve environmental science issues that our customers face, and we offer compliance systems to meet federal, state and international regulations.

The Environmental Affairs Section is equipped to help you develop mud systems that will meet the regulations; to provide the necessary bioassay and analytical services you need; and to offer advice and consultation that will help you complete your project and cleanup at the lowest possible cost.

## Occupational Health

The Occupational Health Group of the QHSE Department provides several important services to both internal and external customers. The group is responsible for the authoring of the Company's Material Safety Data Sheets (MSDS), which provide important and often required information about the safe handling and any hazards of products to both employees and the customers. The group can also perform or provide assistance in the evaluation of an employee's workplace through the use of its own sampling equipment. We perform monitoring on dust, vapors, mist, and/or noise levels and comparisons to the regulatory exposure limits while providing help in the development of controls to mitigate exposures.



# The Environmental Affairs Aquatic Bioassay Laboratory



The primary purpose of this very specialized laboratory is to conduct freshwater and marine ecotoxicological tests on individual additives, systems, laboratory-prepared drilling fluids and field collected samples. The laboratory also has the capabilities for determining other significant criteria such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, dissolved oxygen content, suspended solids, salinity, oil and grease, and numerous other environmentally related parameters.

Our bioassay facility offers the most complete and advanced technology in the industry, ensuring that all tests accurately meet U.S. EPA protocols. Even before testing begins, we maintain strict control of the process. Samples coming into the lab for future work are kept in a walk-in cold room whose temperature is maintained between 35.96 °F and 39.2 °F (2 °C and 4 °C) to protect them from biological or chemical changes that could alter the results.

We maintain our own cultures of mysid shrimp (*Mysidopsis bahia*), sediment reworkers *Leptocheirus plumulosus*, fathead minnows (*Pimephales promelas*), and water fleas (*Daphnia pulex*), as well as the various food organisms required to maintain them. Artificial seawater is formulated in specially constructed holding tanks of 2,000 gal (7,571 L) total capacity, which provide a constant supply of water with carefully controlled salinity and temperature for the continuous culture and testing of the organisms. Additionally, a 1,000 gal (3,785-L) storage tank is reserved for maintaining readily available freshwater for testing purposes.

The bioassay room is equipped with its own backup power generator and is environmentally controlled to maintain

constant temperature, humidity and day/night cycle. Here we run three principal types of aquatic bioassays:

- Acute aquatic bioassays of drilling fluids consist of 96-hour LC<sub>50</sub> tests. This type of test determines the median lethal concentration of a toxic substance in the surrounding water that produces 50% mortality among the organisms tested over a period of 96 hours. These tests are conducted using mysid shrimp in the suspended particulate phase, which is the unfiltered supernatant extracted from a 1:9 mixture of the drilling fluid and seawater that has been allowed to settle for one hour.
- A 96-hour and 10-day definitive bio assay using the standard EPA sediment toxicity test protocol is conducted on a whole mud sample using *Leptocheirus plumulosus*. The whole mud sample is spiked into formulated sediment at different concentrations. A 96-hour LC<sub>50</sub> is then determined for the whole mud sample. LC<sub>50</sub> is the median lethal concentration or the quantity of a toxic substance in the surrounding sediment that produces 50% mortality in the test species. The greater the 96-hour LC<sub>50</sub> value, the lower the toxicity of the whole mud being tested. This test is designed to determine the toxic effects of the drilling fluid to the benthic community.
- Long-term studies of fish and bottom-dwelling organisms, such as mollusks (clams) and sandworms, are conducted using a flow-through system in which the water above the solid phase of the drilling fluid is changed several times a day. These tests are normally run for a period of at least 10 days.

## Additional testing procedures give you more options

- **In addition to marine testing**, we can conduct freshwater tests. Freshwater LC<sub>50</sub> testing capacity has been expanded with culturing of fathead minnows and water fleas.
- **For precise environmental control at extreme temperatures**, we have a reach-in environmental chamber that maintains a constant temperature, humidity and day/night cycle at temperatures ranging from 32 °F to 140 °F (0 °C to 60 °C). This chamber allows us to perform tests such as cool-water toxicity tests on fingerling trout in a cost-effective manner.
- **5-day BOD testing.** Oxygen consumption from waste water is a long-standing environmental standard test protocol that continues to be conducted as needed in the M-I SWACO laboratory.
- **28-day BOD testing.** Biodegradation testing of products used offshore has become an important feature in designing new systems and products. The 28-day BOD test employs ISO procedures to determine readily biodegradable substances.
- **275-day anaerobic biodegradation testing.** Anaerobic biodegradation rate is an important design criterion for synthetic-base fluids. The modified ISO/DIS 11734 protocol published by the EPA in the Effluent Limitation guidelines is routinely conducted to evaluate new, synthetic base fluids and base-fluid blends. The tests are conducted in the reach-in environmental chamber under controlled temperature and light conditions.



- **Environmental Laboratory Facilities**
- **Warming incubator** for bacteriological studies.
- **Phase contrast microscope with photographic capabilities.**
- **Low-temperature incubator** for Biochemical Oxygen Demand studies.
- **Walk-in, constant-temperature, cold room** for sample storage.
- **Reach-in environmental chamber** for toxicity studies at extreme temperatures.
- **Facilities to provide a continuous supply of artificial seawater or freshwater of predetermined parameters**, e.g. salinity, temperature, density and/or pH.
- **An environmentally controlled bioassay room** for static and dynamic bioassays using a variety of marine and freshwater organisms, including mysid shrimp, mud minnows, fathead minnows, water fleas and leptos raised in our own lab.
- **State-of-the-art greenhouse**, equipped with automatic temperature and humidity controls as well as a three-phase, timed, watering system supplied with clean water from an RO filtration unit.
- **Ion-sensing electrodes and meters** for determining, electrical conductivity, oxygen, pH, nitrogen, ammonia, SAR and chlorides.
- ***Eisenia foetida* vermiculture units** for earthworm toxicity screening and vermicompost projects.

# The Incubator for Onshore Environmental Solutions

The Environmental Affairs Greenhouse Laboratory (EAGL) was built at the North Course location to further enhance testing capabilities and address onshore environmental issues. This 20- by 30-ft (6.1 by 9.1-m) structure is equipped with state-of-the-art equipment that allows it to function with the greatest efficiency. A central control linked to evaporative coolers, a gas heater, and motorized ridge vents and aluminum shutters maintains optimal internal temperature year 'round. The facility's automatic, three-stage watering and misting systems supplies clean water to the specimens from the reverse-osmosis water filtration system.

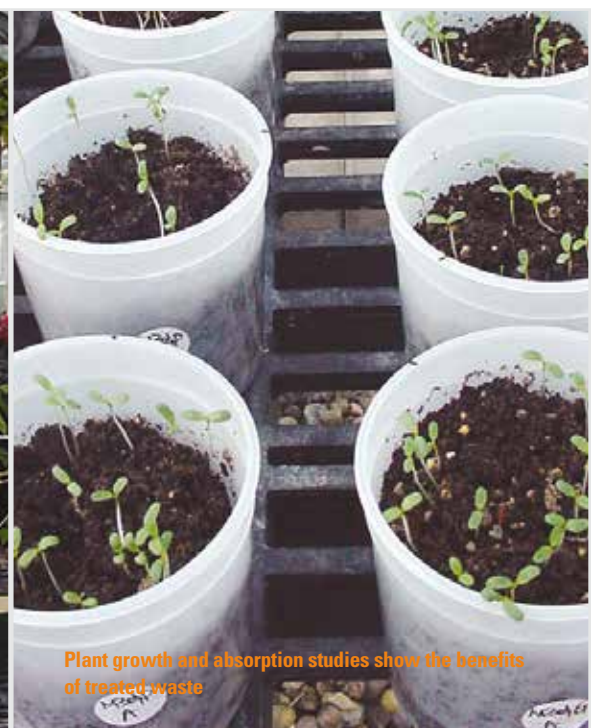
This fully contained, controlled environment is ideal for several varieties of testing and screening where onshore field conditions can be closely simulated. Some of the specific services and capabilities provided by the M-I SWACO Greenhouse and Soil Lab are:

- **Seed Germination and Root Elongation tests.** These tests determine the acute toxicity of drilling-fluid systems and additives for onshore application. It is based on the procedure outlined in ISO 11269 1 and the EPA Seed Germination and Root Elongation test methods.  
**Procedure:** A known concentration of the chemical or fluid is added in series

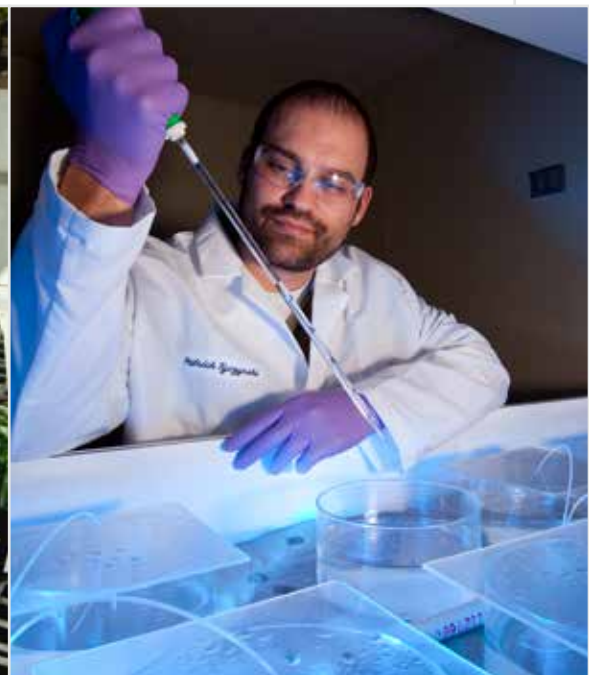
from 0 to 1,000 mg/kg onto lab-formulated control soil. Twenty alfalfa (*Medicago sativa*) seeds are planted in each and allowed to grow for 14 days. At the end of that time, the germinated seeds are counted and their root lengths are measured. This information is entered into statistical software that determines the concentration-response curves and the EC<sub>25</sub> for seed germination and root elongation.

- **Plant growth studies.** This test determines the soil compatibility and performance of treated waste or beneficial byproducts. The procedures follow historic research conducted by the API on drilling-fluid additives in 1974 at Utah State University.  
**Procedure:** A known concentration of the test substance is added in series on a percentage basis mg/kg onto a control soil that can either be lab-formulated or field-collected. Fifteen green bean (*Phaseolus vulgaris*) seeds are planted and allowed to grow for 45 to 60 days. At the end of that time the plant growth and root mass are measured. This information is entered into statistical software that determines the concentration-response curves for plant growth.

- **Plant uptake studies.** These determine the uptake of residual contaminants in soil from products, treated waste or beneficial byproducts. The procedures follow historic research conducted at Purdue University on drilling-fluid additives in the 1980s  
**Procedure:** In this test, a known concentration of the test substance is added in series on a percentage basis mg/kg onto a control soil that can either be lab-formulated or field-collected. Rye grass or chard seeds are planted and allowed to grow. Once the plants produce sufficient mass, the top part of the plant is harvested and evaluated for potential uptake of heavy metals. This information is evaluated on a statistical basis to determine the significance of the plant uptake.
- **Composting.** The greenhouse is used for smallscale bio-treatment techniques to develop and further enhance research in bioremediation of drilling waste.  
**Procedure:** Simulated cuttings are produced in the lab and coated in a manner that mimics field conditions of cuttings ejected from solids-control equipment. Amendments such as hay or peat, water, soil, nitrogen, potassium, and phosphorous are added to aid in bacterial growth and decomposition of the hydrocarbons. This information is



Plant growth and absorption studies show the benefits of treated waste



used to predict the possibility of bioremediation and land application of a particular drilling fluid for a specified location.

- **Leachate testing.** Harmful components, such as salt or sodium that find their way into the mud system can, in some cases, be leached down or naturally attenuated to acceptable regulatory limits, with clean water making the waste acceptable for land application. In other cases, waste is stabilized into a matrix that is designed to minimize harmful leachates.

**Procedure:** Use of a leachate soil-testing cell allows for the evaluation of water percolation through soil and the removal rate for the offensive component. Both the soil matrix and the water are tested using a tube and filter apparatus that allows the water to run through the sample, be collected and analyzed for the component in question. Studies are done to determine the amount of chemical or physical amendment that could be added to aid in the efficiency of this process and/or to evaluate the quality of soil and water after the leaching process.

- **Soil blending and loading rates for land application of drilling waste.** This work is done in conjunction with regional soil, water, and forage testing laboratories. Through these efforts it is possible to determine the effects of

drilling fluid on soil structure and chemical balance that could affect regrowth in the area of application.

- **Earthworm bioassay.** *Eisenia foetida*, cultured in the greenhouse, are placed in glass jars containing fluid-treated soil and survival is measured after 7 and 14 days of exposure. After 90 days, the adult earthworm mass is measured as well as its reproduction. The 14-day toxicity test is indicative of any acute toxicity associated with the fluid or chemical while earthworm mass and reproduction measures chronic toxicity that may be caused by a soil contaminant. Response in the base-fluid treatments is expressed relative to that in the untreated reference soil.

M-I SWACO has also used these facilities to aid research furthering the restoration of coastal wetlands using drill cuttings. We have participated in large-scale university studies where an artificial marsh was set up in the greenhouse in order to develop and test new mud formulations and treatment systems for use in a sensitive wetlands environment.

In summary, the greenhouse and soil lab provide the capabilities to aid in internal product development, provide technical service to the field for waste disposal options, develop testing procedures as tools for regulatory agencies, determine the characteristics of drilling waste as

a beneficial reuse product, and provide general scientific information on basic human health and the environment.

Together, the services of the M-I SWACO Greenhouse and Aquatic Bioassay Laboratories, under the guidance of the Environmental Affairs staff, provide a powerful tool for achieving major environmental goals.

- The support and monitoring of the research and development that goes into all M-I SWACO products, and to the continuous assaying of our products to ensure that they meet the current environmental requirements wherever they are being used around the globe.
- The development and modification of test procedures in conjunction with industry work groups and government agencies to support new regulations and new technology. Assisting customers with field studies and environmental science associated with discharge impacts.
- The provision of bioassay and testing services for our customers that will allow them to operate in the knowledge that they are within regulatory guidelines and solve problems associated with any aspect of drilling and completion fluids usage or disposal.

# Occupational Health



## Protecting the health and safety of customers and M-I SWACO people

The Occupational Health Department has a twofold mission: ensure that our employees and customers understand the safe-handling practices associated with the products that M-I SWACO provides and secure a safe work environment for all of our employees.

The primary method of communicating product-safety information is through the use of Material Safety Data Sheets (MSDS). During the authoring process of the company's MSDS, extensive research is conducted using qualified third-party services along with the suppliers' information on the individual components of a product to determine to what extent, if any, they would pose a hazard. This information is then entered into a state-of-the-art computer program to generate the MSDS. The use of this software ensures that the information in the MSDS is accurately and consistently presented.

The group can also evaluate and, if needed, provide monitoring of workplace environments to ensure that M-I SWACO is protecting its employees and customers from long-term hazards. In some cases, this type of assessment is a requirement of local laws and regulations. For those locations where it is not a local requirement, the M-I SWACO QHSE Management System requires health assessments. Additionally, the evaluation can be utilized to determine whether the Personal Protective Equipment (PPE) that is being used is adequate to control the workers' exposure.

Some of the most universal workplace issues monitored by the Occupational Health group are:

- **Dust** — Health surveillance studies show that exposure to respirable dust continues to be a major health threat in some instances. The purpose of a monitoring program is to study the situation and develop various tools that can be used to assess worker exposure to respirable particulate matter. Those tools can then be used to ensure that particulate levels are within acceptable limits. Direct measurements will enable workers and management alike to immediately assess whether controls are working and encourage corrective action before particulate levels affect workers' health.
- **Heat stress** — Operations involving high air temperatures, radiant heat sources, high humidity, or strenuous physical activities have a great potential for inducing heat stress in employees engaged in such operations. Heat-induced occupational illnesses and injuries and the resultant reduced productivity can occur with excessive exposure to a hot work environment. Heat-induced disorders include transient heat fatigue, heat rash, fainting, heat cramps, heat exhaustion and heat stroke. Aside from these disorders, heat poses the threat of injuries because of accidents caused by slippery palms as a result of sweating, fogged-up safety glasses and dizziness. Proper analyses of the workplace environment can ensure that the proper controls are in place to protect the workers from these types of conditions.
- **Noise** — Excessive noise exposure may cause a temporary change in hearing or a temporary ringing in the ears (tinnitus). These short-term problems usually go away within a few minutes or hours after leaving the area of excessive noise. However, repeated exposures to loud noise can lead to permanent, incurable hearing loss or tinnitus. Noise meters can accurately determine the areas where hearing protection is necessary as well as the type of hearing protection that should be used to control exposure.
- **Ventilation** — Broadly defined, ventilation is a method of controlling the environment with air flow. It is one of the most important engineering controls available for improving or maintaining the quality of the air in the workplace environment. Industrial ventilation can be used to keep airborne concentrations of dust and vapors below explosive or flammable levels and to maintain the air concentrations of toxic particulates, vapors and gases at acceptable/safe levels. Whether using dilution or local exhaust ventilation, it is important to ensure that the proper volume of air is being moved and the placement of the ventilation is appropriate to prevent conditions that could adversely affect workers.



## A valuable shared resource: The Analytical Services Laboratory

Although the Analytical Services Laboratory is positioned within the Research and Development section of M-I SWACO, and while much of its work relates to other than environmental concerns, this group supports our environmental and occupational health work in many ways, so we have included it in this brochure.

The principal environmentally oriented analyses performed within Analytical Services include highly accurate determinations of toxic metals, aromatics and hydrocarbons, specific organic parameters such as oil and grease content, and other inorganic-material determinations related to either environmental or health concerns. They can also measure other potentially hazardous aspects of drilling and completion fluids and wastes, such as flash point, corrosivity and reactivity.

These types of measurements have historically been of most concern to contractors who wish to recycle or otherwise reuse waste water, or to those who use water in secondary- or tertiary-recovery systems. As onshore disposal of drilling fluids and cuttings becomes more restricted, these services will become increasingly more important.

The M-I SWACO Analytical Services Laboratory is dedicated to these activities:

- Supporting the research and development that goes into M-I SWACO products.
- Providing testing services for our customers who desire highly accurate, quantitative data on water quality or other aspects of their drilling, completion and workover operations.
- Ensuring that our employees and customers work in safe environments while on the job.
- Solving environmental, occupational-health or other problems associated with any aspect of drilling-fluids usage, handling, storage or disposal.

## The best people and resources for supporting our customers

The quality of work that any laboratory produces depends mostly upon the people who work within it. M-I SWACO has a staff of highly motivated professionals, educated and trained in a variety of disciplines such as biological engineering, environmental engineering, analytical chemistry, biochemistry, biology, environmental science, biological oceanography, and industrial hygiene.

Many of our top laboratory personnel have national and industry-wide reputations for their knowledge of drilling-fluids chemistry, toxicity and disposal technology. Many have published widely in trade journals on such subjects as reserve-pit disposal, toxicology of drilling fluids, occupational health exposures, environmental auditing, and aspects of worker health and safety. Our scientists are actively engaged in the development of new M-I SWACO products to meet increasingly stringent regulatory requirements around the globe. They also participate in the formulation of reasonable regulations through science and research and by providing expert testimony in agency hearings. M-I SWACO customers can be assured that our products comply with the international, federal, state and local regulations pertaining to their recommended use. The most important focus of our people is the support of our customers, those who utilize our systems and/or products.

Call us—we can help you:

- Develop or customize mud systems with outstanding performance characteristics for particular subsurface geologies, and which also meet applicable environmental regulations for use and disposal.
- Stay apprised of existing and proposed international, federal and state regulations so that you may plan your drilling activities most effectively. Our long-term, in-depth involvement in environmental and occupational health

issues gives us unparalleled expertise we routinely share with our customers.

- Perform toxicity testing and bioassays economically and in a timely fashion.
- Solve environmental and occupational health issues that arise during operations.
- We can also offer advice and consultation on drilling-fluids disposal systems to help you minimize the costs while staying within the bounds of governmental restrictions.

## Occupational Health Department

- **Air sampling pumps** used to measure dust or vapors to which workers are exposed.
- **Air flow calibration meters** to accurately adjust and calibrate the flow of the air sampling pumps.
- **Noise level meters** used to determine the level of noise at a given time and place.
- **Noise dosimeters** to accurately measure an employee's exposure to noise. The employee wears the noise dosimeter during a work shift and it measures noise levels at all the locations the employee visits.
- **Heat stress monitors** used in conjunction with worker observations to ensure that the condition in the workplace meet acceptable standards.
- **Air velocity meters** to ensure that the ventilation is adequate for the working conditions.

**For more information on available services for all aspects of your operations, please contact your local M-I SWACO representative.**



## Analytical Laboratory Facilities

- **Atomic Absorption Spectrophotometer (AA)** for analysis of toxic as well as non-toxic metals
- **Automated mercury analyzer** for the analysis of mercury in various samples by cold vapor atomic absorption
- **X-ray fluorescence spectrometer** to qualitative determine the elements present in various samples, including barite, clays, drilling-fluid products, etc.
- **Inductive Coupled Plasma - Mass Spectrometer (ICP-MS)** for analyses of very low parts per billion of metals in various samples, including barite, drilling-fluid products, waste material, water samples, etc.
- **Laser particle-size analyzer** for precise determinations of particle size distribution from 0.04 to 2,000 microns
- **Gas chromatographs (GC-FID, GC ECD, GC-TCD, GC/MS)** for analysis of organic materials such as crude oils, diesel oils, mineral oils, synthetic-base fluids, residual hydrocarbons after biodegradation, vapor samples, headspace gases, contamination of synthetic drilling fluids, etc.
- **Automated acid digestion system** for the preparation of samples, using approved EPA methods, to be analyzed by ICP-MS or AA
- **Spectrophotometers** for a variety of tests, including determination of ligno sulfonates, hexavalent chromium, sulfates, aromatics, nitrates, etc.
- **X-ray diffraction spectrometer** to determine mineral content of cuttings, cores, muds and other drilling products through a detailed analysis of the crystalline structure within the materials



- **Liquid chromatography (HPLC with UV/ Vis, RI, and Fluorescence Detectors)** for analysis of polymers, surfactants, emulsifiers, PAHs in base fluids, corrosion inhibitors, etc.
- **Ion chromatograph** to analyze for low levels of anions such as halides, sulfides, chromates, carbonates, phosphates, etc.; and cations such as ammonia, sodium, potassium, etc.
- **Infrared (FTIR) spectrophotometer** for the identification of class or family or organic materials in products and systems
- **FTIR microscope** for the observation and identification of organics in very small samples or selected portions of a bigger sample
- **Carbon/ nitrogen/hydrogen/ sulfur/ oxygen analyzer** to determine the ratios of these elements in a material, thereby gaining a general idea of its molecular structure
- **Scanning electron microscope** for defining the structure of clays, minerals and cores, including crystalline structure, pore size and distribution in the sub-micron range; and for the study of metal surfaces for corrosion and various coatings
- **Digital microscopes**, used to capture high resolution images and video of objects with 20X to 1,000X magnification that will also capture three dimensional images
- **Computer-linked swellmeters** for the identification of fluids with maximum swelling inhibition of shales in different formations

## Online Resources

[www.miswaco.com/hddmw](http://www.miswaco.com/hddmw)



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