PROPOSED COURSE OUTLINE
THE *COMPLETE* GROUND-WATER MONITORING FIELD COURSE
June 16 - 20, 2014 – Calgary, Alberta, Canada
Sponsored By Oak Environmental Inc.

Principal Instructors:
David M. Nielsen, C.P.G., C.G.W.P., P.Hg., Principal, The Nielsen Environmental Field School
Gillian L. Nielsen, C.E.S., C.G.W.M.S., Principal, The Nielsen Environmental Field School

Day 1 – Monday June 16th , 2014

8:00 a.m. - 8:30 a.m.
Welcome, Introduction of Instructors and Course Overview
- *David M. Nielsen*

8:30 a.m. - 12:00 p.m. (15-minute breaks at about 9:30 and 10:45)
Optimizing Monitoring Well Placement

- Step 1 - Establishing Objectives, Data Needs and Uses
  - Common Monitoring System Objectives
  - Data Requirements for Designing an Effective Ground-Water Monitoring System
- Step 2 - Assembling and Evaluating Existing Information
  - Important Geographic, Climatic, Geologic, Hydrogeologic, Contaminant-Related and Other Factors Affecting Well Placement
- Step 3 - Developing an Initial Conceptual Site Model
  - Identifying Probable Ground-Water and Contaminant Movement Pathways
  - Identifying Data Gaps That Need to be Filled
- Step 4 – Conducting a Detailed 3-Dimensional Site Characterization Program
  - Filling the Data Gaps in the Initial Conceptual Site Model
  - The Importance of Continuous Sampling and 3-D Subsurface Visualization

- David M. Nielsen

12:00 p.m. - 1:15 p.m. Lunch Break (On Your Own)

1:15 p.m. – 2:25 p.m.
Optimizing Monitoring Well Placement

- Step 5 - Developing a Refined Conceptual Model
  - Graphics Useful for Depicting Subsurface Conditions
  - Identifying the Target Monitoring Zones

For More Information Please Contact - Frank Magdich – Oak Environmental –
Tel # 403 250-9810 or frank@oakenviro.com

- Step 6 - Selecting Optimum Well or Multi-Level Monitoring System Locations
  - Plotting Areal Distribution of Wells/Multi-Level Systems
  - Selecting Vertical Positions and Lengths of Well Screens/Sampling Ports

- David M. Nielsen

2:25 p.m. – 2:40 p.m. Break

2:40 p.m. – 5:30 p.m. (15-minute break at about 3:50 p.m.)
Environmental Drilling Technology for Monitoring Well Installation

- Differences Between Environmental Drilling and Other Drilling
- Factors to Consider in Selecting a Drilling Method
  - Geologic Conditions Expected During Drilling
  - Ability to Recognize Subsurface Conditions During Drilling
  - Ability to Retrieve Representative Formation Samples
  - Presence and Type(s) of Contaminants
  - Potential for and Degree of Formation Damage Caused During Drilling
  - Ability to Meet Borehole and Well Installation Requirements
  - Logistical and Budgetary Constraints
- Descriptions of Commonly Used Environmental Drilling Methods
  - Applications, Limitations and ASTM Standards Available for Each Method
    - Casing Advancement Methods
      - Driving
      - Cable Tool
      - Sonic/Rotasonic
    - Fluid Circulation Methods
      - Mud Rotary
      - Air Rotary
      - Down-Hole Hammer
      - Air Rotary With Casing Driver
      - Dual-Tube Reverse Circulation
    - Auger Methods
      - Hollow-Stem Auger

- David M. Nielsen

5:30 p.m. Course Adjourns for the Day – Meet and Greet after classes

Day 2 – Tuesday June 17th, 2014

8:00 a.m. - 9:10 a.m.
Ground-Water Monitoring Well Design and Construction – Part 1

- ASTM Standard D 5092 on Monitoring Well Design and Construction
- Objectives and Purposes of Monitoring Wells
  - Collection of Water-Level Data
  - Collection of Water-Quality Samples
  - Collection of Hydraulic Test Data
- Potential Sources of Chemical Interference

For More Information Please Contact - Frank Magdich – Oak Environmental –
Tel # 403 250-9810 or frank@oakenviro.com

    - Drilling-Related Sources
    - Well Construction Related Sources
    - Material-Related Sources
- Selection of Well Casing and Screen Materials
    - PVC and Other Plastics
        - ASTM Standards F 480 and D 1785
    - Mild Steel, Carbon Steel, Galvanized Steel, Stainless Steel
    - Other Materials

- David M. Nielsen

9:10 a.m. – 9:25 a.m. Break

9:25 a.m. – 10:35 a.m.
Ground-Water Monitoring Well Design and Construction – Part 2

- Factors Influencing Selection of Well Diameter
    - Equipment Used in the Well
    - Purge Volume and Recovery Rate
- Types and Designs of Well Screens
    - Machine-Slotted Casing
    - Continuous-Wrap, Wire-Wound Screens
    - Other Screen Designs
- Importance of Selecting an Appropriate Well-Screen Length
    - The Well Screen as a Concentration Averaging Device
    - The Well Screen as a Hydraulic Short-Circuiting Device
    - Short Screens vs. Long Screens
    - Multiple-Screen Wells
    - Well Clusters and Well Nests
- Multi-Level Monitoring Systems – Design and Construction

- David M. Nielsen

10:35 a.m. – 10:50 a.m. Break

10:50 a.m. – 12:00 p.m.
Ground-Water Monitoring Well Design and Construction – Part 3

- Selecting the Proper Filter Pack Grain Size and Well-Screen Slot Size
    - Purpose of the Well Screen and Filter Pack
    - Definitions of Terms – Effective Size, Uniformity Coefficient
    - Naturally Developed Wells vs. Filter-Packed Wells
    - Importance of Proper Sieve Analysis of Formation Materials
    - Step-by-Step Filter-Pack and Well-Screen Design
    - Appropriate Combinations of Filter Pack Grain Size and Well Screen Slot Size
    - Appropriate Filter Pack Materials
    - Pre-Packed Well Screens – Advantages and Limitations

- David M. Nielsen

12:00 p.m. – 1:30 p.m. Lunch Break (On Your Own) and Travel to the Field Site

For More Information Please Contact - Frank Magdich – Oak Environmental –
Tel # 403 250-9810 or frank@oakenviro.com

1:30 p.m. - 5:30 p.m.

Field Session 1 – Site Characterization, Soil Sampling and Monitoring Well Installation Using Direct-Push and Sonic Drilling Technology; The Westbay Multi-Level Monitoring System

Station 1: Site Characterization, Soil & Ground-Water Sampling and Ground-Water Monitoring Well Installation Using Direct-Push Technology

- **Objectives of the Field Session**
- **Introduction to Direct-Push Rigs and Tooling**
- **Discrete and Continuous Soil Sampling**
- **Direct-Push Ground-Water Sampling**
  - **Sampling Tool Placement (Based on Soil Samples)**
  - **Sampling Tool Operation to Collect Representative Samples**
  - **Collection of Ground-Water Samples**
- **Installation of a Direct-Push Ground-Water Monitoring Well**
  - **Determining Final Depth to Complete the Well**
  - **Use of Pre-Packed Well Screens**
  - **Development Options for Direct-Push Wells**

- David M. Nielsen & Gillian L. Nielsen
- David Batista, CDS Drilling Services.

Station 2: Site Characterization, Soil Sampling and Ground-Water Monitoring Well Installation Using a Sonic Drilling Rig

- **Objectives of the Field Session**
- **Introduction to Sonic Rigs and Tooling**
- **Continuous Soil Sampling During Sonic Drilling**
- **Installation of a Ground-Water Monitoring Well**
- **Comparison of Sonic and Other Well Installation Methods**

- David M. Nielsen & Gillian L. Nielsen
- To Be Announced, Boart Longyear.

Station 3: The Westbay Multi-Level Monitoring System

- **Objectives of Multi-Level Monitoring Programs**
- **Overview of the Components of the Westbay Multi-Level Monitoring System**
- **Installation Considerations**
- **Sample Collection Methods**
- **Applications of the Westbay Multi-Level Monitoring System**

- Frank Magdich, Oak Environmental Inc.

5:30 p.m. Course Adjourns for the Day

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Day 3 – Wednesday June 18th , 2014

8:00 a.m. – 8:45 a.m.
Review of the Previous Day's Field Session and Practical Problems
- *Gillian L. Nielsen*

8:45 a.m. – 9:50 a.m.
Ground-Water Monitoring Well Design and Construction – Part 4

- Selection and Installation of Annular Seal Materials
  - Bentonite Materials – Chips, Pellets, Granules, Grouts
    - Appropriate Use and Installation
  - Neat Cement Grouts
    - Additives and Their Functions
    - Proper Mixing and Installation

- *David M. Nielsen*

9:50 a.m. – 10:00 a.m. Break

10:00 a.m. – 11:05 a.m.
Ground-Water Monitoring Well Design and Construction – Part 5

- Surface Protection Measures
  - Flush-to-Grade and Below-Grade Completions
  - Above-Grade Completions
  - Surface Seals, Protective Casings, Locks, Bumper Guards
- Alternative Well Completions
  - Single-Screen vs. Multiple Screen Completions
  - Telescoping Well Completions
  - Bedrock Completions
    - Screened Wells vs. Open-Hole Completions
- Direct-Push Well Installation

- *David M. Nielsen*

11:05 a.m. – 11:15 a.m. Break

11:15 a.m. – 12:15 p.m.
Monitoring Well Development Methods

- ASTM Standard D 5521 on Development of Monitoring Wells
- Objectives and Purposes of Well Development
- Applications, Advantages and Limitations of Development Methods
  - Surging and Pumping/Bailing
  - Overpumping and Backwashing
  - Hydraulic Jetting
  - Air-Lift Pumping and Backwashing
  - Development With Compressed Air
- When and How Long to Develop Monitoring Wells

- *David M. Nielsen*

12:15 p.m. – 1:30 p.m. Lunch Break (On Your Own)

1:30 p.m. – 2:40 p.m.
Planning and Executing a Successful Ground-Water Sampling Event

- Components of a Ground-Water Sampling Event
- Sampling Event Planning and Preparation
- The Ground-Water Sampling and Analysis Plan (SAP)
- Objectives and Purposes of the SAP
- SAP Design Options
- Components of an SAP
- Making the SAP User-Friendly
- Addressing the Analysis Portion of the SAP
  - Lab Analysis
  - Field Analysis
  - Analytical Parameter Selection
- Understanding PPM vs. PPB vs. PPT
  - The Consequences of Low Detection Limits
- Standard Operating Procedures to Incorporate Into the SAP
  - Well Inspection and Housekeeping Procedures
  - Well Headspace Screening
  - Water-Level and Product Thickness Measurement
  - Selection and Operation of Purging and Sampling Devices
  - Sampling Point Purging
  - Calibration of Field Instrumentation
  - Field Measurement of Water-Quality Indicator Parameters
  - Sample Pretreatment – Filtration and Preservation
  - Sample Packaging and Shipping
  - Sampling Event Documentation
- Timing of Ground-Water Sampling Events
- Office Preparation for Sampling Events

- Gillian L. Nielsen

2:40 p.m. – 2:55 p.m. Break

2:55 p.m. – 4:05 p.m.
Field Equipment Decontamination

- Objectives of Field Equipment Decontamination
- Available Decontamination Methods and Protocols
  - ASTM Standard D 5088 for Field Equipment Decontamination
- Problems Associated with Chemical Decontamination
- Verifying the Effectiveness of Decontamination Methods

- Gillian L. Nielsen

4:05 p.m. – 4:20 p.m. Break

4:20 p.m. – 5:30 p.m.

For More Information Please Contact - Frank Magdich – Oak Environmental –
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Field Quality Assurance/Quality Control Programs
- The Difference Between Quality Assurance and Quality Control
- The Importance of Field QA/QC
- Typical Components of Field QA/QC Programs
- The Role of Quality Control Samples in Ground-Water Sampling Programs
- Types of QC Samples to Collect, and How and Why to Collect Them

- Gillian L. Nielsen

5:30 p.m. Course Adjourns for the Day

Day 4 – Thursday June 19th, 2014

8:00 a.m. – 9:15 a.m.
The Science Behind Ground-Water Sampling – Part 1
- Objectives and Purposes of Ground-Water Sampling
  - Collection of Representative Water-Level Data
  - Collection of Representative Water Chemistry Data
- The Importance of High-Quality Data in Ground-Water Sampling
  - Accuracy, Precision and Bias
- Ground-Water Level Data
  - Uses of Water-Level Data
    - Defining Site Hydrology – Hydraulic Gradients and Water-Level Mapping
  - General Procedures for Water-Level Measurement
  - Water-Level Measurement Methods
    - Chalked Steel Tape
    - Electric Tapes
    - Pressure Transducers
    - Ploppers
  - Sources of Bias and Error in Water-Level Measurement and How to Avoid Them
    - Operator Error
    - Equipment Error
    - Outside Influences

- *David M. Nielsen*

9:15 a.m. – 9:30 a.m. - Break

9:30 a.m. – 10:45 a.m.
The Science Behind Ground-Water Sampling – Part 2
- Sources of Bias and Error in Ground-Water Sample Collection
  - Purging-Related Sources
  - Sampling Equipment Operation and Sample Collection Procedures
  - Field Indicator Parameter Measurement-Related Sources
- Definition of a “Representative” Sample
- Conditions Under Which Ground-Water Typically Occurs
- Factors Affecting the Representative Nature of Ground-Water Samples
  - Sampling Point Placement, Design, Installation, Development and Maintenance
  - Formation and Well Hydraulics
    - Between Sampling Events

For More Information Please Contact - Frank Magdich – Oak Environmental –
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    - During Sampling Events
  - Chemistry of the Water Column Above and Within the Well Screen
  - Well Purging and Sampling Methods and Associated Issues
    - Agitation and Aeration of the Water Column in the Well
    - Overpumping
    - Sampling-Related Pressure and Temperature Changes
    - Exposure of the Sample to Atmospheric Conditions

- *David M. Nielsen*

10:45 a.m. – 11:00 a.m. Break

11:00 a.m. – 12:15 p.m.
Selection and Operation of Ground-Water Purging and Sampling Devices

- Purging and Sampling Device Selection Criteria
- Impacts of Sampling Devices on Sample Chemistry
- Dedicated vs. Designated vs. Portable Sampling Equipment
- Overview of Available Sampling Devices - Operational Characteristics and Limitations
  - Types of Devices Available
    - Grab Samplers
    - Peristaltic and Suction-Lift Pumps
    - Electric Submersible Pumps
    - Positive Displacement Pumps
    - Inertial-Lift (Tubing/Check Valve) Pumps

- David M. Nielsen

12:15 p.m. – 1:30 p.m. Lunch Break (On Your Own)
1:30 p.m. – 2:40 p.m.
Conventional Purging and Sampling Methodologies

- Objectives of Purging
- Comparison of Traditional Strategies for Purging High-Yield Wells
  - Well-Volume Purging
  - Purging to Field Indicator Parameter Stabilization
  - Using Packers to Isolate Parts of the Water Column
- Problems with Traditional Purging Methods
- Placement of the Purging Device Within the Water Column
- Approaches to Purging Low-Yield Wells
  - Purging to Dryness, Sampling During or After Recovery
    - Physical and Chemical Effects of Purging the Well Dry
  - Alternative Strategies for Low-Yield Wells

- David M. Nielsen

2:40 p.m. – 2:55 p.m. Break

2:55 p.m. – 4:05 p.m.
Low-Flow Purging & Sampling and No-Purge Sampling

- Low-Flow Purging and Sampling
  - Fundamental Concepts of Low-Flow Purging and Sampling – What It Is; How It Works
  - Requirements for Equipment and Flow Rates
  - Well Hydraulics During Low-Flow Purging & Sampling
  - Procedures Used for Low-Flow Purging and Sampling
    - Measuring Drawdown to Stabilization
    - Measuring Field Indicator Parameters to Stabilization
  - Dedicated vs. Portable Sampling Equipment
  - Advantages and Limitations of Low-Flow Purging & Sampling
- No-Purge Sampling
  - Fundamental Concepts of No-Purge Sampling – What It Is; How It Works
  - Equipment and Procedures Used for No-Purge Sampling
  - Advantages and Limitations of No-Purge Sampling

- David M. Nielsen

4:05 p.m. – 4:20 p.m. Break

4:20 p.m. – 5:30 p.m.
Field Parameter Measurement
- Parameters Traditionally Measured and Why They May Not Be Meaningful
  - Temperature, pH, Conductivity
- More Meaningful Parameters
  - Specific Conductance, Dissolved Oxygen, Redox Potential
- Significance and Use of Turbidity as a Field Parameter
- Instrumentation Options for Field Parameter Measurement
  - In-Situ, Flow Cells, Ex-Situ
- Calibration of Field Parameter Analysis Instrumentation
- Common Errors in Field Parameter Measurement

- Gillian L. Nielsen

5:30 p.m. – Course Adjourns for the Day

Day 5 – Friday June 20th, 2014

8:00 a.m. – 9:10 a.m.
Field Filtration and Preservation of Ground-Water Samples
  - Field Filtration of Ground-Water Samples
  - Objectives and Purposes of Sample Filtration
- Naturally-Occurring vs. Artifactual Particulate Matter in Wells
- Overview of Sample Filtration Methods
    - Vacuum Filtration
    - Pressure Filtration
    - In-Line Filtration
  - Which Parameters Should Be Filtered and Which Should Not
  - Filter Preconditioning – Objectives and Procedures
- Field Preservation of Ground-Water Samples
  - Objectives and Purposes of Sample Preservation

For More Information Please Contact - Frank Magdich – Oak Environmental –
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- Physical vs. Chemical Sample Preservation Techniques
  - Advantages and Limitations of Each

- Gillian L. Nielsen

9:10 a.m. – 9:30 a.m. Break and Travel to the Field Site

9:30 a.m. – 12:30 p.m.
Field Session 2 - Ground-Water Sampling (2 Stations of 90 Minutes Each)

Station 1: Conventional Sampling Practices and No-Purge Sampling

- **Overview of the Health & Safety and Housekeeping Aspects of Ground-Water Sampling**
  - **Inspection of the Well to be Sampled**
  - **Preparation of the Work Area**
  - **Wellhead Screening**
  - **Field QA/QC**
- **Conventional Well-Volume Purging and Sampling**
  - **Water-Level and Well-Depth Measurements**
  - **Determining Purge Volumes**
  - **Portable Pumping System**
  - **Implementation of Well-Volume Purging and Sampling**
  - **Sample Collection and Handling**
  - **Field Filtration of Samples**
  - **Field Preservation of Samples**
  - **Preparation of Samples for Shipping**
- **No-Purge Sampling Using the Passive Diffusion Bag Sampler (PDBS)**

- Gillian L. Nielsen

Station 2: Low-Flow Purging and Sampling and No-Purge Sampling

- **Equipment Setup for Low-Flow Purging – Description and Operation**
  - **Portable vs. Dedicated Pumping Systems**
  - **Water-Level Measurement Devices**
  - **Flow-Through Cells for Field Parameter Measurement**
- **Determining Drawdown at Various Flow Rates**
  - **Initial Water-Level Measurement**
  - **Measuring Water Levels During Pumping**
  - **Determining Water Level Stabilization**
- **Determining Stabilization of Water Chemistry**
  - **Pump Operation – Maintaining Flow Rates**
  - **Field Parameter Measurement to Stabilization**
- **Collecting Water Samples Following Field Parameter Stabilization**
  - **Sampling for VOCs with Zero Headspace**
- **No-Purge Sampling Using the HydraSleeve**

- David M. Nielsen

12:30 p.m. – 1:45 p.m. Lunch Break and Return to the Classroom

1:45 p.m. – 2:30 p.m.
Discussion of the Morning's Field Session and Practical Problems
- *Gillian L. Nielsen*

2:30 p.m. – 3:40 p.m.
Sample Handling and Shipment
- Preparation of Samples for Shipment to the Lab
- Sample Shipment Options and Considerations
- Compliance with IATA Shipping Regulations
- *Gillian L. Nielsen*

3:40 p.m. – 3:50 p.m. Break

3:50 p.m. – 5:00 p.m.
Sampling Event Documentation
- Written vs. Electronic vs. Audio-Visual Recording of Field Activities
- Do's and Don'ts When Documenting Field Observations & Measurements
- How to Make Sure Your Field Records Are Admissible in Court
- Sample Security and Chain of Custody
- *Gillian L. Nielsen*

5:00 p.m. - Course Summary, Course Adjourns.