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11.0 Surveying Safety: Geophysical, Geochemical and Line Cutting

Introduction

Many detailed ground geophysical or geochemical surveys are contracted out to specialists, often with a mineral exploration company geologist onsite to monitor the contractor's work. An exploration company should check the contractor's safety record, including their safety program, incident statistics, and Workers' Compensation Board certification or compliance history before committing to a contract. The contract should contain clauses outlining health and safety principles and practices to an acceptable level. It is also prudent to check their insurance coverage. The exploration company must give reasonable information to the contractor regarding site hazards and environmental issues, which may require a site visit by the contractor before work commences. The contractor should provide a supervisor who is responsible for compliance with the authorities having jurisdiction (AHJs) such as occupational health and safety (OHS) legislation and Mines Acts and Regulations. Ideally, the contractor should be familiar with the area, especially if exploration work is undertaken in a new area or country. Otherwise, more review detail than normal is required for local health, safety and environmental conditions.

The type of work involving chainsaws and cutting grid lines is often given to employees or contractors who are local to the project – for example, Aboriginal people. Such employees or contractors may be familiar with chainsaws but not in the industrial setting and not with strict health and safety considerations. Companies and project managers need to develop education systems to educate such local employees on safe practices rather than assuming that, because they have used chainsaws in their everyday life, they do so safely. Given the high level of comfort of such people with the bush or field environment, appreciation of their bush skills, as well as safety requirements of the workplace, need to be handled with sensitivity.

11.1 General Risks and Hazards Associated with All Surveys

Most of the risks and hazards encountered while surveying are associated with the local terrain, weather and climate, the means of transportation used to access the survey area, and the degree of remoteness where the survey takes place. These risks and hazards are covered in the relevant chapters of the PDAC Health and Safety Toolkit, particularly in Chapter 6 Safe Traversing Practices. Cross references are cited throughout this chapter when referring to general risks and hazards. The risks and hazards specific to geophysical and geochemical surveys or line cutting are addressed in the appropriate section of this chapter.

Depending on the type of survey, individuals may need to be physically capable of carrying heavy loads, as some geophysical survey equipment is very heavy, as is the cumulative weight of geochemical samples collected during a day's work. Slips, trip, falls and back strains are common injuries and may be associated with specific terrain (refer to Chapter 6, section 6.4 Traversing in Specific Terrain). The most serious injuries are usually caused by transportation related accidents so it is important to follow the safety guidelines in the relevant transportation chapters. Also, heavy loads should be lifted and carried in a safe manner to avoid back injuries.

11.1.1 Essential Safety Guidelines for All Surveys

Employees who conduct surveys should be trained to perform their work safely. New or inexperienced employees should be teamed with experienced employees who are familiar with the terrain, climate and equipment. Before experienced personnel begin work in unfamiliar terrain

or a new region, they should receive training to become familiar with risks and hazards of the terrain, climate and location.

Contractors should provide trained survey crews with written safe operating procedures (SOPs) that address the specific hazards of survey work. Refer to chapter 6, section 6.3.1, Development of Safe Operating Procedures, for detailed information regarding safety procedures that should be in place. Some practices should be carried out each day before a crew starts work. SOPs should cover, but not be limited to, the following topics:

1. **Training:** Survey employees should be trained for the work they carry out and be familiar with the manufacturer's safe operating procedures (SOPs) and guidelines in the instruction manuals that accompany the survey equipment and tools they use.
2. **Tracking system:** Develop a tracking system to record where employees are working each day. Record the planned survey routes or work sites on a centrally located map or white board at the camp or base. Location updates including changes in plans should be called in and recorded.
3. **Communications:** Develop a communication call-in system to maintain contact with employees. Employees should carry functioning communications equipment appropriate for the area. For additional information, refer to Chapter 19 Communications.
4. **Emergency response plans (ERPs):** Survey crews should develop ERPs that address site specific risks and hazards and potential injuries associated with specific surveys, terrain and the degree of remoteness. When a contractor's employees are based at a project site, the ERP for survey crews should be integrated with the exploration project ERPs. For additional information, refer to Chapter 3, Emergency Response.
5. **Tool and equipment check:** Before departing for work, each survey crew should check their equipment. They should have: (a) all tools, fully charged communication and navigation equipment with spare batteries; (b) required personal protective equipment (PPE) including bear spray, as appropriate; (c) suitable clothing for the weather and potential changes; and (d) appropriate survival kits and first aid kits. If conditions are dry, carry fire suppressant materials when using tools or survey equipment that could start a fire (e.g., chainsaw, small generator or electrical equipment).
6. **Transportation:** Crews should perform an inspection check of their mode of transportation to make sure it is in good working order and all equipment is present. Refer to the appropriate inspection and equipment sections in chapters 13 Vehicles; 14 All-Terrain Vehicles; 15 Snowmobiles; and 17 Boats, Canoes and Inflatables. When using air support, refer to chapter 16 Aircraft and follow the SOPs regarding aircraft, the pilot's orders, and hold special briefings as required.
7. **Supervision:** Workers should receive appropriate supervision in the field while performing surveys.
8. **Working alone:** Follow the regulations of the authorities having jurisdiction (AHJs) to protect the health and safety of workers. Develop and implement the required SOPs if it is necessary for employees to work alone. Refer to section 2.1.1 Working Alone vs. the "Buddy System".

11.1.2 General Safety Tips

- **Weather related risks:** Be fully prepared for the local weather and climate. Carry a suitable survival kit, extra water and food, etc. Wear appropriate clothing and carry rain gear and extra clothing in case you become stranded and must spend a night away from camp. Lightning can be a serious risk depending on the location and especially when carrying out electrical surveys. Be prepared and follow lightning safety precautions

including the 30-30 rule (see below, bullet point number 5, in section 11.2.2). For additional information, refer to Chapter 8, Survival, and sections 9.2 Lightning, 9.9.3 Hypothermia, and 9.10.3 Hyperthermia.

- **Personal protective equipment (PPE):** Required PPE will vary depending on the risks and hazards of each type of survey and the terrain. Safety glasses should be required for most surveys. It is usually advisable to wear high visibility vests. Hearing protection may be required (e.g., when using a chainsaw). Wear gloves to protect hands from cuts and infections. Refer to section 4.2 Hazard Control and Personal Protective Equipment.
- **Footwear:** Wear leather boots that provide good ankle support and traction appropriate for the terrain. It is advisable to wear waterproof boots when working in extremely wet areas and heavy, insulating boots during very cold weather. As stable footing is very important, appropriate high quality boots may be considered PPE by some companies. Refer to section 6.3.5 Clothing for information regarding footwear.
- **Footing and balance:** Carrying heavy equipment or samples hinders good balance. Be vigilant when traversing cut lines and/or climbing over logs or debris. Because some surveys are carried out along straight lines, it may not be possible to avoid difficult and sometimes dangerous terrain (e.g., cliffs, swamps). While trees and brush are usually cut down to ground level, stubs or “pungies” may remain if the ground was snow-covered when the lines were cut. It is easy to trip over them and get cut or impaled, especially when carrying a heavy pack or surveying equipment.
- **Snow and ice:** Follow all appropriate precautions when working on snow and ice. Refer to section 6.4 Traversing in Specific Terrain and Chapter 15 Snowmobiles for information regarding appropriate safety equipment and routines. Section 15.11 contains important information about self rescue after falling through ice.
- **Be critically aware of fire risks.** Carry appropriate fire extinguishing equipment, including: a fire extinguisher, extinguishing powder, water and/or a small shovel when using gasoline powered machinery (e.g., chainsaws, generators, brush cutters, power augers). Keep the exhaust area clear of vegetation and place hot machinery on bare rock so it will not start a fire. Always observe fire bans.
- **Wildlife and insects:** Where bears are a hazard, be trained in bear safety procedures and carry appropriate deterrents including bear pepper spray. Be aware of potential fauna at ground level. Watch out for signs of bees or wasps which often build nests in the ground. Do not place your hands where they might be bitten by a venomous snake or stung by scorpions or insects. When working in insect infested areas and using insect repellent, avoid applying it to your eyes and mouth. Do not overuse repellent as it is absorbed through the skin. Be vigilant when wearing head nets as they restrict your range of vision. Follow medical advice regarding the use of anti-malarial medications and avoid mosquito bites when working where malaria and other serious insect-borne diseases are present. For detailed information, refer to the relevant sections in Chapter 10 Wildlife, section 12.8.4 Protection from Insect Bites, and information regarding relevant diseases in sections 12.8.5 and 18.6.5.
- **Audio entertainment equipment:** In general, it is not good practice to allow employees to wear personal electronic music devices with headphones or earplugs (including iPods) when working. Headphones or earplugs interfere with the ability to clearly hear directions via radio communication, noise due to machine malfunctions and dangerous wildlife, etc.
- **Survey completion:** When a survey is completed remove all equipment, including wires. Fill in holes if they present a future tripping hazard to workers or to animals.

11.2 Geophysical Survey Safety

Exploration programs often involve airborne and/or ground geophysical surveys to assess economic potential or define the features of ore deposits. When geophysical surveys are conducted with fixed wing aircraft or helicopter support, employees should follow the SOPs and guidelines in Chapter 16 Aircraft.

These guidelines cannot address safety issues for airborne geophysical surveys in any detail. In general, safety regarding airborne surveys relies on the safe practices of charter airlines and pilots. It is important for survey employees to communicate their survey requirements and never push pilots to fly when conditions are not safe. Employees or equipment operators should always speak up if they have a question regarding safety or a procedure that potentially affects safety.

The companies involved in airborne geophysics have developed their own safety guidelines. They are available on the International Airborne Geophysics Safety Association (IAGSA) website at: http://www.iagsa.ca/Contract_Annex990325.pdf

Occasionally borehole geophysical surveys are carried out in conjunction with drill programs. When these surveys are performed, employees should also follow the relevant guidelines found in Chapter 20 Drilling Sites.

Section 11.2 of this chapter primarily covers safety information specifically related to ground geophysical surveys. All geophysical survey crews should be familiar with the general guidelines in sections 11.1.1 and 11.1.2 and relevant information in Chapter 6 Safe Traversing Practices.

11.2.1 Specific Risks and Hazards Associated with Geophysical Surveys

- Slips, trips and falls caused by rough terrain, slippery surfaces, balance problems from carrying heavy equipment or backpacks
- Electric shock caused by poor communication with the operator, not following SOPs, wet ground, lightning storms
- Injuries or death caused by accidents when travelling by vehicles, ATVs, snowmobiles, boats or aircraft
- Impact injuries and cuts caused by the misuse of tools such as mattocks, shovels, mechanical augers, post hole drills
- Back strains and injuries caused by carrying heavy survey equipment, carrying heavy backpacks, improper lifting techniques
- Fires caused by short circuits in electrical wires or equipment such as generators, explosives, improper fuelling procedures or spills, carrying insufficient fire extinguishing materials
- Hypothermia caused by working in cold weather conditions, effects of wind chill, wearing inadequate clothing, dehydration, exhaustion
- Water-related risks include drowning and cold water immersion hypothermia caused by falling into water during dangerous stream crossings, breaking through ice
- Health risks from diseases and infections caused by contact with contaminated water or soils containing parasites, viruses and bacteria

11.2.2 Field Safety Tips for Geophysical Surveys

Electrical Surveys Methods

The most hazardous geophysical surveys are those that employ electric current, which includes induced polarization (IP) surveys and electromagnetic (EM) surveys. The set up for both is similar, as long lengths of wire are laid down in a designated area and readings are taken when the wire is pulsed with electricity from a generator.

IP surveys have potentially more serious risk of injury than other geophysical surveys due to the use of high voltage electric current. Surface electromagnetic (EM) surveys, also known as ground pulse electromagnetic or fixed loop EM surveys, use lower voltages and therefore do not usually present the same degree of risk of electrocution to the operators. Even so, all employees who participate in surveys using electricity should receive thorough training in the safe use of survey equipment. It is imperative that all employees who operate transmitters are fully aware of the hazards associated with the use of high voltage equipment.

Companies that conduct electrical surveys should develop and implement specific SOPs in addition to the general guidelines recommended in section 11.1.1.

The following guidelines apply to both IP and EM surveys:

1. Emergency response plans (ERPs)

- All field personnel should be familiar with first aid for electrical burns and how to respond to a co-worker who may be electrocuted.
- Take appropriate fire precautions as the equipment used in electrical surveys can cause a fire if the equipment malfunctions or overheats. Wires may become hot due to poor contact with electrodes or if they become detached and lie in direct contact with the ground. Fire extinguishing equipment must be present where a transmitter uses a motor generator.

2. Safety procedures for survey layouts

- If working in a populated area, post the survey site, date and time at central locations to notify the public (e.g., post office, community centre, grocery store). Hire “sentries”, as required, to supervise all electrical equipment, especially exposed wires and electrodes. Curious children and people are highly vulnerable to serious injury.
- Place “High Voltage” signs on any unsupervised geophysical electrode sites that carry high voltage or currents exceeding the milli-ampere range. Place signs in populated areas where electrodes are out of sight and use sentries, as needed.
- When pulling electrical wires and cables across terrain, it is advisable to pull it by hand or use a snowmobile or 4-wheel ATV (rather than a motor bike). Before pulling, carefully check the wire or cable to be sure it has no kinks or knots and very few splices, as these may catch on roots etc. Do not drag wire. If the cable breaks while being pulled, it will stretch first and then whip back at the driver when it breaks.
- Place wire where it will not harm people or animals. Place it on the ground with sufficient slack so it stays on the ground. Make sure wires are placed so domestic animals will not be harmed.
- It is advisable to bury cables and wires where they cross trails or paths, especially if they are heavily travelled routes. Bury them out of sight and anchor

them solidly on either side of the route. When crossing a paved road, secure wire to the asphalt with fencing staples or other secure means in at least three places. If burying is not possible, it is imperative that wires or cables are solidly anchored on each side of the trail, path or road. In all situations, wire should be secured and flagged on both sides of a trail, path or road for 6 metres with flags placed every 0.5 metres. In addition, the wire should be marked with flagging where it crosses roads or paths to provide additional visibility in case it still rises up. If an animal, person or vehicle contacts and lifts or drags the cable or wire, it will tighten and rise up across a road or path unless it is solidly anchored. A raised wire can seriously injure or even decapitate someone passing on bicycle, snow machine, ATV etc.

- Contractors should maintain a record of the amount and location of the wire deployed and removed. When a survey is completed, inspect the wire insulation for breaks and damage when picking up wire. Repair damage or replace the wire as necessary. Using damaged wires increases the likelihood of someone receiving an electric shock.

3. Safety procedures for handling wires that may carry electric current

- Do not hold the ends of a transmission wire in each hand, as your body will complete a circuit if the current is turned on.
- Do not touch any exposed metal of any potentially energized transmission wire.
- Follow correct safe methods when making temporary field splices.
- Beware of wet wires. It is possible to receive an electric shock if there are breaks in the wire's plastic casing where the wire passes through a puddle of water.

4. Radio communication protocol

Develop a very clear radio protocol to indicate "power on" and "power off" to avoid shock and the potential electrocution of a worker handling the wires. The generator operator must never apply electrical current to grounded wires or ungrounded loops of wire unless he or she notifies the rest of the crew *and* receives confirmation that they know the system will be energized. "Confirmation" means a clear, positive verbal response usually sent over a radio. An arm wave and/or two clicks of the radio microphone do not qualify as confirmation, as they are both signals that can be easily misunderstood.

5. Lightning safety

Take extreme precautions whenever a lightning storm approaches. Refer to section 9.2 Lightning in chapter 9 of the health and safety toolkit for detailed information and references about lightning safety. Survey crews need to be aware of the weather around them while working. When a storm approaches:

- Immediately cease all operations. When thunder is first heard, shut off all power sources and disconnect all wires and cables from the instruments. Do not attempt to collect any wires or cables. Lightning can travel more than a kilometre along wires. Lengths of wire or large loops may have very high voltages induced by a lightning strike a long distance away; this is not only dangerous, it can also destroy equipment.
- Move all personnel and easily portable instruments to a sheltered location, preferably a safe shelter or a field vehicle. If it is necessary to remain outdoors, do not seek shelter under a tall tree. If working on high ground, attempt to move to a lower elevation. Avoid areas of tall metallic objects (e.g., power lines, antennas, drill rigs).

- Follow the “30-30 Rule” when thunderstorms are moving into the area. If you see lightning, count the time until you hear thunder. If the time is 30 seconds or less, you should immediately go to a safer place. After the thunderstorm has moved away, wait 30 minutes before leaving the safe location and resuming work. Information about this important rule is available on the following websites:

<http://archive.safety-council.org/info/community/lightning.html>
http://www.crh.noaa.gov/pub/tg/crh_boltblue.php

6. Additional safety tips for electrical survey methods

- Be sure the transmitter power is off except when actual measurements are being made. Always verify that the power is off before you remove or connect electrodes, change personnel on a task, or attempt any field repairs. Do not move a generator while it is turned on.
- Inspect the transmitter and generator for damage and loose components each day before work. If IP or loop wire must remain in place beyond the time required for the survey, they should be monitored regularly to make sure they remain in a safe position on the ground. Where IP wires or loops are not safe, corrective action should be carried out immediately. Keep records of any inspections of the IP wires or loops noting their condition, the condition of posted signs and other safety concerns.
- Watch your footing and take care when lifting geophysical equipment because it is often very heavy. Use correct lifting procedures found in section 4.3 of chapter 4, Lifting and Back Protection.
- In addition to regular PPE, it may be advisable to wear nonconductive electric shock resistant boots. Avoid wearing steel toed boots, as they are more conductive than regular leather boots.

Ground Magnetic Surveys

Although most magnetic surveys can be done by one person, it is not advisable for surveyors to work completely alone. It is much better to work in pairs along parallel lines within shouting distance of each other in case problems develop.

- To avoid falls that may result in serious injury or damage to equipment, try to make the magnetometer as streamlined as possible (e.g., taping cables). By preventing tangles, the equipment is less likely to get hung up on vegetation during survey traverses.
- The check-in schedule should take into account the fact that the radio will probably be turned off to diminish noise. It is advisable to develop and adhere to a suitable check-in schedule with either an end-of-line or a designated time for the check-in.
- To counteract noise, carry metal objects in exactly the same place every day (e.g., keep the can of bear spray on your right hip and the pen in your left pocket). While surveyors try to carry as little metal as possible, it is still essential to carry PPE. If working in bear country – do not leave your bear deterrents behind.



Figure 11.1: Ground magnetic survey traverse © Erika Tamboline

Gravity Surveys

Survey crews with several people carry out this type of survey. As precise determinations of all coordinates including elevation are essential, two surveys are usually done at the same time – the precise surveyed location as well as the gravity measurement.

- Follow company and site specific SOPs for the type of terrain and transportation used.
- Pay attention to fire prevention if a car battery or a small generator is used for a power source at the GPS base station.

Seismic Surveys

Employees who carry out seismic surveys should be competent and fully trained. If explosives are used, obtain appropriate permits and make sure blasters have proper certification.

- Handle and store explosives according to requirements of the authorities having jurisdiction (AHJs). Transport explosives according to dangerous goods requirements. Refer to section 21.6 Explosives for additional information, located in chapter 21.
- Most shallow holes used to contain explosives are dug by hand so employees should be trained to use their tools safely and keep them in good working order.
- Wear appropriate PPE when using tools and equipment, which may include ear protection from noise as well as eye protection, good footwear and high visibility vests.
- Develop a protocol to make sure the area is clear before a blast takes place.
- If seismic surveys use truck mounted drill rigs, refer to Chapter 20 Drilling Sites for specific information regarding safe drilling guidelines.

Ground Penetrating Radar Surveys

Ground penetrating radar is useful for locating underground power lines, pipelines and cables. Follow traversing SOPs and general safety guidelines. No specific risks are involved with techniques or equipment used in these surveys.

11.3 Geochemical Survey Safety

Geochemical surveys usually involve collecting samples at regular intervals either along streams or in a grid pattern on land. Although each sample may be small, the accumulated weight and volume can result in an employee carrying a very heavy backpack. Learn as much as possible from knowledgeable local people about specific risks and hazards so crews are prepared, especially for stream sediment surveys.

Specific Risks and Hazards Associated with Geochemical Surveys

- Back strains and injuries caused by lifting heavy samples, heavy backpacks, using improper lifting techniques
- Slips trips and falls caused by rough ground, wet and/or slippery surfaces, wearing footwear with poor traction, balance problems from carrying heavy equipment or backpacks
- Hypothermia caused by working in cold wet weather, effects of wind chill, wearing inadequate clothing, dehydration, exhaustion
- Impact injuries caused by the misuse of tools such as mattocks, shovels, mechanical augers, post hole drills
- Health risks include diseases and infections caused by contact with contaminated water or soils containing parasites, viruses, and bacteria
- Water-related risks include drowning and cold water immersion hypothermia, which may be caused by falling into water while sampling, attempting dangerous stream crossings, when working from boats, when water is a greater depth than anticipated
- Injuries or death caused by accidents when travelling by vehicles, ATVs, snowmobiles, boats or aircraft

11.3.1 General Prevention and Preparation

All geochemical survey crews should be familiar with the relevant safety routines, guidelines and tips found in sections 11.1.1 and 11.1.2 and in Chapter 6 Safe Traversing Practices.

- **Back care:** Collecting silt and mineral samples is strenuous work. Use correct lifting procedures and properly constructed backpacks. Carry loads that are appropriate for your personal strength and physical size; do not overload your backpack or show off. Get help if you need it. Refer to chapter 4, section 4.3 Lifting and Back Protection.
- **Footing:** It is easy to lose your balance when wearing a heavy pack. To prevent slips, trips and falls, watch your footing at all times, especially late in the day when you are tired. Boots should have high grip soles for work on slippery surfaces (e.g., rounded or algae covered rocks). In some wet terrain it may be advisable to wear rubber boots or use caulks (replaceable steel spikes screwed into the soles of special boots).
- **Tools:** Use mattocks, shovels, picks, etc., correctly. Use caution when traversing so you do not fall on them.

- **Wear gloves to protect your hands.** Geochemical sampling may expose your hands to soils with disease causing organisms and it is easy for cuts to become infected. Soil-borne diseases include but are not limited to: hookworm, tetanus, histoplasmosis, and numerous fungal diseases. Make sure tetanus immunizations are up-to-date.
- **Animals and insects:** Be aware of potential fauna at ground level. Watch out for signs of bees or wasps, which often build nests in the ground. Do not place your hands where they might be bitten by a venomous snake or stung by scorpions or insects. Digging up samples may disturb them. In bear country, be equipped with bear deterrents and pay attention to your surroundings. Sampling is quiet work so make sufficient noise to avoid startling a bear. Wear bright rather than dark clothing to avoid being mistaken for animal prey, as you appear smaller when sampling low to the ground. Refer to the relevant sections of Chapter 10 Wildlife.
- **Transportation risks:** Follow general and site specific SOPs that address the appropriate transportation risks. Refer to the guidelines sections in the relevant chapters.



Figure 11.2: Geochemical samples are often small. Wear gloves to protect your skin. © Erika Tamboline

11.3.2 Stream Sediment Surveys

Working near streams can be extremely dangerous. Fast flowing currents can sweep a person away if they fall in or lose their footing. Stream sediment surveys may require sample collection and/or panning the heavy minerals to form concentrates. These surveys often require the worker to collect samples while standing in water. Sampling may take place in various fluvial environments – fast flowing water, glacial outflow streams, or wide braided streams or rivers with gravel bars, slow meandering streams etc. Access may require helicopters, rafts, walking through

mud or swamps, or negotiating slippery boulders and/or steep outcrops. Lichen covered rocks and logs are particularly hazardous. Water may be colder and deeper than anticipated.

Cross references: Everyone conducting stream sediment surveys should be familiar with the relevant information in the following chapters and sections of the *e3 Plus* health and safety toolkit:

- Chapter 6 Safe Traversing Practices, especially section 6.4.5 Traversing Safety Regarding Streams, Rivers and Lakes
- Chapter 9, section 9.9.3 Hypothermia
- Chapter 10 Wildlife
- Chapter 17 Boats, Canoes and Inflatables, especially section 17.12.3 Cold Water Immersion Hypothermia

Specific Risks and Hazards Associated with Stream Sediment Sampling

- Drowning or cold water immersion hypothermia caused by falling into water from stream banks, boats, attempting a dangerous stream crossing, not wearing a PFD
- Slips, trips and falls caused by wet, slippery or rough ground, wearing inadequate footwear
- Stranding caused by impassable streams or weather, transportation fails to return
- Health risks include diseases and infections caused by contact with contaminated water containing parasites, viruses, and bacteria
- Foot disorders caused by standing in water for long periods of time

Preventions and Precautions

There are additional risks and hazards associated with stream sediment surveys and panning sampling methods.

- **Working alone:** When following a grid line, sediment sampling can be done alone although it is much safer practice to work with a partner. Rather than each worker sampling a separate grid line alone, it is preferable to work in pairs and “leap frog” past each other by collecting the sample at every other site. This way, workers are in constant contact. If this cannot be done, employees working on parallel grid lines should be in regular and frequent radio contact if they are not actually in sight of each other. Site specific SOPs should be implemented regarding working alone.
- **Hypothermia:** Standing in water for long periods of time can increase the chances of developing immersion foot or hypothermia during cool weather.
 - Dress to stay warm and dry.
 - All employees who risk falling into cold water should receive training and understand the importance of: (1) *wearing* a personal flotation device (PFD), (2) how to work at self rescue, and (3) how to treat a hypothermia victim.
- **Hyperthermia:** When working in very warm climates, try to work in shade, use sunscreen and keep hydrated. Create your own shade, if necessary. Take special care of your feet to prevent fungal diseases, which are common when feet are wet for long periods of time.
- **Transportation:** Some surveys may require access by helicopter or boat.

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- Aircraft: Choose drop off locations carefully when using helicopter support. The water may be deeper, swifter, and/or colder than anticipated. A helicopter should never depart before the survey crew members are safely on shore when the landing site is a bar or an island. Check for the presence of bears before landing, if appropriate. Carry survival equipment in case the transportation cannot return as planned. Follow SOPs and guidelines in chapter 16 Aircraft.
- Boats: Use appropriate sized boats for the task when working on rivers and streams, lakes or oceans. Follow safe boating procedures and guidelines.
 - Wear a life jacket or personal flotation device (PFD) when working on water. Due to “cold shock”, wearing a PFD is your most important means of defence against drowning and cold water immersion hypothermia.
 - Line (haul) boats, canoes and rafts through rapids.
 - Be especially careful to avoid sweepers (trees fallen into a river). If a raft flips against a sweeper, it is almost impossible to rescue the occupants if they are thrown into the water.
- **Stream crossings: Plan surveys to avoid crossing streams**, especially where flowing water is deeper than mid-calf.
 - If stream crossings are absolutely necessary, plan them carefully. Carry and use appropriate safety equipment (e.g., rope, PFD). Fast flowing water as deep as the knees can easily sweep people away if they fall in or slip. Be familiar with safe methods to cross streams and wear a PFD if there is a chance of falling in.
 - Wear a PFD or use a safety belt and line even when working near fast flowing waters or where banks are steep or slippery.
 - Stranding: It is possible to become stranded if stream waters rise suddenly. Carry sufficient survival gear in case it is necessary to spend a night away from camp. It is better to remain out overnight than risk a dangerous stream crossing.
 - If flash floods are a hazard, seek local knowledge and heed weather forecasts regarding flood warnings. By studying topographic maps it may be possible to determine potential emergency exit routes from narrow gorges. Refer to chapter 9, section 9.5 Floods, for additional information and appropriate precautions.
 - If sampling in agricultural areas where fences frequently cross streams, especially near roads, never climb the fence to cross the stream. It is surprisingly easy to end up tangled upside down with your head submerged with a resulting high risk of drowning.
 - Swampy meandering streams are difficult to work in. Carry a stout stick and extra socks.
 - In some places it is advisable to check with knowledgeable local sources regarding the possible presence of quicksand.
- **Health risks:** Depending on location, the water you must work in may carry diseases – whether they are streams, rivers, lakes, ponds, tailings ponds, or surface runoff from storms, etc.
 - Waterborne diseases include but are not limited to: giardiasis, schistosomiasis, cholera, hookworm, typhoid, leptospirosis and various forms of dysentery. Wear rubber gloves and avoid touching your face and mouth.
 - Insect-borne diseases include: West Nile virus, malaria, dengue fever and yellow fever. In addition there are diseases carried by ticks and various flies (tsetse flies, sand flies).

- Foot disorders: Usually, feet will be wet for long periods of time. Depending on the climate, feet may be subject to immersion foot if they are continuously cold and wet or fungal diseases if they are continuously warm and wet. Wear appropriate boots and change socks frequently. Make sure your feet are dry and warm at night. Follow good foot hygiene to prevent “foot rot”. Refer to chapter 9, section 9.9.6 Immersion Foot.
- Tailings ponds may contain toxic chemicals that can cause illnesses.
- Refer to chapter 12, section 12.8.5 and chapter 18, section 18.6.5 for information regarding specific diseases.
- **Animal and insect risks:**
 - Reptiles: Know what snakes live in the region and the relative risks from them. Most are harmless and should not be destroyed due to personal fears. Learn about their habitat, where, and when to expect them. Most snakes swim when necessary and water is the preferred habitat of some snakes (e.g., water moccasins, water cobras, anacondas). Some present more risk than others, especially if the species is aggressive or temperamental (water moccasins, anacondas). Crocodiles: Follow safe guidelines where crocodiles pose a danger to humans.
 - Insects: Increased numbers of mosquitoes are usually present near water. Some insects such as blackflies that transmit river blindness (onchocerciasis) may be found almost exclusively near water.
 - Leeches: Depending on the location, they may be a potential problem, as infections may develop where they have pierced the skin.
 - Refer to chapter 10 Wildlife for additional information.
- **Clothing and PPE:** Protect your body from cold water and infections.
 - Wear appropriate boots – rubber boots are a minimum. Depending on the water depth, it may be appropriate to wear hip waders, but be aware of the risks of wearing high waders and falling into swift flowing water. If they fill with air it may be impossible to right yourself, which increases the risk of drowning.
 - Gloves: Heavy waterproof rubber gloves are recommended. Check frequently for pinhole leaks and replace them immediately when they leak, especially if waterborne diseases are a risk.
 - Carry extra socks and/or dry inserts for boots when your feet are frequently immersed in water. Use inserts on alternate days so they dry out.
 - Waterproof clothing or rain gear: Carry good rain gear to help stay dry. Refer to section 6.3.5 Clothing in chapter 6 for tips regarding appropriate fabrics and clothing.

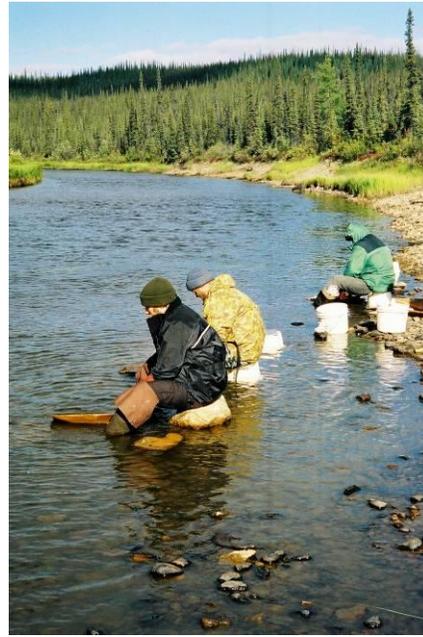


Figure 11.3: Stream sampling © Erika Tamboline

11.4 Line Cutting Safety

Cut line or picket grids are used for control for some geophysical and geochemical surveys. A cut line or picket grid is normally established from a base line with a series of cross lines spaced at specific intervals. Base lines may be surveyed in or laid out on a specific compass bearing. Cross lines are normally established perpendicular to the base line and tie lines are sometimes used to ensure greater accuracy of the grid. Lines are usually cut using axes or machetes and chainsaws. In areas with no forest, picket stakes can be used to mark a survey grid. Crews that cut lines should work as a team and not alone. As their work often requires felling large trees, it is imperative to watch out for the safety of co-workers. Workers should follow written safe operating procedures (SOPs) for falling and bucking, as required by the authorities having jurisdiction (AHJs).

The type of work involving chainsaws and cutting grid lines is often given to employees or contractors who are local to the project area – for example, Aboriginal people. Such employees or contractors may be familiar with chainsaws but not in the industrial setting and not with strict health and safety considerations. Companies and project managers need to develop education systems to educate such local employees on safe practices, rather than assume that because they have used chainsaws in their everyday life that they do so safely. Given the high level of comfort of local people with the bush or field environment, an appreciation of their bush skills, as well as safety requirements of the workplace, need to be handled with sensitivity.

Use of geophysical equipment with built in GPS (Global Positioning System) units are reducing the requirement for cut lines, especially for surveys that use magnetometers, etc. Soil geochemistry surveys require fewer cut lines when surveyors carry handheld GPS units. Where no cut lines are used, technical survey crews should exercise greater care when travelling across the ground. The preferred approach to geophysical and geochemical surveys is one that avoids line cutting, where possible. This is largely for environmental reasons. For the same reason, it is also preferable to minimize the width of cut lines and minimize felling of larger trees. The

objective should be to make the line sufficiently safe for the technical crew that will follow, but at the same time maximize the chance for the native vegetation to recover and reclaim the land.

Chapter 5 Field Equipment Safety contains information regarding the safe use of implements and equipment commonly used for field work. Please refer to section 5.6 Chainsaws in chapter 5 for details regarding chainsaw, tree felling, bucking and limbing safety. This information is placed in section 5.6 because working with chainsaws and tree felling is also done by company employees at project and camp sites.

Specific Risks and Hazards Associated with Line Cutting

Line cutting is frequently done during winter months which can increase risks and hazards. Risks and hazards include but are not limited to:

- Severe injuries or death due to:
 - Chainsaw accidents (often due to kickback), which may result in cuts, lacerations, or amputations
 - Being hit by falling trees or bucked sections of logs
 - Inability to correctly assess trees before cutting due to poor visibility (wind, fog, rain, snow)
- Slips, trips and falls due to:
 - Rough or unstable ground
 - Dangerous terrain such as cliffs, swamps, steep slopes
 - Ice and snow-covered ground
 - Inadequate footwear
 - Unstable body position while cutting trees or clearing brush
- Back strains and injuries due to working in awkward body positions while cutting
- Cuts, blisters, lacerations from using hand tools
- Transportation accidents due to:
 - Excessive speed while travelling by vehicles, ATVs, snowmobiles, or boats
 - Inadequate training for the mode of transportation
 - Using an inappropriate mode of transportation for the terrain or ground conditions
- Hypothermia, frostbite may develop due to exposure to cold temperatures, the effects of wind chill, dehydration, exhaustion, and/or wearing inadequate clothing, .
- Wildlife and insect risks include attacks from large animals such as bears and cougars, and bites and stings from snakes, insects, and scorpions etc.
- Water-related risks include drowning and cold water immersion hypothermia due to falling into water, attempting dangerous stream crossings, breaking through ice

Preventions and Preparations for Cutting Lines

Line cutting crews should be familiar with the relevant safety routines, guidelines and tips found in sections 11.1.1 and 11.1.2 and general safe field practices refer to Chapter 6 Safe Traversing Practices.

SURVEYING SAFETY

- Survey crews should follow essential pre-job tool and equipment checks before departing for work each day. Properly maintained tools help prevent accidents.
- Line cutters should not work alone. A “cutter” and a “brusher” are a team. They should travel to and from the work site together and should always be within visual and shouting distance of each other during line cutting operations.
- Training: Employees should be trained to use surveying, cutting, and clearing tools properly and maintain them in good condition. Use appropriate sheaths to store and transport axes, machetes, knives, brush hooks and other sharp tools. This can prevent injuries when the tools are carried by hand. Refer to Chapter 5 Field Equipment Safety regarding specific tools.
- PPE: Line cutters must wear additional PPE due to specific risks and hazards associated with chainsaws and felling trees.
 - In addition to safety glasses, line cutters should wear high visibility hard hats with ear defenders (ear muffs) and a face shield, high visibility vests, gloves, steel toed boots or caulked boots. Caulks (replaceable steel spikes screwed into the soles of special boots) offer much better traction than ordinary soles when working in wet forests or other slippery conditions. Caulk boots may be made of leather or rubber.
 - Chainsaw operators should wear chainsaw pants or chaps, which are designed to slow the cutting action of the blade should the chainsaw kickback or slip and hit the operator in the leg. They should cover as much of the leg as possible but not impede movement.
- Line cutting crews need to know the purpose for cutting the lines in order to use the proper survey standards. Some surveys have different clearance width requirements. For example: electrical survey methods require thorough clearing to avoid wire and equipment hang ups, while some lines may only need minimal clearing and blazes on trees to be acceptable.
- Location: Employees working on established cut lines or picket grids should understand the layout of the grid and its orientation to keep track of their location. If the grid is accessed by a trail, whether on foot, by ATV, snowmobile or other means, all persons working on the grid should know the grid coordinates where the access trail enters the grid so they can return to the access trail at the end of the day. Mark the access trail to the grid clearly with flagging tape, cairns or other means.
- Marking coordinates: Carefully mark both the base line and the tie line coordinates. Use the appropriate method to mark the survey coordinates of each station, which may be with pickets, tags, flagging tape and/or tree blazes. Prepare a plan map showing the grid and coordinates. It is not advisable to use fire to burn lines even though it may be common practice in some localities.
- Cut off saplings, trees and stumps at ground level to avoid creating stubs or “pungies” that become a tripping or impaling hazard. Trim overhead vegetation to reduce the hazard of protruding branches, which may cause eye injuries. Stubs can cause tire damage to equipment such as ATVs. At the same time, try to leave as much as possible of the root systems of the plants, as that way the recovery will be maximised.
- Brushers and other crew members must stay at least two tree lengths away during falling operations. The cutter must check the area and not begin cutting until everyone is out of range. Keep onlookers away from the cutting site and work areas.
- Firearms: Where bears are a hazard and it is deemed necessary to carry a firearm, the persons who have permission to carry and use firearms must have all required training

and certification. In Canada, only people who have a Possession and Acquisition Licence (PAL) *and* who are both competent *and* confident should have permission to use a firearm. Refer to chapter 10, section 10.3.9.3 and chapter 18, section 18.2.2 for additional information regarding the use of firearms.

Cutting Tracks or Grids with Heavy Equipment

Using heavy equipment to cut tracks is generally not advisable due to the potentially severe environmental impact caused by the equipment. If using heavy equipment is unavoidable:

- Discuss the safety aspects of working in difficult terrain with operators before work begins (e.g., slopes, cliffs, swamps).
- Only experienced and certified operators should operate heavy equipment.
- Keep workers on foot and keep light vehicles away from heavy equipment. Use barriers when possible. Workers on foot must not turn their back on moving heavy equipment when they are working in an area with no separation.
- Refer to chapter 21, section 21.3 Heavy Equipment for additional information regarding safe operating procedures and the use of heavy equipment.

Information about the safe use of chainsaws and safe working procedures for line cutting are available on the following websites:

http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/bc_faller_training_standard_1.pdf

http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/bc_faller_training_standard_2.pdf

http://www.ccohs.ca/oshanswers/safety_haz/chainsaws/sawoperations.html

http://www.ccohs.ca/oshanswers/safety_haz/chainsaws/handling.html

http://www.ccohs.ca/oshanswers/safety_haz/chainsaws/kickback.html

http://www.ccohs.ca/oshanswers/safety_haz/chainsaws/safeuse.html

11.5 Resources

The Prospectors & Developers Association of Canada (PDAC) thanks the following for granting permission to include material from their publications.

Association for Mineral Exploration British Columbia
Aurora Geosciences
SJ Geophysics Ltd.

Their permission does not imply that they endorse the PDAC Health and Safety Toolkit. The PDAC is solely responsible for the content of the Toolkit.

Books

Health and Safety Committee. (2006) *Safety Guidelines for Mineral Exploration in Western Canada*. Fourth edition. Association for Mineral Exploration British Columbia. Also available at: <http://www.amebc.ca/documents/resources-and-publications/publications/current/safety%20guidelines-web.pdf>. Accessed November 5, 2009.

Internet Resources

Canadian Association of Geophysical Contractors. *Drilling Alone*.
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Mineral Resources Tasmania. *Mineral Exploration Code of Practice – Exploration guidelines*.
http://www.mrt.tas.gov.au/pls/portal/docs/PAGE/MRT_INTERNET_PAGE_GROUP/MRT_PUBLICATIONS/MRT_EXPLORATION_CODE_OF_PRACTICE/CODE4B.PDF. Accessed November 5, 2009.

National Ocean and Atmospheric Administration. National Weather Service Weather Forecast Office. *“Bolt from the Blue”*. http://www.crh.noaa.gov/pub/ltg/crh_boltblue.php. Accessed November 5, 2009.

Prospectors & Developers Association of Canada. *e3 Plus: A Framework for Responsible Exploration. Excellence in Environmental Stewardship*. www.pdac.ca/e3plus. Accessed November 5, 2009.

Workplace Health, Safety and Compensation Commission of New Brunswick. (2006) *Working Safely in the Woods. Chicots*. http://www.worksafenb.ca/docs/ChicotsGuide_e.pdf. Accessed October 23, 2009.

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http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/bc_faller_training_standard_1.pdf. Accessed November 5, 2009.

WorkSafeBC and the BC Forest Safety Council. *BC Faller Training Standard Part 2 of 2*.
http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/bc_faller_training_standard_2.pdf. Accessed November 5, 2009.