

Navy Environmental Health Center



Standard Operating Procedures for Screening Risk Assessment on Potential Sources of Potable Water

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Purpose. This Standard Operating Procedure (SOP) focuses on determining the suitability of raw waters as potential sources for drinking water. In addition, it provides procedures for certifying the potability of drinking water sources. It is not intended to outline procedures for establishing a routine drinking water surveillance program, as these procedures are clearly defined in other publications and organic units more appropriately perform this function.

Screening Raw Water Sources. When choosing a potential raw-water source, quantity, quality, accessibility, security and proximity to supported units must be taken into account. Once engineering personnel have identified a potential water source, a sanitary survey of the proposed water point and surrounding area must be performed to detect evidence of contamination and/or identify potential sources of pollution. Sources of water contamination may include accidental or deliberate chemical or biological spills or industrial pollution and agricultural discharges. Appendix A lists examples of pollution sources and contaminants associated with them.

Surface Water Sources. Surface water sources (lakes, rivers, streams, etc.) are generally more vulnerable to pollution and chemical agent contamination than are groundwater sources (wells). For rivers and streams, an area two miles upstream from the proposed water point should be checked for sources of pollution and/or evidence of contamination¹. For lakes and/or saltwater sources, all potential sources of pollution within a two-mile radius of the water point should be identified. This defines the **source area**. The **protection zone** within the source area includes the area within 400 feet from the banks of the reservoir, or primary stream, 200 feet from tributaries and 2,500 feet from any raw water intake². Pollution sources within the protection zone represent a greater risk of contaminating the surface water source.

Groundwater Sources. The minimally acceptable protection zone radii for groundwater sources, except wells in fractured rock, is 600 feet for potential sources of microbial contamination and 1500 feet for chemical contamination. For sources located in fractured rock the size of the protection zone radii should be increased by 50% to 900 feet and 2250 feet respectively. If the direction of groundwater flow is known, the radii shifts the location of each circle upgradient by $\frac{1}{2}$ the radius².

Raw Water Sampling. Samples of each potential drinking water source should be obtained for chemical analysis to evaluate its treatability characteristics. Knowing what contaminants are present in the raw water and comparing that to the relative effectiveness of the Reverse Osmosis Water Purification Units (ROWPU) listed in Appendix B will allow you to estimate how effective treatment will be in removing those contaminants and perform a preliminary risk assessment associated the drinking water source. In most cases a single, split sample will suffice for water treatability screening. Half the sample should be screened using field analytical instruments e.g., the DREL 2010 and INFICON Hapsite, and the other half returned to the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) for definitive chemical analysis.

In the unlikely event that a potential water point is selected that has several point sources of pollution within the protection zone or the water point is subject to heavy runoff from rain, it may be necessary to obtain several samples over time to adequately characterize raw water

quality. Another alternative would be to monitor the individual point sources to determine their contribution to the degradation of water quality.

Procedures for Screening Raw Water Sources.

1. Determine the location (latitude, longitude) of the surface water intake preferably by using a global positioning system (GPS).
2. Delineate the source area and protection zones based on the search criteria outlined above for specific water source.
3. Compile an inventory of **possible contamination activities** (PCAs) within the source area and protection zone (document PCAs with photographs if possible), and the potential contaminants associated with those PCAs.
4. Prepare a prioritized listing that identifies the PCAs to which the source is most vulnerable, including those associated with contaminants detected in the water supply. Appendix C lists the relative risk to the drinking water source associated with PCAs. Prepare an assessment map that shows:
 - a. Location of the drinking water source
 - b. Source area and protection zones
 - c. Location of all potential “very high risk” and “high risk” contaminant sources.
5. Perform preliminary risk assessment and communicate risk based on the treatability characteristics of the raw water.

Potable Water Certification. Preventive medicine personnel must certify treated water as potable water for consumption after conducting microbiological and chemical analyses. Preliminary certification should be granted after completion of bacteriological analysis and field chemical analyses using the DREL 2010 and/or other field analytical equipment. Final certification should be granted only after the results of complete chemical analyses are returned from the USACHPPM laboratory. Treated field water quality standards can be found in **Department of the Army Technical Bulletin TB MED 577, Sanitary Control And Surveillance of Field Water Supplies.** Issuing water to units should not be delayed while chemical or microbiological analyses are being completed.

Certification Procedures. Chemical analysis of one sample of treated water and representative samples from various points within the distribution system collected for bacteriological analysis should be sufficient to validate your assumptions about the effectiveness of treatment and serve as a basis for "certifying" the drinking water supply. Comparing the analytical results to the USACHPPM Technical Guide 230, Chemical Exposure Guidelines for Deployed Military Personnel and TB Med 577 should allow you to qualitatively estimate residual health risk and make a decision about the safety of the drinking water supply. Although not a medical department responsibility, security in and around the water production area might also be a point of interest. There should be some precautions in place to ensure that the drinking water supply is not contaminated post treatment.

While PM-MMART/FDPMUs may be called upon to provide continuing laboratory support, routine water quality surveillance and water point inspections are the responsibility of preventive medicine personnel assigned to the unit charged with water production.

Water samples must be shipped within 48 hours of sample collection. If possible, collect samples from Saturday afternoon through Tuesday morning. This will ensure that someone is available at USACHPPM - Europe to receive your samples and forward them on to Aberdeen for analyses with minimal delay. Water sampling procedures are included with the USACHPPM Backpack Sampling Kit. A USACHPPM Potable Water Sample Field Data Sheet is attached as Appendix D. Sample shipping instructions may be found in the Environmental Site Assessment SOP.

Suggested language for potable water certification.

Preliminary certification. "An assessment of the potable water production point located at (*location and GPS coordinates*) operated by (*unit name*) was completed by (*unit*) on (*date*). The water point will provide (provides) water to (*list units*). The assessment included evaluation of potential sources of pollution within the source area and chemical and bacteriological analyses of both raw and treated water samples. Field water quality analyses reveals that the water produced at this site meets the (*short and/or long-term field water quality standards*) published in Department of the Army Technical Bulletin TB MED 577, Sanitary Control And Surveillance of Field Water Supplies. Based on these results preliminary certification of the water point is granted. Water may be issued to units immediately. Final certification is, however, withheld pending receipt of a definitive water quality analyses from the U.S. Army Center for Health Promotion and Preventive Medicine.

Final certification. Results of a definitive water quality analyses performed by the U.S. Army Center for Health Promotion and Preventive Medicine indicate that the water produced by (*unit*) at (*location and GPS coordinates*) meets all relevant drinking water quality requirements. Accordingly, final certification of the water point is granted.

Handling exceedances. Field water quality analyses (*and/or definitive analyses performed by USACHPPM*) reveals that the drinking water produced by (*unit*) at (*location and GPS coordinates*) exceeds the (*short and/or long-term field water quality standards*) for (*specify compound(s)*) published in Department of the Army Technical Bulletin TB MED 577, Sanitary Control And Surveillance of Field Water Supplies. Risk analysis performed using U.S. Army Center for Health Promotion and Preventive Medicine Technical Guide 230 reveals that consuming water produced at this location represents a (*extremely high, high, moderate or low*) health risk. (*Provide specific recommendations for remedial action based on potential health risk.*)

Personnel who consumed water produced at this location should be informed of the potential health risk and individual medical record entries should be made. The medical record entry should describe the nature of the exceedance, duration of consumption and characterization of risk for adverse health outcome.

References

1. Department of the Army Technical Bulletin 577, Sanitary Control And Surveillance of Field Water Supplies, March 1986
2. U.S. Environmental Protection Agency, State Source Water Assessment And Protection Programs Guidance (EPA 816-R-97-009), August 1997
3. USACHPPM Technical Guide 251 (Draft), A Soldier's Guide to Environmental and Occupational Health Field Sampling During Military Deployment, November 2001
4. USACHPPM Technical Guide 230, Chemical Exposure Guidelines for Deployed Military Personnel, January 2002

Appendix A

Sources of Pollution and Potential³ Contaminants

Activity	Potential contaminants
Agricultural Activities: spraying, fertilizing, and livestock management	Pesticides and herbicides, nitrates, nitrites, bacteria, <i>Cryptosporidium</i> , <i>Giardia</i> , other microbiological contaminants
Wastewater Treatment Plant Discharge	Nitrates, nitrites, bacteria, viruses, protozoans, heavy metals, other chemicals (organic and inorganic)
Improper Household Waste Disposal	Cleaning fluids, degreasers, used motor oil, paints and paint thinners, soaps and detergents
Leaking Storage Tanks (Above or Underground)*	Petroleum products, acids, bases, other organic chemicals
Hazardous Material Spills	Petroleum products, acids, bases, other organic chemicals
Landfills	Various organic and inorganic chemicals
Injection Wells	Arsenic, heavy metals, cyanide, various organic and inorganic chemicals
Mining Operations	Arsenic, heavy metals, oxidation by-products, acids
Drilling Operations	Petroleum products, chloride, sodium, barium, strontium, radionuclides
<p>*Examples of activities/industries associated with use/handling of listed hazardous materials or materials which may contaminate drinking water include: gas stations, dry cleaners, distribution centers, chemical manufactures, water and wastewater treatment facilities, car-care centers, airports, golf courses, electroplaters, metal finishers, laboratories, machine shops, railroads, highway maintenance storage areas (salts), military bases, oil/gas production facilities, printers, photo finishers, refineries, wood shops, leather tanning facilities, textile production.</p>	

Appendix B

WATER PURIFICATION BY REVERSE OSMOSIS⁴

This information tables provide information on the performance of the reverse osmosis water purification unit (ROWPU) with respect to removal of soluble contaminants from source waters.

TABLE 1. REJECTION OF SALTS BY A TYPICAL RO MEMBRANE*

Salt	Rejection, percent
Sodium chloride	98
Magnesium chloride	98
Calcium chloride	99
Magnesium sulfate	99
Sodium bicarbonate	98
Sodium nitrate	93
Sodium fluoride**	98

* Filmtec®, spiral wound, thin film composite polyamide. Data are provided by the manufacturer for pure solutions of each salt; they are not applicable to mixtures of salts.

**Fluoride rejection is pH dependent: about 75% at pH 5, 50% at pH 4, 30% at pH 3.5 and 0 % at pH <3.

TABLE 2. REJECTION OF HEAVY METAL SALTS BY TYPICAL RO MEMBRANES

Salt	Rejection, percent
Nickel sulfate	99
Copper sulfate	99
Arsenic (+5) salts	99
Arsenic (+3) salts	69 and lower
Cadmium salts	99
Lead salts	97
Mercury salts	33-78
Chromium (+6) salts	97
Chromium (+3) salts	96

TABLE 3. REJECTION OF SOME ORGANIC CHEMICALS BY TYPICAL RO

MEMBRANES

Chemical	Rejection, percent
<hr/>	
Aldehydes and Alcohols	
Formaldehyde	35
Methanol	25
Ethanol	70
Isopropanol	90
Sucrose (cane sugar)	99
Acids	
Acetic acid	60-90
Fluoroacetic acid*	98-99
Phenol	56-87
Benzoic acid	87-92
Solvents	
Trihalomethanes	50-80
Chloroethylenes	15-90
BTEX	15-50
Chlorobenzene	40-50
Herbicides	
Atrazine	96
Alachlor	98
Linuron	98

* Rodenticide; extremely toxic to humans

TABLE 4. REJECTION OF NBC AGENTS BY REVERSE OSMOSIS

Agent	Rejection, percent
T-2	100
Microcystin	100
Ricin	100
Saxitoxin	100
GB	>99
VX	>99
BZ	>99
Hydrogen cyanide	<25*
¹³¹ I	>95
⁸⁵ Sr	>99
¹³⁴ Cs	>98

*pH ≤ 8.5

Appendix C

Risks Associated with Possible Contaminating Activities²

Table 1. Possible Contaminating Activities (PCAs) associated with Very High potential risks. Very High risk PCAs are considered to have the highest potential for drinking water contamination, greater than those designated High risk (Table 2), Moderate risk (Table 3), or Low risk (Table 4). The risk rankings are based on the general nature of activities and the contaminants associated with them. An asterisk [*] indicates PCAs that may be associated with microbiological contamination.

COMMERCIAL/INDUSTRIAL

Automobile-related activities
 - Gas stations
 Chemical/petroleum processing/storage
 Dry cleaners
 Metal plating/ finishing/fabricating
 Plastics/synthetics producers

RESIDENTIAL/MUNICIPAL

Airports - maintenance/fueling areas
 Landfills/dumps
 *Septic systems - High density (>1/acre)
 (for groundwater sources otherwise M)
 *Wastewater Treatment Plants

AGRICULTURAL/RURAL

* Animal Feeding Operations
 * Concentrated Aquatic Animal Production
 Facilities
 * Managed Forests (VH for surface water in
 otherwise H)

OTHER

Underground injection of commercial/
 industrial discharges
 Historic gas stations
 Historic waste dumps/landfills
 Injection wells/dry wells/sumps
 Known contaminant plumes
 Military installations
 Mining operations
 - Historic
 - Active
 Underground storage tanks
 - Confirmed leaking tanks

VH -	Very High
H -	High
M -	Medium
L -	Low

Table 2. Possible Contaminating Activities (PCAs) associated with High potential risks.

High risk PCAs are considered to have less potential for drinking water contamination than those designated Very High risk (Table 1), but greater potential for contamination than those designated Moderate risk (Table 3), or Low risk (Table 4). The risk rankings are based on the general nature of activities and the contaminants associated with them. An asterisk [*] indicates PCAs that may be associated with microbiological contamination.

COMMERCIAL/INDUSTRIAL

Automobile related Activities
- Body shops
- Repair shops
Boat services/repair/refinishing
Chemical/petroleum pipelines
Electrical/electronic manufacturing
Fleet/trucking/bus terminals
Furniture repair/manufacturing
Home manufacturing
Junk/scrap/salvage yards
Machine shops
Photo processing/printing
Research laboratories
Wood preserving/treating
Lumber processing and manufacturing
Wood/pulp/paper processing and mills
*Sewer collection systems

RESIDENTIAL/MUNICIPAL

Railroad yards/maintenance/fueling areas
*Sewer collection systems
Utility stations - maintenance areas
*Wastewater Treatment Plants

AGRICULTURAL/RURAL

* Grazing (> 5 animals/acre)
* Animal Feeding Operations
* Other animal operations Concentrated Aquatic Animal Production Facilities
Other aquatic animal operations
Farm chemical distributor/ application service
Farm machinery repair
*Septic systems- low density (<1/acre)
*Lagoons/liquid wastes
Machine shops
Pesticide/fertilizer/petroleum storage and transfer areas
Managed Forests (VH for surface water otherwise H)
Agricultural Drainage
Wells- Agricultural, Irrigation

OTHER

Industrial discharges
Illegal activities/ unauthorized dumping
Mining – Sand/Gravel
Wells- Oil, Gas, Geothermal
Salt water intrusion
*Recreational area - surface water source
Underground storage tanks:
- Non-regulated tanks (tanks smaller than regulatory limit)
- Not yet upgraded or registered tanks
Snow Ski Areas
Recent (< 10 years) Burn Areas
Dredging

VH -	Very High
H -	High
M -	Medium
L -	Low

Table 3. Possible Contaminating Activities (PCAs) associated with Moderate potential risks. Moderate risk PCAs are considered to have a lower potential for drinking water contamination than those designated Very High risk (Table 1) and High risk (Table 2), and a greater potential for drinking water contamination than activities designated Low risk (Table 4). The risk rankings are based on the general nature of activities and the contaminants associated with them. An asterisk [*] indicates activities that may be associated with microbiological contamination.

COMMERCIAL/INDUSTRIAL

Car washes
 Parking lots/malls (>50 spaces)
 Cement/concrete plants
 *Food processing
 Funeral services/graveyards
 Hardware/lumber/parts stores

RESIDENTIAL/MUNICIPAL

*Septic systems - High density (>1/acre)
 (VH if in Zone A, otherwise M)
 Drinking water treatment plants
 Golf courses
 Housing - High density (>1 house/0.5 acres)
 Motor pools
 Parks
 Waste transfer/recycling stations

AGRICULTURAL/RURAL

* Other animal operations
 Other aquatic animal operations (H in Zones for surface water, otherwise M)
 Crops, irrigated (berries, hops, mint, orchards, sod, greenhouses, vineyards, nurseries, vegetables)
 NOTE: Drip-irrigated crops are considered Low risks.
 *Sewage sludge (biosolids) land application
 Fertilizer, pesticide/herbicide application
 Managed Forests (M for ground water)
 Agricultural Drainage

OTHER

Above ground storage tanks
 Wells – water supply
 Construction/demolition staging areas
 Contractor or government agency equipment
 storage yards
 Managed forests
 Transportation corridors
 - Freeways/state highways
 - Railroads
 - Historic railroad right-of-ways
 - Road right-of-ways (herbicide use areas)
 Hospitals
 Storm drain discharge points
 Storm water detention facilities
 Artificial recharge projects – nonpotable water (includes recycled, storm, and untreated imported water)
 - Injection wells
 - Spreading basins
 Snow Ski Areas (H in Zones for surface water, otherwise M)
 Recent (< 10 years) Burn Areas (H in Zones for surface water, otherwise M)
 Dredging (H in Zones for surface water, otherwise M)

VH -	Very High
H -	High
M -	Medium
L -	Low

Table 3-4. Possible Contaminating Activities (PCAs) associated with Low potential risks.

Low risk PCAs are considered to have a lower potential for drinking water contamination than those designated Very High risk (Table 3-1), High risk (Table 3-2) or Moderate risk (Table 3-3). The risk rankings are based on the general nature of activities and the contaminants associated with them. An asterisk [*] indicates PCAs that may be associated with microbiological contamination.

COMMERCIAL/INDUSTRIAL

*Sewer collection systems
Appliance/Electronic repair
Office buildings/complexes
Rental yards
RV/mini storage

RESIDENTIAL/MUNICIPAL

*Sewer collection systems
Apartments and condominiums
Campgrounds/Recreational areas
Fire stations
RV parks
Schools
Hotels, Motels

AGRICULTURAL/RURAL

Crops, non-irrigated (e.g. Christmas trees, grains, grass seeds, hay) (or drip-irrigated crops)
* Septic systems – low density (<1/acre)

OTHER

Underground storage tanks
- Decommissioned - inactive
- Upgraded and/or registered – active
Roads/Streets
Artificial recharge projects - potable water
- Injection wells
- Spreading basins
Medical/dental offices/clinics
Veterinary offices/clinics
*Surface water - streams/lakes/rivers
Wells – Monitoring, test holes, borings

VH -	Very High
H -	High
M -	Medium
L -	Low

Appendix D

Potable Water Sampling Field Data Sheet

<i>Section I - Administrative Data</i>		
1. Sample ID*:	7. Collecting Unit*:	11. Lab ID:
2. Location:	8. Unit Spec ID:	12. Job No:
3. Country:	9. Mission ID:	13. Project No:
4. Operation:	10. Shipping ID:	14. Europe ID:
5. Sampling Date*:	15. Sample Notes:	
6. Sampling Time*:		
<i>Section II - Field Data</i>		
16. Collectors Name*:		20. Sample Amount:
17. Collectors Phone No*:		21. Sampling Device:
18. Water Source*: <small>(Circle One)</small> Source / Treated / Distribution System		22. Sample Kit Type*: <small>(Circle One)</small> Deployment / EPA / Other If Other, Explain:
19. Water Type* <small>(Circle One)</small> RWW / TW / RS / DS / T / FD / F / WC		
23. Initial pH:		26. Turbidity: NTU
24. Water Temperature: oC		27. Free Available Chlorine: mg/L
25. Conductivity: mV		28. Total Dissolved Solids: mg/L
<i>GEOLOCATION</i>	<i>Decimal Degrees</i>	OR
29. Latitude*:		
30. Longitude*:		
31. MGRS*:		
32. Field Notes*:		
<i>33. Sampling site Graphic</i>		<i>34. Analysis</i>
<div style="border: 1px solid black; height: 150px; width: 100%;"></div>		Metals: <input type="checkbox"/>
		VOC: <input type="checkbox"/>
		SVOC: <input type="checkbox"/>
		Herbicides: <input type="checkbox"/>
		Pesticides: <input type="checkbox"/>
		Diquat: <input type="checkbox"/>
		Endothall: <input type="checkbox"/>
		Glyphosate: <input type="checkbox"/>
		MBAS: <input type="checkbox"/>
		EDB/DBCP: <input type="checkbox"/>
Cyanide: <input type="checkbox"/>		
Tritium: <input type="checkbox"/>		
Alpha/Beta: <input type="checkbox"/>		

POTABLE WATER SAMPLING FIELD DATA SHEET INSTRUCTIONS

-----SECTION I - ADMINISTRATIVE DATA-----

1. **Sample ID** - Sample ID number CCC_LLL_MMMM_YYDDD_ZZ
 Where: CCC – Country 3 letter abbreviation code
 LLL - Camp abbreviation (i.e. first three letters of camp name)
 MMM - Water sample number for that camp on that particular day (e.g. 01W, 02W, 03W, etc)
 YYDDD - jday code, last two digits of the year & three digit julian day of the year [e.g 02001 for 1-Jan-2002].
2. Location – Camp or location of sample
3. Country – Country in which location or camp is located.
4. Operation – Name of operation ongoing in the area of the sample [e.g. Operation Allied Force (OAF), etc] if applicable
5. **Sampling Date** – Date sample was collected (e.g. 01-Jan-2002)
6. **Sampling Time** – Time sample was taken (e.g. 16:00)
7. **Collecting Unit** - Unit collecting the sample (e.g. TAML, 71st MEDDET, etc).
8. Unit Spec ID – Unit specific ID associated with the sample if any.
9. Mission ID – Unit mission ID associated with the sample if any.
10. Shipping ID – Shipping ID associated with sample (e.g. Fedex tracking number)
11. Lab ID – Unique ID number assigned at CHPPM-Main laboratory, if applicable.
12. Job No. – Job number assigned at laboratory.
13. Project No. – Project number assigned by laboratory or project officer.
14. Europe ID - Unique ID number assigned at CHPPM-Europe laboratory, if applicable.
15. **Sampling Notes** – Any notes or comments associated with the sample (e.g. short holding time, unusual circumstances, etc).

-----SECTION II - FIELD DATA-----

Note: The Sample ID, Sampling Date, and Sampling Time at minimum should also be recorded on the sample label.

16. **Collectors Name** – The name of the person collecting the sample.
17. **Collectors Phone No** - The phone number of the person collecting the sample.
18. **Water Source:**
 Source Water - Raw water before treatment
 Treated Water - Collected after the water passes through a typical type of treatment such as a ROWPU
 Distribution System - Collected at representative points in the distribution system
19. **Water Type:**

RWW - Raw Well Water	DS - Distribution System	F – Flushed
TW - Treated Water	T – Tap	WC - Water Coolers
RS - Raw Surface	FD - First Draw	
20. Sample Amount – Amount of sample collected if sample is not part of a kit.
21. Sampling Device – The device used to collect the sample if a unique device was used.
22. **Kit Type** – Type of collection kit used.
 Deployment kit – Deployment sampling kit
 EPA Kit – Regular EPA sampling kit
 Other – Sample collected or analyzed by other kits or methods, explain
23. Initial pH – The initial pH of the water before the sample is taken or before preservatives are added, if known
24. Water Temperature – The initial ambient temperature of the water being sampled, if known
25. Conductivity – The initial conductivity of the water being sampled, if known
26. Turbidity – The initial turbidity of the water being sampled, if known
27. Free available chlorine – The initial free-available chlorine (FAC) of the water being sample, if known
28. Total dissolved solids – The initial total-dissolved-solids (TDS) of the water being sampled, if known
29. **Latitude** – Sample latitude location in decimal degrees [from GPS]
30. **Longitude** – Sample longitude location in decimal degrees [from GPS]
31. **MGRS** – Location in Military Grid Reference System (MGRS) from GPS, ten digit grid with grid square identifier (e.g. 34TEN1234567890)
32. **Field Notes** - Notes relating to sampling episode (e.g. unusual circumstance, weather, potential pollution sources, etc)
33. Sampling Site Graphic – Any graphical or pictorial description of the sampling site. May include a digital picture of the sampling site once sample is processed.
34. Analysis – Check boxes for laboratory analysis, if no boxes are checked it will be assumed all laboratory analysis are requested.