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A Groundwater Sampler's Handbook for Pollution Control Department of SIU-C

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not erudite, but quite readable;
good summarization of materials
but little in way of synthesizing relati
conceptual topics & development of
new ground.

A Groundwater Sampler's Handbook
for
Pollution Control Department
of
SIU-C

April 1989
Jarvis L. Schultz

for UHON 490 Fall '89
Sect 755

Rational

My groundwater experiences started with an internship at Weston/Gulf Coast Laboratories in University Park, Illinois. I worked with the field crew primarily in the sampling of groundwaters from the monitoring wells of landfills.

My honor's project began as an essay on hazardous waste disposal problems, but ended with a radically different product. This Groundwater Sampler's Handbook is a compilation of information that was either disjunctly found throughout Pollution Control's landfill project, non-existent, or unthought of.

This situation allowed my internship experience to be expanded to the advisory level. I was not just responsible for the physical sampling, as during the internship, but rather for the bringing together of much scattered information, adding my experience, and putting together a suitable reference source for future project managers at Pollution Control. My interest in the thesis on waste disposal waned as I saw the chance to produce something that would be functional and, further, would allow me to both use my internship experiences directly and also to expand upon that base.

Sincerely,

Jarvis L. Schultz

April, 1989

OUTLINE OF HANDBOOK

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Outline

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GROUNDWATER OVERVIEW

Groundwater, what is it? It has been in the environmental news a lot during the last decade and it's what we're sampling at two of our project sites; reasons enough for us to learn a bit about the subject. Contrary to some commonly held beliefs groundwater is not contained in a complex of underground rivers or lakes. In its simplest definition it is the water that is held within the pores of underlying rock and soil formations. These pores and fractures within the substratum, termed interstices, allow the groundwater to slowly move within these formations (Driscoll, 1986). The geological formations which hold the groundwater are generally termed aquifiers or aquitards. An aquifer refers to formations that can hold and transmit substantial amounts of water, often in an economic sense (Driscoll, 1986). Aquitards can hold and move only relatively small amounts of groundwater.

Aquifers and aquitards are often found together - the aquifer, being sandwiched by one or more aquitards.
The aquitard, if above the aquifer, prevents aquifer contamination from the surface and regardless of positioning, helps to direct the groundwater flow (Wilson, 1982).
Aquifers that have aquitards both above and below are termed confined aquifers; those without a protective overlying aquitard are termed unconfined (fig. 1).

Groundwater moves through its aquifers along the hydrologic gradient; one propelling force being, as in surface waters, gravity. Unlike surface waters though, groundwater movement is also affected by pressure from confinement and resistance of the aquifer material to forward movement. More exactly the groundwater within an aquifer possesses some potential energy called 'head'. Friction generated as the water moves through the resistance of the aquifer causes a loss of potential energy - thus water from the beginning of a measured travel has more potential energy than at the end; i.e. groundwater flows from zones of higher potential yield toward those of lower potential. Henri Darcy in 1856 produced an equation for groundwater flow that has become known as Darcy's Law:

$$V = (K) \frac{h_1 - h_2}{L}$$

Where: V = velocity

h_1, h_2 = the head at two points

L = distance between points 1 and 2

K = a referenced constant representing the permeability of the aquifer

(Driscoll, 1986)

Again, groundwater flow rates vary with the composition of the aquifer. For example deep sand aquifers will normally have faster flow rates than shallow shale aquifers. Some heavily fractured basaltic rocks, though, may conduct groundwater almost as well as sand or gravel (Wilson, 1982). Speeds may ran from a few inches per week in crystalline aquifers to several feet per hour in sand aquifers (Todd, 1970). The term upgradient refers to the direction the flow is coming from; downgradient refers to the direction the flow is going to in relation to a point of reference.

HYDROLOGIC CYCLE

Equally ~~as~~ important as groundwater behavior within aquifiers is an understanding of how water reaches these aquifiers; in short an overview of the hydrologic budget. This system, or budget is concerned with the balance that must exist between the water entering a given environment, the water leaving such, and the portion that is stored within. The major contributors to the system are rain and snow, major withdrawls are made in the form of evapotranspiration from lakes, ponds or swamps, and streamflow. Storage areas for water include soil moisture and groundwater in aquifiers. Gains in the water storage component of the system may cause a loss in surficial resources with lowered amounts of locally available water. While negatively affecting one section of the environment this increase in groundwater flow could add to a distant streamflow that the aquifer supplies ~~releases in~~to (fig. 2).

Most groundwater movement in the United States is from aquifers to rivers and streams. This is in contrast to arid areas where flow may be from surface waters to groundwater; here the evaporation potential is greater and pulls surface water into groundwater. Illinois, a relatively precipitation rich state follows the norm for the United States and other temperate regions.

Illinois receives 35-42 inches of precipitation a year. Eighty-one percent of it enters the soil, 62% forms soil water which evaporates ~~out~~ and 12% is added to the groundwater baseflow that is eventually either pumped up by man or released as stream or riverflow (fig. 2; source: ILEPA).

GROUNDWATER POLLUTION

Man, as we know, has shown a great capacity to pollute the earth. This ability has unfortunately not been confined to just our land surface and atmosphere but has also plagued our groundwater supplies. Mankind has damaged his groundwater supplies through mismanagement of landfills, waste injection wells, surface spills, inefficient mining operations (acid wastes, heavy metals) and careless agricultural practices (pesticide and fertilizer leaching). While we should be cognizant of all these problems I will deal only with the potential pollution aspects of landfills.

Landfills vary widely in their construction. In general a landfill is constructed in stages; the whole tract of land owned by the waste disposal company is not excavated at once, filled with garbage and covered up. Rather, small plots of the site called "cells" are excavated, filled, compacted, and covered individually. Any major municipal landfill permitted by the EPA today will include an impermeable liner of clay or synthetic sheeting and, if necessary, leachate and methane gas recovery or disposal systems (fig. 3). Leachate is formed by water that has seeped through the covered garbage of the fill and combined with any solu~~a~~ble garbage or products from rotting garbage. Leachate can vary widely in its characteristics from being almost clear and of high viscosity to being similar in appearance to motor oil. Drainpipes lining the bottom of some landfills may form the leachate collection system, pumping this leachate to a central collecting point.

Methane gas produced by the anerobic breakdown of garbage is usually not collected; rather pipes are driven down into the fill and the escaping flammable methane is burned off.

Of these two landfill byproducts the most dangerous to groundwater, by far, is leachate. Leachate has been found to be consistently high in iron and chlorides and often in phosphate, organic nitrogen, sulphur, chemical oxygen demand (COD) and trace metals (Noble, 1976). This leachate upon reaching groundwater, with these parameters at high levels, could lead to various potential problems which we will discuss later.

It is worth mentioning that the two landfills we monitor were permitted before many of the EPA's latest regulations came into effect. As a result neither Jackson nor Saline County landfills have constructed impermeable clay liners or leachate collection systems. While to the best of my knowledge this has not posed a serious environmental threat yet, only time will tell of any possible future damage.

With the realization of possible contamination problems and resource damage (50% of Illinois households obtain their drinking water from groundwater sources) several federal laws have been passed for protection of both groundwaters and other drinking water sources; especially as they are affected by waste disposal practices (following four summaries are after Novick, 1983).

The Clean Water Act of 1972, while not the first clean water act, contained amendments that year requiring, for the first time, states to produce a plan for controlling pollution of both their ground and surface waters.

The Safe Drinking Water Act of 1974 authorized the EPA to impose maximum water contaminant levels on public drinking water supplies. In addition, this act also regulated the uses of deep injection wells for waste disposal.

The Resource Conservation and Recovery Act (RCRA) established, in 1976, standards for storage, treatment and disposal of hazardous wastes. This especially affected surface dumps, waste lagoons and other such disposal practices. This act also established a permitting and monitoring programs for disposal sites.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund), when it went into effect in 1980, basically gave the EPA the authority to identify, evaluate, and cleanup abandoned hazardous waste sites-especially if they posed an imminent public health risk. A government trust fund termed Superfund covers the cost of cleanups in the event an individual or corporation is not held financilally responsible.

GROUNDWATER MONITORING

Obviously it was RCRA that forced landfills into their groundwater monitoring programs and thus Pollution Control's participation in their operations. The EPA established that landfills would be monitored quarterly. During the initial four quarters of monitoring a large load of background parameters must be monitored to establish current groundwater quality (fig. 4). After the first year only the routine parameters are monitored (fig. 5). The EPA establishes their routine parameter list on an individual site basis. This determination depends both on the characteristics of the site and on the site permit, i.e. what wastes the EPA has permitted to be dumped. Sampling and testing for contaminants that won't be found, because the EPA's dumping permit for the disposal facility will not allow them on site, is a waste of time, money and resources.

Groundwater samples are taken from monitoring wells placed around the perimeter of the site (fig. 6), and at times, near a particular cell. The garbage fill itself may not be positioned within 50 ft. of any well; if this occurs the well is likely to be plugged and abandoned for a more representative well. Specific well locations depend on the aquifer chosen to be monitored, number of wells in the monitoring program, positons giving the best spatial cover, and access by drilling rigs. Wells must reach the aquifer that may be affected by the site, and with the least number of wells (considering financial and logistical constraints) give the best representation of how the waters in the target aquifer are, or are not, being contaminated. Furthermore these points must obviously be accessible during construction by drilling rigs and later by sampling teams. Usually a minimum of three wells are necessary to monitor both upgradient and downgradient conditions. Upgradient samples, of course, give information concerning groundwater before it passes under the site, downgradient wells tell of groundwater conditions after passage (fig. 6). Any changes between upgradient and downgradient wells, therefore, in all probability, are caused by the facility being monitored.

There are two types of structures that we monitor; wells and piezometers. Piezometers are simply small diameter casings that reach into the aquifer - allowing for measurement of the groundwater or piezometric surface. No samples are drawn from these points; only measures of depth. Jackson County landfill has no piezometers, Saline County has 2, G105 and G111 (fig 6).

Monitoring wells vary in their design from very simple arrangements to more complex forms but their basic constructions are generally similar. Most often a borehole is drilled to the appropriate aquifer and a slotted section of PVC or stainless steel pipe, called the screen, is placed in this borehole at the predetermined sampling depth, i.e. where contamination is most likely to occur. The area around the screen is packed with gravel and at the top of the aquifer a bentonite seal is packed. The well casing, of the same material as the screen, is of course continued after the screen, through the gravel, bentonite and finally past the cement fill and final seal at ground level (fig. 7). Often an outer casing of aluminum or steel with a locking cap is placed around the projecting well casing for protection from both vandalism and landfill traffic. In any case the well casing itself is capped to avoid surface contaminants from entering the aquifer and affecting sample integrity.

The choice of material used for the well pipe (PVC or stainless steel) is often made on the basis of cost. As a result PVC wells are often chosen. Stainless steel wells are more durable and in some circumstances less reactive with substances in the substratum - yielding a potentially more representative sample, but typically cost twice as much per foot to install.

After installation a new monitoring well must be "developed". This is accomplished by removing large volumes of water from the well; thus allowing the new construction to collapse around the screen as fine particles are removed with the water (Franconeri, 1983). When clear water begins to be removed and pH and Standard Conductivity readings have stabilized the development process is complete and representative samples are more assured.

Purging and sampling of monitoring wells may be accomplished by any one of several methods, four of which we will look at, one of which we use.

Bailing is the simplest, cheapest, and most labor intensive. Bailers are lengths of PVC, stainless steel, or teflon pipe with a check ball at one end. These samplers are lowered into the well, allowed to fill, and raised out; the check ball preventing water from pouring out. Teflon bailers were developed for use in volatile chemical analysis (Grant, 1983). Bailing is versatile but inefficient for removals of large quantities of water or for use with deep wells. In addition the possibility of cross contamination exists if a bailer is ineffectively cleaned between wells.

The hand-operated-pump sampler is made of PVC pipe sections with an inner section of smaller PVC pipe forming a simple pump system. This method is efficient if large volumes of water must be removed from a fairly shallow well. A fairly long setup time and limited depth capabilities often preclude its use.

Submersible pumps, similar but specialized forms of the pumps used in domestic wells, may be used. These pumps efficiently remove large amounts of water with little physical labor but demand more equipment, fuel and money. Cross-contamination may still be a problem.

Dedicated sampling systems are far and away the best quality sampling method for retaining sample integrity but are also extremely expensive. This method places a pump permanently within the well at the proper sampling depth. From that point on sampling consists only of hooking up an external compressor and letting the water be pumped up. This mehtod decreases physical labor and cross contamination possibilities but, again, demands much in the way of finances.

Our sampling methods include only the bailer. Although we have at times used the hand-operated-pump, its difficulty in setup and fragileness of construction overode what savings it actually produced over bailing as far as water removal.

PARAMETER INFORMATION

Before moving into our actual sampling procedures and before we leave the background section of this manual it may be practical to explore the parameters we sample for. What do these values tell us?

In short these tests can be broken down into 2 groups;

field tests and lab tests.

Field parameters are usually quick tests easily performed with portable equipment. These are tests that need to be performed quickly before such things as time or temperature affects the values obtained. Our field tests include pH, standard conductivity, and sample temperature. (Note: lab & field test information from Standard Methods, and Driscoll, 1986).

pH is a measure of the hydrogen ion concentration of the sample; a measure of the acidity or alkalinity. This may show the presence of acids or bases within the sample, the presence of which is obviously negative. The test can be related to standard conductivity. This is run on Saline County only.

Standard Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This measure depends on the presence of ions and their concentrations. Inorganic acids, bases, and salts make good conductors. Organic molecules that don't disassociate in water make poor conductors and thus have a low standard conductivity (S.C.). This test is related to ROE and pH and is run on both Jackson and Saline County landfills.

Sample temperature is related to the depth of the well and may vary - especially since our wells are relatively shallow. This reading can give a measure of thermal pollution possibilities (although this would not be common to landfills). This is a quick, easy, parameter that is run on both Jackson and Saline Counties.

Lab parameters are more involved tests that are preserved for by addition of acids, bases, or cold storage as required. These parameters include Chlorides, Boron, COD, Ammonia, Iron, Sulfates, ROE, and T.O.C.

Chlorides are a good early indicator of possible coming problems because it is easily leached from the surrounding soil. Chlorides can corrode metal pipes and structures and high levels can harm plant life. This test is run on both Jackson and Saline Counties.

Boron is most often found as a residue from household cleaning agents or industrial wastes. Levels as low as 1-2 mg/L can be adverse to plant growth. Low doses may affect human nervous system. This test is run on both Jackson and Saline Counties.

Chemical Oxygen Demand, or COD, is a measure of O_2 equivalent of organic matter in a sample that may be oxidized by a strong chemical oxidant. This is a measure of stress that waste puts on the receiving water. Leached organics would affect the COD. This test is run on Jackson County only.

Ammonia is naturally present in groundwaters to a small extent although it is absorbed into soil particles and clays. It is not readily leached. This is a product of decay of plant and animal proteins and the degradation of organic wastes and is thus toxic to biological life when finally released into streams. This test is run on Jackson County only.

Iron may be found from readily leached natural deposits, iron bearing industrial wastes, acidic mine drainages or buried scrap. We generally find fairly high readings due to the former strip mined nature of our sites. This test is run on

Jackson County only.

Residual on Evaporation (ROE) may show disturbances in the aquifer or well. Hardness of the water, soluble salts and minerals from the fill may all affect this. This test is related to S.C. and is run on both Jackson and Saline counties.

Total Organic Carbon (TOC) is a total measure of organic matter in the sample. It can be related to COD, but is more complete. While it may not replace the COD test, this test procedure has less interference possibilities. TOC is run only on Saline County.

Sulfates (SO_4) are naturally present in the environment, but high levels may be caused by high sulfur coal mines and coal mining drainage wastes. This test is run on Saline County only.

For observed and expected ranges in any of these tests' values refer to Table 1.

Procedures

What follows is a procedure for the proper sampling of Saline and Jackson County landfills by personnel of the Pollution Control Department of SIU-C. While these methods may be extrapolated to other sites to an extent, their details would most likely need refinement.

Day one: The purging of the monitoring wells.

A. Purging refers to the removal of the stagnant water column that has been sitting in the well since the last sampling. Removal of this water and subsequent influx of a fresh aquifer sample provides a more representative sample to be taken day 2.

B. Refer to the site maps for well locations.

C. Equipment

1. Calculator
2. Reference values (Table 2)
3. Bailer with rope
4. Site maps
5. Keys to Jackson County wells
6. 5 gallon bucket
7. Depth indicator
8. Distilled water

D. Three casing volumes of water should be purged from each well; unless well goes dry before that.

E. The casing volume is determined by measuring the total depth of the well, the depth of the water surface within and the diameter of the well. These measurements will give you the height and diameter of the water column.

F. Refer to Table 2 and multiply out volume.

G. Remove three times that casing volume from the well by submerging bailer to bottom of well, allowing it to fill, bringing it up and pouring it into the 5 gallon bucket to keep tally of the amount removed.

H. After required quantity is removed, properly close well cap and rinse bailer with distilled water.

I. Move on to next well.

Day Two: Sampling of Wells.

Equipment

1. Keys for Jackson County wells
2. Field sheets, calculator, Table 2
3. Bailer with rope
4. Field pH meter
5. Standard conductivity meter
6. Sample bottles (labeled with site name, well #, date)
7. Coolers with ice (for sample transport)
8. Distilled water
9. Depth indicator
10. Tape measure

A. Fill out all appropriate blanks on field sheet.

B. Open well, obtain measure of stick-up (Fig. 7); record

C. Measure depth to water with depth indicator; record

D. If it is the second quarter of the year obtain a total well depth with depth indicator.

E. Use bailer to obtain sample.

F. Condition each sample bottle before filling.

G. Fill all sample bottles for that well.

H. Take pH, S.C., and temperature readings as required; record. Note: pH not required at Jackson County.

I. Place samples in cooler.

J. Close up well, finish filling in entire field sheet, rinse bailer.

K. Move on to next well.

L. As soon as possible filter and preserve as required. For example, two liters of sample from each well at Jackson and Saline Counties.

  1. All Jackson County samples are filtered.

    a. 500 mls per well preserved with H_2SO_4 to a pH < 2 for COD and Ammonia analysis.

    b. 500 mls per well preserved with HNO_3 to a pH < 2 for Iron analysis.

    c. Refrigerate all remaining samples.

  2. Saline County has 250 ml per well preserved with H_2SO_4 to pH < 2 <u>before</u> filtering to be sent out for TOC analysis.

     The rest of the samples are filtered and refrigerated.

Following is a list of recommendations to help assure representative samples and improve field documentation. These are not in order of importance.

1. Wash bailer and rope thoroughly with detergent before and after sampling event.
2. Rinse bailer with distilled water between wells.
3. Refrain from allowing bailer and/or rope to lay on ground when sampling; use plastic sheeting or bags.
4. Be sure to condition all sample bottles before using.
5. Filter and preserve samples <u>as soon as possible.</u>
6. To ease later completion of EPA reports use 24 hour time scale and decimal foot measurements (Table 2) on field sheets.
7. Make copious notes in comments section of field sheet; abnormal lab results could be traced back to surrounding transient but vital conditions at the time of sampling.
8. Double check bottle identification with well identification before obtaining sample.
9. Fill out entire field sheet; cross out those values not required.
10. All work, of course, should be done in ink.
11. Label bottles of preserved samples with site name, well #, test to be ran, and preservative.

Comments/Suggestions

With the completion of this overview and consideration of the present sampling practices of Pollution Control I would like to offer several suggestions for review.

First, and probably least important, is the possible use of disposable gloves when obtaining samples. This practice would further the move toward improved sample representability and integrity, and may make the sampling team more cognizant of their actions in all phases of sampling i.e. learning to take the time to do things properly. I realize this idea seems to be a case of overkill (gloves are most important when sampling for volatile organics which Pollution Control does not) and wasted resources, and further, that waste and the idea of an environmentally sound Pollution Control do not agree. In spite of this I believe that moves should be made to form sound protocol habits now - with the first groundwater samplings that many Pollution Control personnel are exposed to.

Second, I believe the time lag between the sampling and filtering/preserving of samples should be shortened. By doing these activities in the field rather than back at the lab we can cut down on required lab time upon returning from the site. Negative aspects to this move would be an increase in necessary field equipment and a longer stay in possibly harsh field conditions. Positive aspects would be improved sample representability and shortened in-lab time spent upon return - the time when the team is the most tired and liable to make mistakes.

In addition, and with a radical move to ease our demands on day two of the sampling process, it may be possible to do one complete bailing and sampling event in a single day. This would entail bailing each well, in turn, according to protocol, returning to the first well bailed, collecting samples, and continuing through each of the wells again. The possibility of this method hinges on the recharge rate of the bailed wells; sufficient water must travel into the well after bailing for a complete sample to be obtained. Recharge rates can be obtained during day one of the process to obtain an estimate of this idea's feasibility for future sampling events.

In closing, I can only urge that the samplings be performed, in a sense, "by-the-book"; not necessarily this sampling handbook per se, but by following every applicable protocol consideration that you, as a sampler, may be aware of, or have learned from your own sources. The focus in Pollution Control is on real-world experience. Attempt to make the most of this idea by always performing the best job possible, stressing always for the closest to perfection you can achieve with the resources you've been given.

For further information on the various aspects of groundwater mentioned here you may wish to refer to these soucres.

Groundwater and Wells 2nd edition by F. G. Driscoll, 1986, published by Johnson Division, St. Paul, Minnesota. 1089 pp.

An excellent reference work covering such areas as aquifer system formation, weather patterns, hydrologic cycle, groundwater chemistry and exploration, well hydraulics, well drilling, groundwater law and various other related topics. Good appendices and reference list.

Groundwater (a non-techical guide) by J. Wilson, 1982, published by Academy of Natural Sciences, Philadelphia, Pennsylvania. 105 pp.

A good beginning book covering groundwater basics. Various topics include availability, use, quality and influences of human activities upon groundwater. Filled with helpful charts and graphs.

Sanitary Landfill Design Handbook by G. Noble, 1976, published by Technomic, Westport, Connecticut. 285 pp.

While somewhat dated, this book gives a good picture of the considerations that go into starting up a new landfill. It's age may even make it more applicable to the older landfills in this area, giving a good background for the sites Pollution Control deals with.

Procedures for the Collection of Representative Water Quality Data from Monitoring Wells by J. P. Bibb et al., 1981, published by Cooperative Resources Report of Illinois, Champaign, IL. 61 pp.

Covers very well the aspects that may affect monitoring data. Includes sections on pumping equipment, sample collection and preservation, and analytical methods. Not a "how to" guide but more of a comparison work. Helpful reference section.

In addition to these few sources many periodicals and journals either specialize in ground water or cover it to some extent. These include:

"Environmental Science and Technology" published by The American Chemical Society, 1155 16th St. Washington D.C.

"Pollution Engineering" published by Pudvan Publishing Co. 1935 Shermer Road Northbrook, IL.

"Waste Age" published by National Solid Wastes Management Association, Suite 512, 1730 Rhode Island Ave., Washington D.C.

"Groundwater Monitoring Review" published by Water Well Journal Publishing Co., 500 W. Wilson Bridge Rd., Worthington, OH.

Complementing these various books and journals is the information concerning groundwater that may be found in the landfill files at Pollution Control under "Groundwater Articles". This folder contains worthwhile articles and pamphlets from various sources.

Table 1

Parameter Ranges and Recommended Levels for Groundwater

Parameter	Site	Recommended Range	Observed Levels
pH	Saline	6.5 - 8.0	5.0 - 6.5
SC	Jackson & Saline	50 - 1500	1300 - 6900
Temperature	Jackson & Saline	microhms/cm variable	variable
Chlorides	Jackson & Saline	250 mg/L	1 - 200 mg/L
Boron	Jackson & Saline	.1 - 1.0 mg/L	0.1 - 1.0 mg/L
COD	Jackson	unavailable	2 - 100
Ammonia	Jackson	10 - 15 ug/L	0.1 - 15 mg/L
Iron	Jackson	0.3 mg/L (for taste)	.01 - 33 mg/L
ROE	Jackson & Saline	500 mg/L	500 - 5000 mg/L
SO_4	Saline	250 mg/L	100 - 4000 mg/L
TOC	Saline	unavailable	3 - 20 mg/L

Sources: Standard Methods; Driscoll, 1986; Pollution Control Data Files

Table 2.- Helpful referance values and conversions for field measurements and documentation.

IN.	0.1 FT.	IN.	0.1 FT.
0.5	0.042	5.5	0.458
1.0	0.083	6.0	0.500
1.5	0.125	6.5	0.542
2.0	0.167	7.0	0.583
2.5	0.208	7.5	0.625
3.0	0.250	8.0	0.667
3.5	0.292	8.5	0.708
4.0	0.333	9.0	0.750
4.5	0.375	9.5	0.792
5.0	0.417	10.0	0.833
		10.5	0.875
		11.0	0.917
		11.5	0.958
		12.0	1.000

CASING VOLUMES

3/4 = 0.0229 GAL./FT.
1 " = 0.0408 GAL./FT.
2 " = 0.1632 GAL./FT.
3 " = 0.3670 GAL./FT.
4 " = 0.6528 GAL./FT.
5 " = 1.0191 GAL./FT.
6 " = 1.4680 GAL./FT.

TEMPERATURE

°C = (5/9 x TEMP.°F) - 32 incorrect; 5/9(F -32)
°F = (9/5 x TEMP.°C) + 32

Volume of Water in Casing or Hole

Diameter of Casing or Hole (In)	Gallons per foot of Depth	Cubic Feet per Foot of Depth	Liters per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509 x 10^{3}
1½	0.092	0.0123	1.142	1.142 x 10^{3}
2	0.163	0.0218	2.024	2.024 x 10^{3}
2½	0.255	0.0341	3.167	3.167 x 10^{3}
3	0.367	0.0491	4.558	4.558 x 10^{3}
3½	0.500	0.0668	6.209	6.209 x 10^{3}
4	0.653	0.0873	8.110	8.110 x 10^{3}
4½	0.826	0.1104	10.26	10.26 x 10^{3}
5	1.020	0.1364	12.67	12.67 x 10^{3}
5½	1.234	0.1650	15.33	15.33 x 10^{3}
6	1.469	0.1963	18.24	18.24 x 10^{3}
7	2.000	0.2673	24.84	24.84 x 10^{3}
8	2.611	0.3491	32.43	32.43 x 10^{3}
9	3.305	0.4418	41.04	41.04 x 10^{3}
10	4.080	0.5454	50.67	50.67 x 10^{3}
11	4.937	0.6600	61.31	61.31 x 10^{3}
12	5.875	0.7854	72.96	72.96 x 10^{3}
14	8.000	1.069	99.35	99.35 x 10^{3}
16	10.44	1.396	129.65	129.65 x 10^{3}
18	13.22	1.767	164.18	164.18 x 10^{3}
20	16.32	2.182	202.68	202.68 x 10^{3}
22	19.75	2.640	245.28	245.28 x 10^{3}
24	23.50	3.142	291.85	291.85 x 10^{3}
26	27.58	3.687	342.52	342.52 x 10^{3}
28	32.00	4.276	397.41	397.41 x 10^{3}
30	36.72	4.909	456.02	456.02 x 10^{3}
32	41.78	5.585	518.87	518.87 x 10^{3}
34	47.16	6.305	585.68	585.68 x 10^{3}
36	52.88	7.069	656.72	656.72 x 10^{3}

1 Gallon = 3.785 Liters
1 Meter = 3.281 Feet
1 Gallon Water Weighs 8.33 lbs. = 3.785 Kilograms
1 Liter Water Weighs 1 Kilogram = 2.205 lbs.
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419 x 10^{3} cubic meters per meter of depth

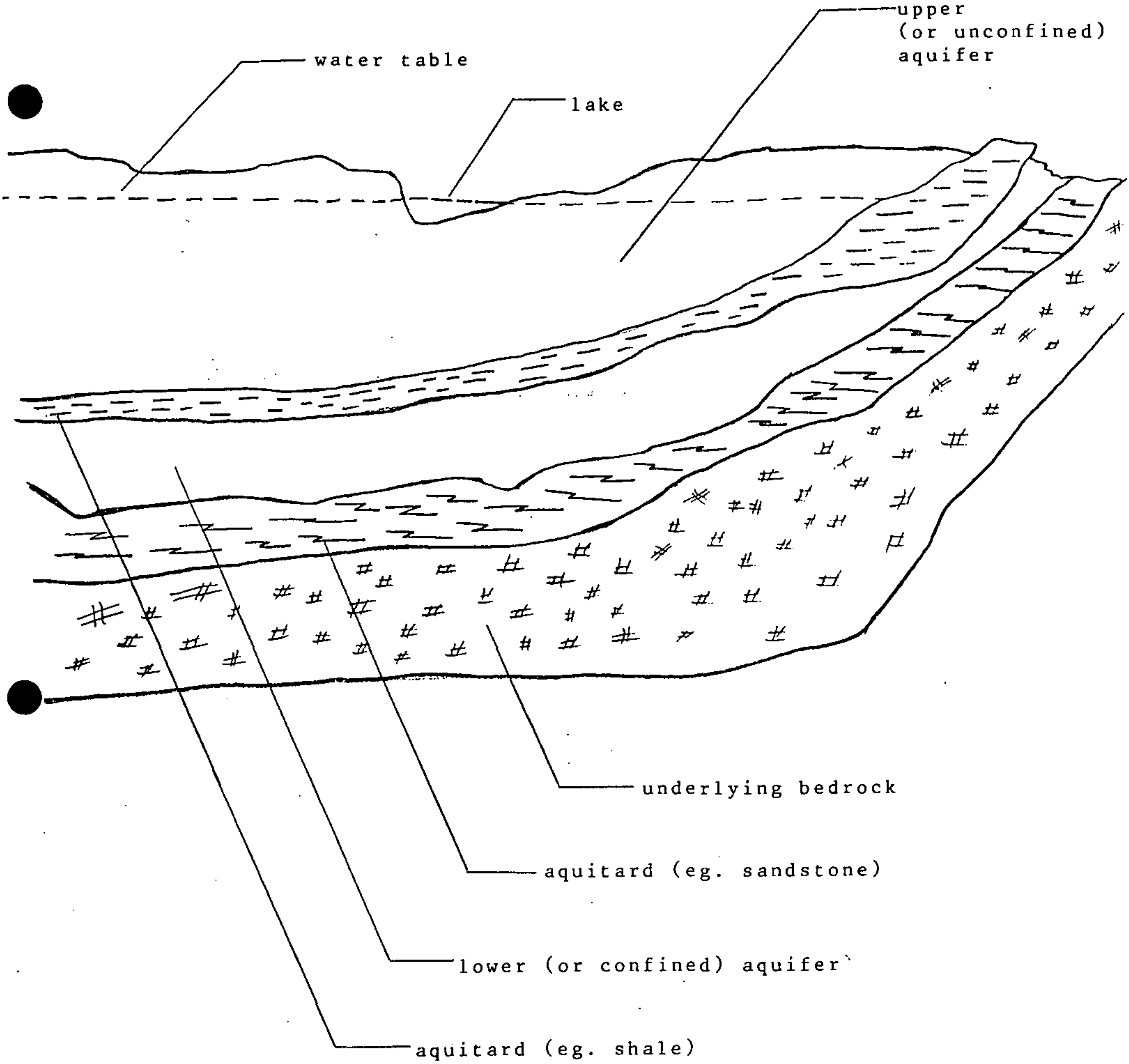


Fig. 1- Geologic cross section illustrating both confined and unconfined aquifers.

ILLINOIS' HYDROLOGIC BUDGET

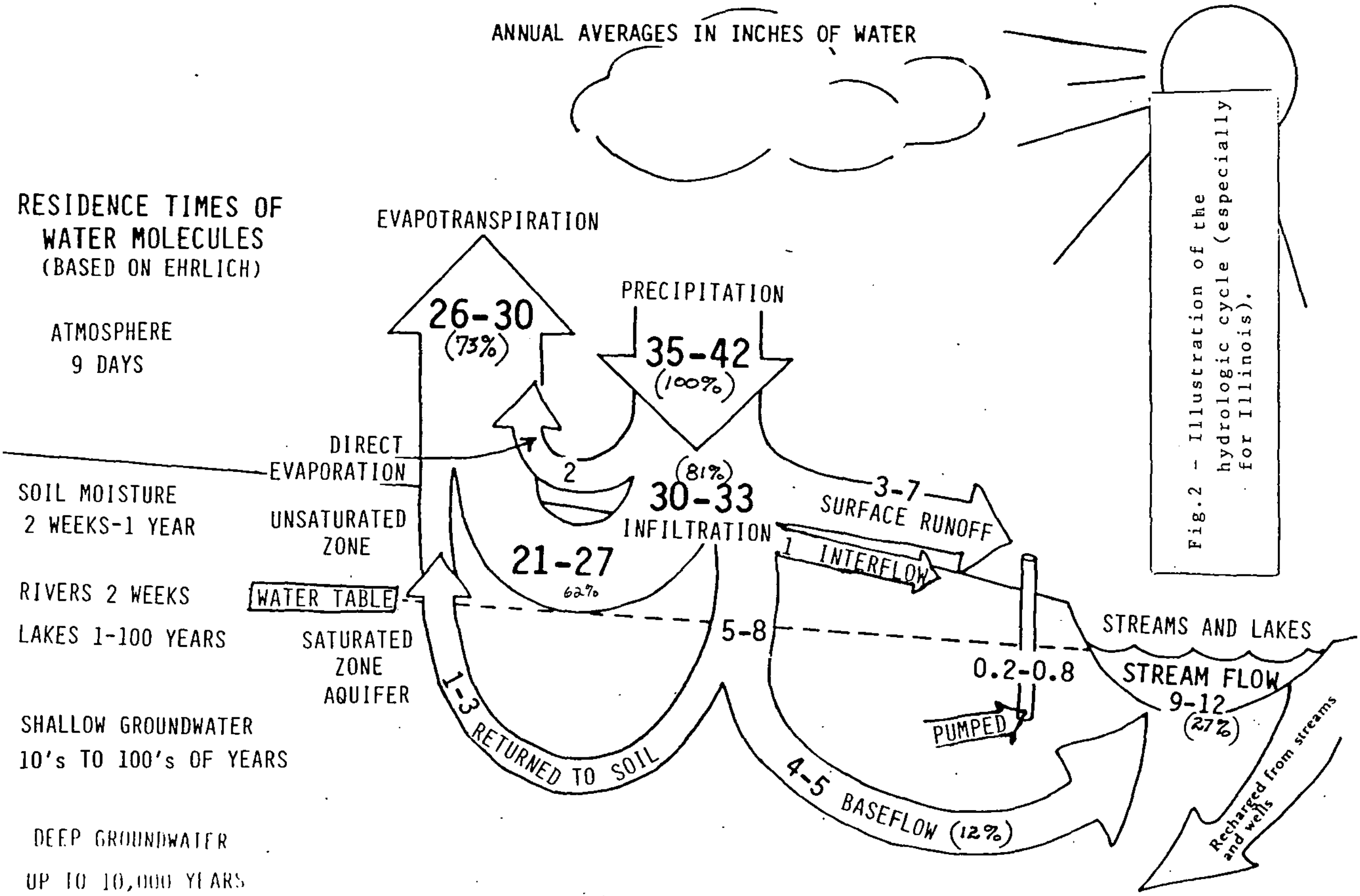


Fig.2 - Illustration of the hydrologic cycle (especially for Illinois).

ADAPTED FROM MATERIAL PROVIDED
BY THE ILLINOIS STATE WATER SURVEY

SOURCE : ILEPA

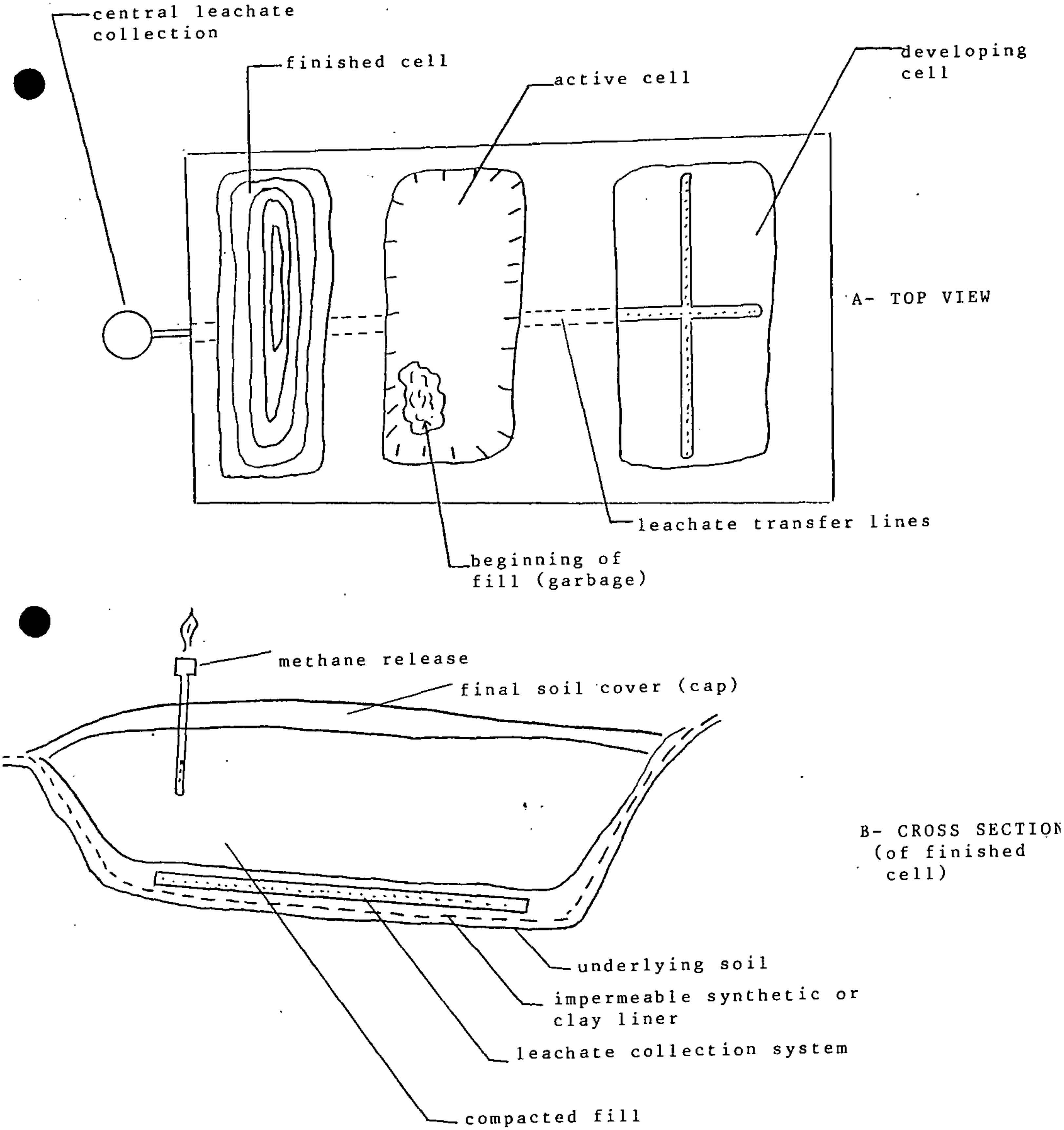


Fig.3 - Generalized landfill overview.

IEPA/DLPC

CHEMICAL ANALYSIS FORM

Page 2 of 2

RECORD CODE L P C S M 0 2 (1–7)
TRANS CODE A (8)

SITE INVENTORY NUMBER 1 6 5 8 0 8 0 0 0 1 (9–18)
MONITOR POINT NUMBER G 1 1 0 (19–22)

REGION S CO. SALINE
DATE COLLECTED 23 M / D / Y 28

SALINE COUNTY LANDFILL
FACILITY NAME

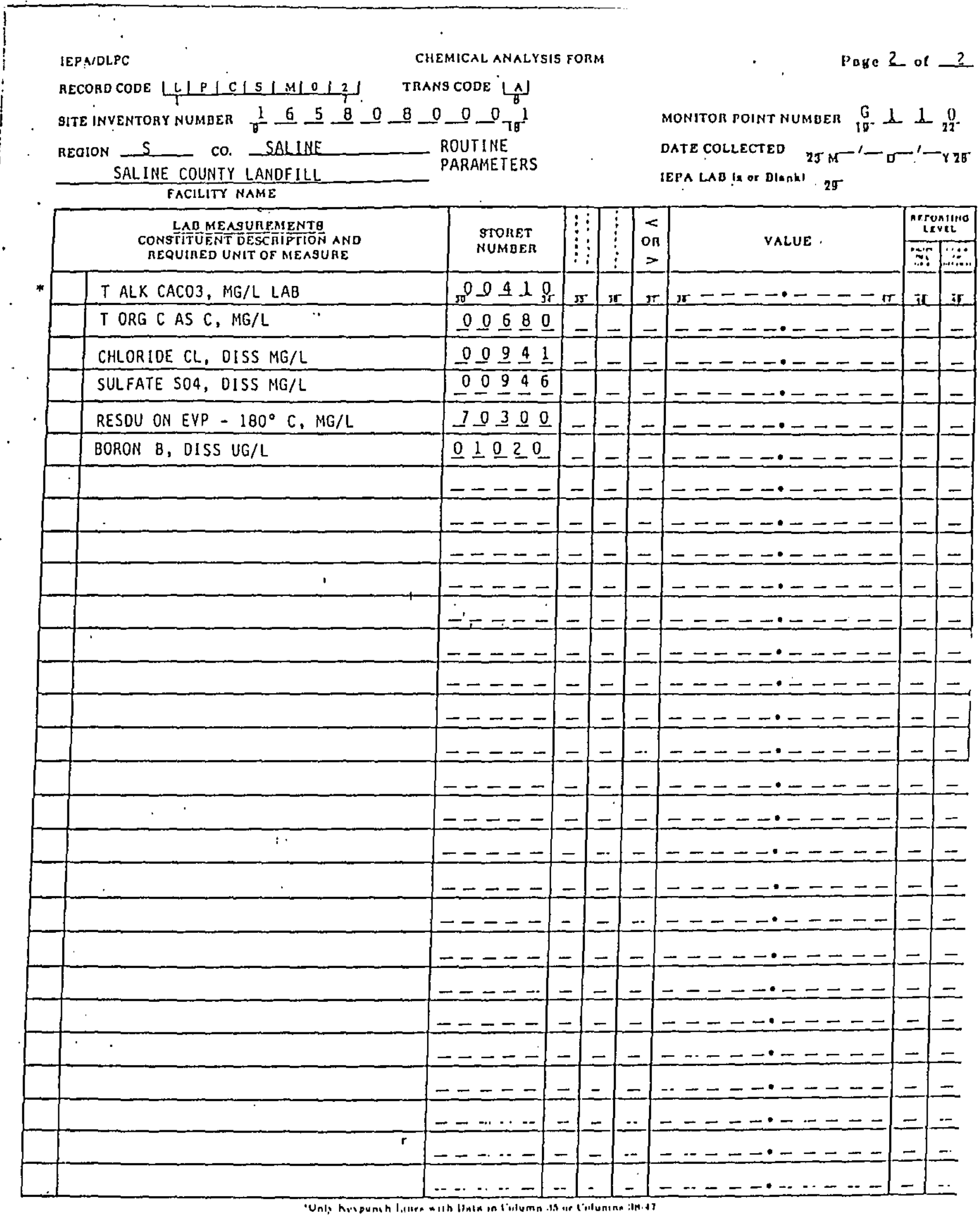
BACKGROUND PARAMETERS

IEPA LAB (x or Blank) 29

	LAB MEASUREMENTS CONSTITUENT DESCRIPTION AND REQUIRED UNIT OF MEASURE	STORET NUMBER			< OR >	VALUE	REPORTING LEVEL	
							[illegible]	[illegible]
*	T ALK CACO3 MG/L LAB	0 0 4 1 0 (30–34)	35	36	37	38 . 47	48	49
	NH3+NH4- N DISS MG/L	0 0 6 0 8				.		
	NO2&NO3 N DISS MG/L	0 0 6 3 1				.		
	PHOS-DISS MG/L P	0 0 6 6 6				.		
	T ORG C AS C MG/L	0 0 6 8 0				.		
	CYANIDE, TOTAL MG/L	0 0 7 2 0				.		
	CALCIUM CA, DISS MG/L	0 0 9 1 5				.		
	MGNSIUM MG, DISS MG/L	0 0 9 2 5				.		
	SODIUM NA, DISS MG/L	0 0 9 3 0				.		
	PTSSIUM NA, DISS MG/L	0 0 9 3 5				.		
	CHLORIDE CL, MG/L	0 0 9 4 1				.		
	SULFATE SO4, DISS MG/L	0 0 9 4 6				.		
	FLUORIDE F, DISS MG/L	0 0 9 5 0				.		
	ARSENIC AS, DISS UG/L	0 1 0 0 0				.		
	BARIUM BA, DISS UG/L	0 1 0 0 5				.		
	BORON B, DISS UG/L	0 1 0 2 0				.		
	CADMIUM CD, DISS UG/L	0 1 0 2 5				.		
	CHROMIUM CR, DISS UG/L	0 1 0 3 0				.		
	IRON FE, DISS UG/L	0 1 0 4 6				.		
	LEAD PB, DISS UG/L	0 1 0 4 9				.		
	MANGANESE MN, DISS UG/L	0 1 0 5 6				.		
	NICKEL NI, DISS UG/L	0 1 0 6 5				.		
	SILVER AG, DISS UG/L	0 1 0 7 5				.		
	ZINC ZN, DISS UG/L	0 1 0 9 0				.		
	SELENIUM SE, DISS UG/L	0 1 1 4 5				.		
	PHENOLS TOTAL UG/L	3 2 7 3 0				.		
	RESIDUE ON EVAP 180 C MG/L	7 0 3 0 0				.		
	MERCURY HG, DISS UG/L	7 1 8 9 0				.		

*Only Keypunch Lines with Data in Column 36 or Columns 38-47

Fig.4 - Page 2 of Saline Co.'s IEPA Quarterly Groundwater Monitoring Report showing background parameters.



IEPA/DLPC

CHEMICAL ANALYSIS FORM

Page 2 of 2

RECORD CODE L P C S M 0 2

TRANS CODE A

SITE INVENTORY NUMBER 1 6 5 8 0 8 0 0 0 1

MONITOR POINT NUMBER G 1 1 0

REGION 5 CO. SALINE

ROUTINE PARAMETERS

DATE COLLECTED M / D / Y

SALINE COUNTY LANDFILL

FACILITY NAME

IEPA LAB (x or Blank)

	LAB MEASUREMENTS CONSTITUENT DESCRIPTION AND REQUIRED UNIT OF MEASURE	STORET NUMBER			< OR >	VALUE	REPORTING LEVEL	
*	T ALK CACO3, MG/L LAB	00410				.		
	T ORG C AS C, MG/L	00680				.		
	CHLORIDE CL, DISS MG/L	00941				.		
	SULFATE SO4, DISS MG/L	00946				.		
	RESDU ON EVP - 180° C, MG/L	70300				.		
	BORON B, DISS UG/L	01020				.		
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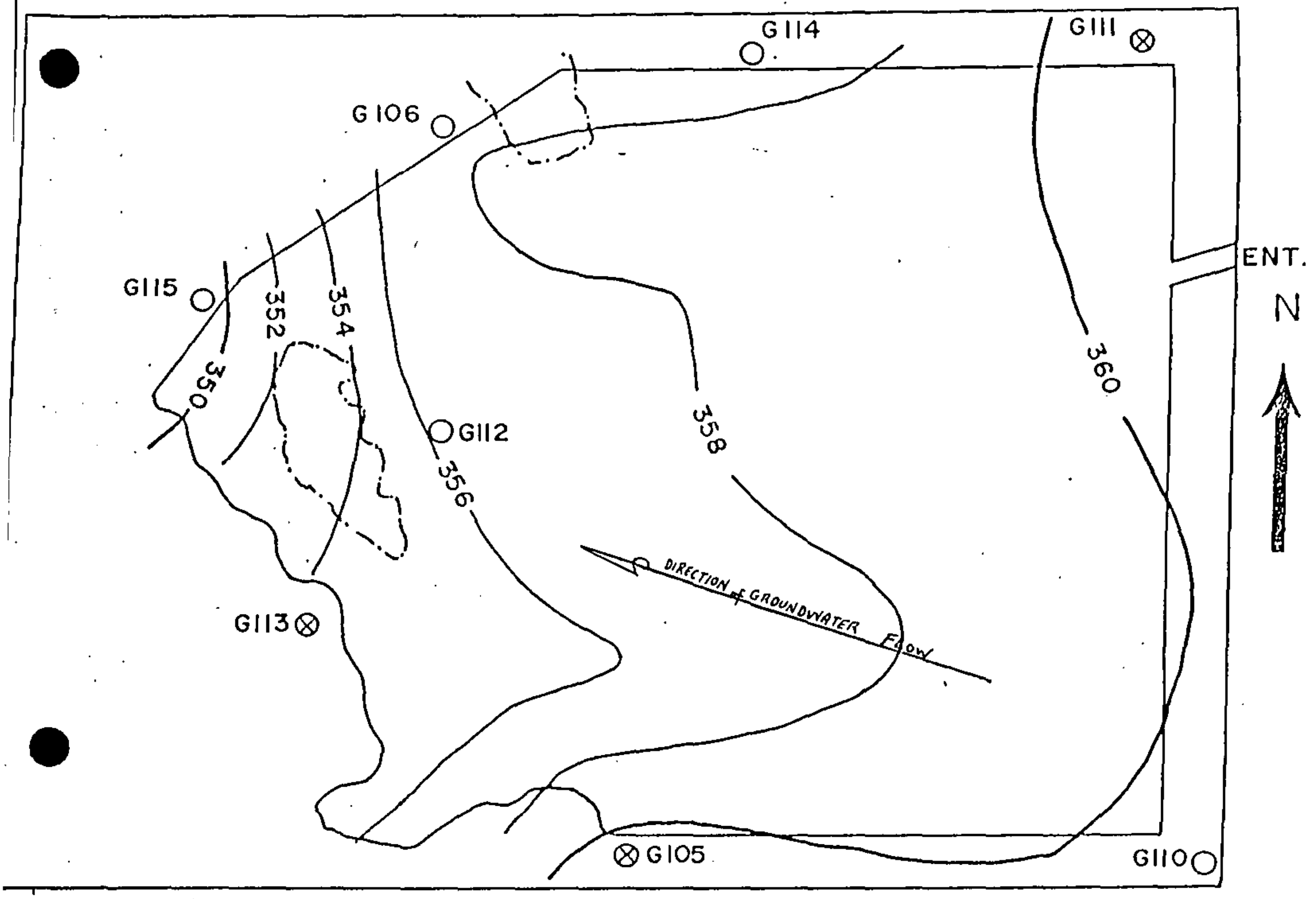
*Only Keypunch Lines with Data in Column 35 or Columns 38-47

Fig.5 - Page 2 of Saline Co.'s IEPA Quarterly Groundwater Monitoring Report showing routine parameters

PART OF THE SW 1/4, SW 1/4, SEC.5, T10S, R7E, 3 P.M.



SCALE: 1" = 200'

MONITORING WELLS ○

G106, G110, G112, G114, G115

PIEZOMETERS ⊗

G105, G111, G113

PIEZOMETRIC MAP SHOWING TWO FOOT CONTOURS OF GROUNDWATER ELEVATIONS BASED ON THE AVERAGE OF 4 QUARTERLY MEASUREMENTS OF EXISTING PIEZOMETERS AND MONITORING WELLS.

Fig.6 - Saline Co. Landfill site map showing well locations and groundwater flow direction.

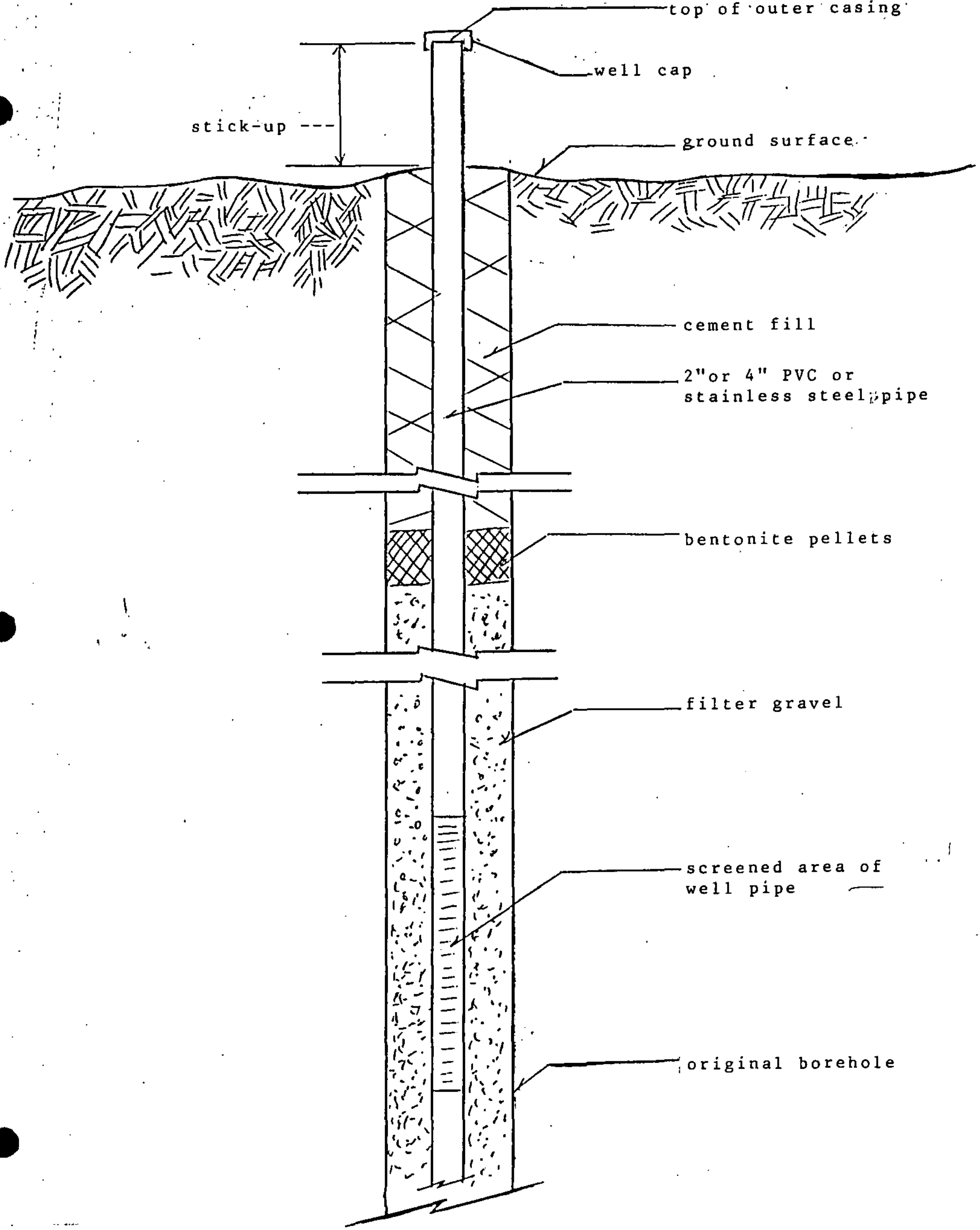


Fig. 7- Generalized representation of a groundwater monitoring well.

Appendix 1. Compilation of useful dates, addresses, and values

DATES of IMPORTANCE

	[Sample Between]	[IEPA Reports Due]
1st Quarter	January 15 - February 15	April 15
2nd Quarter	April 15 - May 15	July 15
3rd Quarter	July 15 - August 15	October 15
4th Quarter	October 15 - November 15	January 15

Send Reports To: Cheryl Putting

Division of Land and Noise
IEPA
2200 Churchill Road
Springfield, IL 62706
Phone: (217) 782-6760

Site wells and elevations from MSL

Saline County	
G105	374.5
G106	370.4
G110	388.9
G111	415.7
G112	363.8
G113	355.4
G114	386.5
G115	356.3

Jackson County	
G101	406
G102	400
G103	400
G104	408
G105	410

[illegible]TE: Any questions regarding the filling out of IEPA Quarterly Groundwater Monitoring forms may be addresses to their instructions found in the back of this folder.

Literature Cited

Driscoll, G.G. 1986. Groundwater and Wells. Second edition. Johnson Division, St. paul, Minnesota. 1089 pp.

Franconeri, P. 1983. Groundwater Monitoring Well Primer. Pollution Engineering 15 (8): 24-26.

Grant, D. 1983. Groundwater Sampling, Objectives, Well Design, Instrumentation. Isco Inc. reprint of information from Pollution Equipment News, October 1983.

ILEPA - Unknown source of Illinois Hydrologic cycle chart. Orignal source of data was Illinois State Water Survey.

Noble, G. 1986. Sanitary Landfill Design Hadbook, Site selection investigation and design. Technomic Publishing, Westport, CT 285 pp.

Novick, S.M. 1983. Groundwater Protection Standards: The Confusion in the Hazardous Waste Laws. The Environmental Forum: a publication of the Environmental Law Institute 2 (1): 7-11.

Standard Methods for the Examination of Water and Wastewater. 16th edition 1985. American Health Association, Washington, D.C. 1268 pp.

Todd, D.K. 1970. The Water Encyclopedia. Water Information Center. Port Washington, NY 559 pp.

Wilson, J. 1982. Groundwater. Academy of Natural Sciences. Philadelphia, Pennsylvania 105 pp.

LANDFILL SAMPLING FIELD SHEET

SITE NAME: ____________ FIELD PERSONNEL: ______ ______ ______

DAY: ______ DATE: ___ ___ ___ TIME: ________ AM PM

DAY MO YR

WELL I.D.: ________ ___ piezometer WEATHER:

___ well

ELEVATION FROM MSL: ________ Ambient Temp.: ________

Ⓐ Depth to water from well-cap: ________ ft

Ⓑ Stick-Up: ________ ft

Ⓒ Water depth from land surface: ________ f
(A-B)

Total depth of well from well-cap: ________ ft pH: ________ S.C.: ________ Sample Temp.: ________

NOTES (RE: sample appearance, site characteristics, etc.)

SITE NAME: ____________ FIELD PERSONNEL: ______ ______ ______

DAY: ______ DATE: ___ ___ ___ TIME: ________ AM PM

DAY MO YR

WELL I.D.: ________ ___ piezometer WEATHER:

___ well

ELEVATION FROM MSL: ________ Ambient Temp.: ________

Ⓐ Depth to water from well-cap: ________ ft

Ⓑ Stick-Up: ________ ft

Ⓒ Water depth from land surface: ________ f
(A-B)

Total depth of well from well-cap: ________ ft pH: ________ S.C.: ________ Sample Temp.: ________

NOTES (RE: sample appearance, site characteristics, etc.)

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND POLLUTION CONTROL
CHEMICAL ANALYSIS FORM

Page 1 of 2

RECORD CODE L P C S M 0 1 (1–7)   TRANS CODE A (8)

REPORT DUE DATE 36 M __/__ D __/__ Y 41

FEDERAL ID NUMBER ____________

SITE INVENTORY NUMBER 0 7 7 0 2 0 0 0 0 2 (9–18)

MONITOR POINT NUMBER G 1 0 1 (19–22) (see Instructions)

REGION S   CO. JACKSON

DATE COLLECTED 23 M __/__ D __/__ Y 28

DESOTO / ALLEN #2

LOCATION   RESPONSIBLE PARTY

IEPA LAB (x or Blank) 29 (see Instructions)

FOR IEPA USE ONLY

COMPLAINT NO. ______

DATE RECEIVED 42 M __/__ D __/__ Y 47

SAMPLING PURPOSE CODE 48 (see Instructions)

TIME CARD PROGRAM CODE 49 __ __ 52 & UNIT CODE 53

BACKGROUND SAMPLE (X) 54

TIME COLLECTED (24 HR CLOCK) 55 H __:__ M 58

UNABLE TO COLLECT SAMPLE 59 (see Instructions)

MONITOR POINT SAMPLED BY 60 (see Instructions)   OTHER (SPECIFY) ______

SAMPLE FIELD FILTERED - INORGANICS (X) 61   ORGANICS (X) 62

SAMPLE APPEARANCE 63 ____________ 102

COLLECTOR COMMENTS 103 ____________ 142

SPECIAL INSTRUCTIONS TO LAB ____________

COLLECTED BY ______   143 INITIALS 145   DIVISION OR COMPANY ______   TRANSPORTED BY ______   DIVISION OR COMPANY ______

LAB USE ONLY

LAB SAMPLE NO. ______   LAB NAME ______   LAB ID NO. 148 __ __ 149

DATE RECEIVED ______   AND ADDRESS ______

TIME RECEIVED ______

SAMPLE TEMP OKAY __ (Y/N)   SAMPLE PROPERLY PRESERVED __ (Y/N)   DATE COMPLETED ______   FORWARD ______

LAB COMMENTS 150 ____________ 199

SUPERVISOR SIGNATURE ______

RECORD CODE L P C S M 0 2 (1–7)   TRANS CODE A (8)

	FIELD MEASUREMENTS CONSTITUENT DESCRIPTION AND REQUIRED UNIT OF MEASURE	STORET NUMBER	REMARKS	DUPLICATE	< OR >	VALUE	REPORTING LEVEL	
							[illegible]	[illegible]
X	DEPTH TO WATER (ft. below LS)	7 2 0 1 9 (30–34)	35	36	37	38 ______ 47	48	49
	ELEVATION OF GW SURFACE (ft. ref MSL)	7 1 9 9 3						
	TOTAL WELL DEPTH (ft. below LS)	7 2 0 0 8						
	ALKALINITY TOTAL (mg/l as CaCO3) - Field	0 0 4 3 1						
	REDOX POTENTIAL (millivolt) - Field	0 0 0 9 0						
	pH (units) - Field	0 0 4 0 0						
	SPEC CONDUCTANCE (umhos) - Field	0 0 0 9 4						
X	TEMP OF WATER SAMPLE (°F) - Field	0 0 0 1 1						

This Agency is authorized to require this information under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1004 and 1021. Disclosure of this information is required. Failure to do so may result in a civil

/DLPC

CHEMICAL ANALYSIS FORM

Page 2 of 2

RD CODE L P C S M 0 2 (1–7)   TRANS CODE A (8)

INVENTORY NUMBER 0 7 7 0 2 0 0 0 0 2 (9–18)

MONITOR POINT NUMBER G 1 0 1 (19–22)

ON S   CO. JACKSON

DATE COLLECTED 23 M __/__ D __/__ Y 28

DESOTO / ALLEN #2
LOCATION   RESPONSIBLE PARTY

IEPA LAB (x or Blank) 29

LAB MEASUREMENTS CONSTITUENT DESCRIPTION AND REQUIRED UNIT OF MEASURE	STORET NUMBER	[illegible]	DUPLICATE	< OR >	VALUE	REPORTING LEVEL	
						[illegible]	[illegible]
COD LOW LEVEL MG/L	30 0 0 3 3 5 34	35	36	37	38 — 47	48	49
NH3+NH4 N DISS MG/L	0 0 6 0 8						
CHLORIDE CL, MG/L	0 0 9 4 1						
BORON B, DISS UG/L	0 1 0 2 0						
IRON FE, DISS UG/L	0 1 0 4 6						
RESIDUE DISS-180 C MG/L	7 0 3 0 0						

RECORD CODE L P C S M 0 1 (1–7) TRANS CODE A (8)

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND POLLUTION CONTROL
CHEMICAL ANALYSIS FORM

Page 1 of 2

REPORT DUE DATE 36 M ___ / D ___ / Y 41

FEDERAL ID NUMBER ___

SITE INVENTORY NUMBER 9 1 6 5 8 0 8 0 0 0 1 18

MONITOR POINT NUMBER 19 G 1 0 6 22 (see Instructions)

REGION S CO. SALINE

ROUTINE PARAMETERS

DATE COLLECTED 23 M ___ / D ___ / Y 28

SALINE COUNTY LANDFILL
FACILITY NAME

IEPA LAB (x or Blank) 29 (see Instructions)

FOR IEPA USE ONLY

COMPLAINT NO. ___

DATE RECEIVED 42 M ___ / D ___ / Y 47

SAMPLING PURPOSE CODE 48 (see Instructions)

TIME CARD PROGRAM CODE 49 ___ 52 & UNIT CODE 53

BACKGROUND SAMPLE (X) 54

TIME COLLECTED (24 HR CLOCK) 55 H ___ : ___ M 58

UNABLE TO COLLECT SAMPLE 59 (see Instructions)

MONITOR POINT SAMPLED BY 60 OTHER (SPECIFY) (see Instructions)

SAMPLE FIELD FILTERED - INORGANICS (X) 61 ORGANICS (X) 62

SAMPLE APPEARANCE 63 ___ 102

COLLECTOR COMMENTS 103 ___ 142

SPECIAL INSTRUCTIONS TO LAB ___

COLLECTED BY ___ 143 INITIALS 145 ___ DIVISION OR COMPANY ___ TRANSPORTED BY ___ DIVISION OR COMPANY

LAB USE ONLY

LAB SAMPLE NO. ___ LAB NAME AND ADDRESS ___ LAB ID NO. 146 ___ 149

DATE RECEIVED ___

TIME RECEIVED ___

SAMPLE TEMP OKAY (Y/N) SAMPLE PROPERLY PRESERVED (Y/N) DATE COMPLETED ___ FORWARD ___

LAB COMMENTS 150 ___ 199

SUPERVISOR SIGNATURE

RECORD CODE L P C S M 0 2 (1–7) TRANS CODE A (8) (COLUMNS 9-29 FROM ABOVE)

	FIELD MEASUREMENTS CONSTITUENT DESCRIPTION AND REQUIRED UNIT OF MEASURE	STORET NUMBER			< OR >	VALUE	REPORTING LEVEL	
X	DEPTH TO WATER (ft. below LS)	7 2 0 1 9 (30–34)	35	36	37	38 ___ • ___ 47	48	49
X	ELEVATION OF GW SURFACE (ft. ref MSL)	7 1 9 9 3				•		
	TOTAL WELL DEPTH (ft. below LS)	7 2 0 0 8				•		
	ALKALINITY TOTAL (mg/l as CaCO3) - Field	0 0 4 3 1				•		
	REDOX POTENTIAL (millivolt) - Field	0 0 0 9 0				•		
X	pH (units) - Field	0 0 4 0 0				•		
X	SPEC CONDUCTANCE (umhos) - Field	0 0 0 9 4				•		
X	TEMP OF WATER SAMPLE (°F) - Field	0 0 0 1 1				•		
X	DEPTH TO WATER FR MP FT	7 2 1 0 9				•		
A	WELL DEPTH ELEVATION FT REF MSL	7 2 0 2 0				•		

[illegible] under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1004 and 1021. Disclosure of this information is required. Failure to do so may result in a civil

IEPA/DLPC

CHEMICAL ANALYSIS FORM

Page 2 of 2

RECORD CODE L P C S M 0 2 (1–7) TRANS CODE A (8)

SITE INVENTORY NUMBER 1 6 5 8 0 8 0 0 0 1 (9–18)

MONITOR POINT NUMBER G 1 0 6 (19–22)

REGION S CO. SALINE

ROUTINE PARAMETERS

DATE COLLECTED 23 M __/__ D __/__ Y 28

SALINE COUNTY LANDFILL

FACILITY NAME

IEPA LAB (x or Blank) 29

LAB MEASUREMENTS CONSTITUENT DESCRIPTION AND REQUIRED UNIT OF MEASURE	STORET NUMBER			< OR >	VALUE	REPORTING LEVEL	
T ALK CACO3, MG/L LAB	00410 (30–34)	35	36	37	38 . 47	48	49
T ORG C AS C, MG/L	00680				.		
CHLORIDE CL, DISS MG/L	00941				.		
SULFATE SO4, DISS MG/L	00946				.		
RESDU ON EVP - 180° C, MG/L	70300				.		
BORON B, DISS UG/L	01020				.		
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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
Division of Land Pollution Control
April, 1984

INSTRUCTIONS FOR COMPLETING CHEMICAL ANALYSIS FORMS

The collection of site monitoring data is needed to evaluate the effect of treatment, storage, and disposal facilities on water quality. This form is to be used by individual sites in complying with their monitoring requirements. The forms sent directly to the site operator are to be kept by him and used as originals for making copies. These originals are NOT to be written upon. The site operator is requested to use the originals to make his own supply of chemical analysis forms. He will then use these copies in submitting the required reports. It will be the site operator's (or his designee's) responsibility to collect the sample, complete all applicable parts of the form, and see that the form and sample are delivered to a laboratory of his choice, to be analyzed for the proper parameters. Pertinent laboratory information must be included on all analysis forms. Note that the chemical analysis form allows for the less than symbol (<). Therefore, laboratories must report an absolute value or a less than value. Zeros will not be accepted. It will be the responsibility of the site operator and/or his designated lab to match up the correct monitor point number with the correct sample. The site operator should supply the laboratory performing his analytical work with a copy of these instructions. For this system to work, all persons responsible for completing the form must be familiar with the following directions.

GENERAL RULES IN FILLING OUT THE FORM

Print or type one character over one dash. Punctuation marks occupy a full space. When making a numerical entry where there are more than enough spaces, put in leading zeros. For example, enter 0 2 0 1 8 3 not 2 / 1 / 8 3.

Print legibly, as these forms will go directly to a keypunch operator who has no knowledge of our terminology and, therefore, will be unable to interpret your entries if they are not legible.

There are a few numbers and letters which tend to look alike when handprinted. To enable the keypunch operator to easily distinguish between these numbers and letters, use the following conventions:

Numbers	Letters
0	Ø
1	I
2	Ƶ
5	S

Also, to distinguish between U and V, write them u and v.

INSTRUCTION FOR SPECIFIC ITEMS

1. Page 1 of —. Since this is a multi page form, it is necessary to include the total number of pages in the report being submitted. Example: If the report is made up of 3 pages, you would have Page 1 of 3, Page 2 of 3, and Page 3 of 3. This information will be preprinted on the form.

2. Ignore 'Record Code' and 'Trans Code' (spaces 1 - 8). These are for use by keypunch operators.

3. Report Due Date (spaces 36-41). This date indicates the reporting period for the data being submitted. The date must be entered numerically month, day, year. Example: If the data being submitted is for the report due July 15, 1984, the date entered would be 07/15/84.

4. Federal ID Number. This is a USEPA identification number which has been assigned to certain sites. If applicable, this will be preprinted on the form.

5. Site Inventory Number (spaces 9-18). This is the IEPA identification number which has been assigned to every site. This will be preprinted on the form.

6. Region. This is an IEPA assigned letter referring to 1 of 4 regions in which the site is located. This will be preprinted on the form.

7. County, Location, Responsible Party. This is the file heading which the IEPA has assigned to the site. This will be preprinted on the form.

8. Monitor Point Number (spaces 19-22). This is the IEPA assigned number that identifies the specific monitor point where the sample is taken. The Agency will assign monitor point numbers upon establishment of the monitoring program. This will be preprinted on the form.

9. Date Collected (spaces 23-28). This is the date the sample is collected. The date must be entered numerically month, day, year. Example: If the sample is collected May 8, 1984, the date entered would be 05/08/84.

10. IEPA Lab (space 29). This is for IEPA use only. It indicates that the sample was collected by IEPA personnel and analyzed by an IEPA lab.

11. Please note that items 5-9 must be completed on all pages of the form.

12. The above information except for the Report Due Date (item 3) and the Date Collected (item 9) will be preprinted on the form. It is the responsibility of the site operator to verify that the preprinted

information is accurate. It is further the responsibility of the site operator or his designee to complete the Report Due Date (item 3) and the Date Collected (item 9). Please note that the Date Collected appears on all pages of the form. Therefore this must be completed on all pages.

13. Spaces 42-53 are for IEPA use only. Please do not write in these spaces.

14. Background Sample (space 54). This indicates whether the sample collected is part of the background "initial quality" data for the monitor point. If this is the case, please put an "X" in space 54.

15. Time Collected (spaces 55-58). This indicates the time the sample was collected. The time must be entered in military format. For samples collected in the PM simply add 12 hours. Example: the sample is collected at 3:45 p.m. Add 12 hours to this and record 15:45 on the form.

16. Unable to Collect Sample (space 59). If a sample cannot be collected, select the appropriate code from the table below and enter it in space 59.

Unable to Collect Sample Table

A	Sampling Equipment Malfunction.
B	Monitoring Point Could Not Be Located.
C	Area Flooded - Could Not Get to Monitor Point.
D	Stream Dry.
E	Stream Frozen.
F	Pond Dry.
G	Pond Frozen.
H	Well Not Yet Installed.
I	Well Dry.
J	Well Damaged or Destroyed.
K	Well Obstructed.
L	Well Silted In.
X	None of the Above, See Collector Comment Section for Reason Unable to Collect Sample.

In cases where a sample cannot be collected, it is not necessary to send the analysis form to the laboratory which normally performs the analytical work. When the applicable portions of the analysis form are completed, it can be sent directly to:

Illinois Environmental Protection Agency
Division of Land Pollution Control #24
Compliance Monitoring Section
2200 Churchill Road
Springfield, Illinois 62706

17. Monitor Point Sampled By (space 60). Indicate the method used to collect the sample by selecting the appropriate code from the table below and enter it in space 60.

Monitor Point Sampled By Table

1	Bailer Not Otherwise Indicated Below. Specify on Form.
2	Pump Not Otherwise Indicated Below. Specify on Form.
3	Other. Sampling Method Not Specified Below. Specify on Form.
A	Bailer -- Teflon.
B	Bailer -- PVC.
C	Bailer -- Plastic Other than Above. Specify on Form.
D	Bailer -- Galvanized.
E	Bailer -- Copper.
F	Bailer -- Stainless Steel
G	Bailer -- Metal Other Than Above. Specify on Form.
H	Pump -- Suction Lift.
I	Pump -- Submersible.
J	Pump -- Air Lift.
K	Pump -- Gas Lift.
L	Pump -- Squeeze or Bladder.

(Table continued to next page)

Monitor Point Sampled By Table - Continued

M	Grab -- Using a Dipper.
N	Grab -- Using a Weighted Bottle.
O	Grab -- Using Sample Bottle
P	Grab -- Glass "Thieving" Tube.
Q	Grab -- Other than Above. Specify on Form.
R.	Tap off of a Distribution Line.

18. Sample Field Filtered (spaces 61 & 62). Indicate if the sample was field filtered by placing an 'X' in space 61 if the inorganic constituents of the sample were field filtered and an 'X' in space 62 if the organic constituents of the sample were field filtered. Analyses of groundwater samples for inorganic constituents are to be performed on samples which have been field filtered.

19. Sample Appearance (spaces 63 - 102). This is the physical characteristic of the sample at the time of collection (e.g., turbidity, color, etc.)

20. Collector Comments (spaces 103-142). This space provides for comments made by the sample collector at the time of sample collection.

    Note: Both Sample Appearance (item 19) and Collector Comments (Item 20) will be computerized. Please use care in filling these sections out. Print only one character to a dash and please print legibly.

21. Collected By. The person collecting the sample is to sign the form in the space provided. That person is to indicate their title and/or company they represent.

22. Collector's Initials (spaces 143-145). The initials of the sample collector are to be recorded in spaces 143-145.

23. Transported By. The person transporting the sample to the laboratory is to sign the form in the space provided and indicate their title and/or company they represent. If the sample is mailed or shipped to the laboratory this is to be indicated in this space.

24. Field Measurements (Bottom of Page 1). This area of the form is to be used to record any field measurement made concerning the sample collection. Only those items marked with an 'X' to the left are required to be completed. However, if other field measurements are made, please provide that information in the appropriate spaces.

ABBREVIATIONS USED IN THIS SECTION

ft = feet
LS = Land Surface
REDOX = Oxidation-Reduction Potential
ref = reference
GW = Groundwater
MSL = Mean Sea Level

For field measurements which may have a minus value (i.e. Redox Potential), place a "-" sign in the Remarks column (column 35). See the Remarks Table for other codes which may be applicable here.

For field measurements which may have a less than or greater than value, place the appropriate "<" or ">" symbol in column 37.

Value (columns 38-47). This is the space to report the value measured for the constituent of interest. All values are to be lined up on the decimal point. Make sure that the value reported is in the required unit of measure.

Reporting Level (column 48 and 49). This is used to indicate the reporting level for the value measured. Column 48 indicates the number of positions left or right of the decimal point. Column 49 indicates which direction (left or right) of the decimal point. Example: If specific conductance is measured to be 135.7, columns 48 and 49 would be 1 R respectively.

Any field measurement which is required to be done in replicate (i.e., pH, spec. conductance), can not be included in the Field Measurements section (bottom of page 1). Replicate measurements must be listed on page 2 in the Lab Measurement section. Field measurements can be listed in the Lab Measurement section. For facilities required to make replicate measurements, this information will be preprinted on the form. If replicate measurements are being made, column 36 (Replicate) must be completed. Each replicate is to be numbered in sequence.

Example: Four replicate measurements of pH would be listed as follows.

Constituent	STORET Number	Replicate	Value
pH - Field	0 0 4 0 0 30 34	1 36	7 . 8 38 47
pH - Field	0 0 4 0 0	2	8 . 2
pH - Field	0 0 4 0 0	3	8 . 0
pH - Field	0 0 4 0 0	4	7 . 7

INSTRUCTIONS FOR LABORATORIES

25. Lab Identification Number (Middle of page 1, spaces 146 - 149). This is an identification number identifying the laboratory performing the analysis. For laboratories which have been certified for potable water analyses by the Illinois Environmental Protection Agency, enter the last four digits of their lab certification number. Laboratories which have not been certified should contact Mark Haney of the Division of Land Pollution Control, Compliance Section (217/782-6761), for assignment of an identification number. Please note that we will only assign an identification number. This number does not constitute lab certification.

26. Lab Comments (Middle of page 1, spaces 150-199). This space can be used to report values which are larger than the space provided. It can also be used to report any remarks that are not covered by the remark code table below. Note: The Lab Comment Section will be computerized. Please use care in filling this section out. Print only one character to a dash and please print legibly.

    All other applicable information in the Lab Use only seciton (middle of page 1) should be completed and the laboratory supervisor should sign in the appropriate space.

27. Page 2 and Successive Pages. The top of these pages (Site Inventory Number, Monitor Point Number, and Date Collected) must match what is on page 1. For the majority of cases, each monitoring point will have a minimum of two pages.

28. Lab Measurements. The Agency will attempt to preprint the constituents which a facility is required to monitor for in this section. However, it is the site's responsibility to test for all constituents required by the site's monitoring program. Please notify Mark Haney (217/782-6761) if a required constituent has been left off the analysis form.

    This section will include the constituent description and the required unit of measure. Please note that the unit of measure for some constituents may be mg/l while the unit of measure for other constituents may be ug/l.

29. STORET Number (columns 30-34). This is a 5 digit code number identifying the chemical constituent being reported. This number will be preprinted on the form.

    Example: If you are required to monitor for iron, chloride and residue on evaporation; these will be preprinted on the form as follows:

Constituent	STORET Number
CHLORIDE, MG/L	0 0 9 4 0 30 34
IRON FE, DISS UG/L	0 1 0 4 6
RESIDUE DISS - 180 C MG/L	7 0 3 0 0

30. Remarks (column 35). This code indicates why a particular constituent was not tested for or other pertinent remarks. Select the appropriate code from the table below and enter it in column 35.

Remarks Table

-	Negative Value.
A	Well Does Not Allow Access to Measure Depth to Water or Total Depth.
B	Field Measuring Equipment Break Down or Malfunction.
C	Value Reported is Larger than Spaces Provided; See Lab Comment Section for Value.
D	Value was Calculated, or Estimated.
E	Sample Bottle Broken in Transit to Lab.
F	Sample not Properly Preserved for This Constituent.
G	Sample was Discarded Before Constituent was Analyzed For.
H	Lab Accident, Sample Lost.
I	Not Enough Sample to Analyze for Constituent.
J	Sample Interference, Could Not Analyze for Constituent.
K	Presence of Constituent Verified but Not Quantified.
L	Sample Analyzed but Analysis Lost.
M	Sample Lost
U	Indicates Constituent was Analyzed for but not Detected.
X	Remark not Listed Above, see Lab Comment Section or Collector Comment Section.

31. Replicate (column 36). If replicate measurements are being made, column 36 (Replicate) must be completed. Each replicate is to be numbered in sequence.

Example: Four replicate measurements of Total Organic Carbon (TOC) would be listed as follows.

Constituent	STORET Number	Replicate
T ORG C AS C MG/L	0 0 6 8 0 30 34	1 36
T ORG C AS C MG/L	0 0 6 8 0	2
T ORG C AS C MG/L	0 0 6 8 0	3
T ORG C AS C MG/L	0 0 6 8 0	4

For facilities required to make replicate measurements, this information will be preprinted on the form.

32. Less Than or Greater Than Symbols (Column 37). For a constituent which has a less than or greater than value, place the appropriate "<" or ">" symbol in column 37. Since this form allows for the less than symbol (<), laboratories must report an absolute value or a less than value. Zeros will not be accepted.

33. Value (columns 38-47). This is the space to report the value measured for the constituent of interest. All values are to be lined up on the decimal point. Make sure that the value reported is in the required unit of measure.

34. Reporting Level (column 48 and 49). This is used to indicate the position of the last significant digit. Column 48 indicates the number of positions left or right of the decimal point. Column 49 indicates which direction (left or right) of the decimal point. Example: Iron is analyzed for and found to be 1560.0 ug/l. If six is the last significant digit, then the reporting level (column 48 and 49 would be 2 L.

35. Once all required analyses and requested information have been provided the form is to be sent to:

Illinois Environmental Protection Agency
Division of Land Pollution Control #24
Compliance Monitoring Section
2200 Churchill Road
Springfield, Illinois 62706

MN:cb/0668d,12-20

Illinois Environmental Protection Agency · 2200 Churchill Road, Springfield, IL 62706

DIVISION OF LAND POLLUTION CONTROL
CHEMICAL ANALYSIS FORM (LPC 160)

CLARIFICATION MEMO
October, 1984

Clarification of REPORTING LEVEL (column 48 and 49).

The reporting level is used to indicate the position of the <u>last</u> significant digit. Column 48 indicates the number of positions that the significant digit is left or right of the decimal point. Column 49 indicates which direction (left or right) of the decimal point. The reporting level is dependent on the analytical capability of the laboratory doing the analytical work. Contact Monte Nienkerk (217/782-6762) with any questions.

<u>Example</u>:

Oil and Grease is analyzed for and reported to be 300.00 mg/l.

1. If the three is the only significant digit, then the reporting level would be recorded as follows:

Constituent	Value											Reporting Level	
Oil & Grease	__	__	3	0	0	.	0	0	__	__	__	3	L
	38		*								47	48	49

2. If the zero, two places to the left of the decimal point, is the last significant digit; then the reporting level would be recorded as follows:

Oil & Grease	__	__	3	0	0	.	0	0	__	__	__	2	L
				*									

3. If the zero, one place to the left of the decimal point, is the last significant digit; then the reporting level would be recorded as follows:

Oil & Grease	__	__	3	0	0	.	0	0	__	__	__	1	L
					*								

4. If the zero, one place to the right of the decimal point, is the last significant digit; then the reporting level would be recorded as follows:

Oil & Grease	__	__	3	0	0	.	0	0	__	__	__	1	R
							*						

*Last significant digit.

(OVER)

G103 COD= 26.7

Cvilk G102 p.l Monitor pt sampled by E

Minimum Reporting Levels have been established for all constituents which have maximum concentration limits. These minimum reporting levels are as follows:

Constituents	Minimum Reporting Levels		
Aldrin (ug/l)	1	R	
Alpha, total (pc/l)	1	L	
Ammonia (mg/l)	1	L	2 R
Arsenic (ug/l)	1	L	
Barium (ug/l)	3	L	
Beta, total (pc/l)	1	L	
Boron (ug/l)	3	L	2L
Cadmium (ug/l)	1	L	
Chlordane (ug/l)	1	L	
Chloride (mg/l)	2	L	1 L
Chromium (ug/l)	2	L	
Chromium-Hex (ug/l)	2	L	
Chromium-Tri (ug/l)	3	L	
Coliform, total (#/100 ml)	1	L	
Copper (ug/l)	2	L	
Cyanide (mg/l)	3	R	
DDT (ug/l)	1	L	
Dieldrin (ug/l)	1	R	
Endrin (ug/l)	1	R	
Fecal Coliform (#/100 ml)	1	L	
Fluoride (mg/l)	1	R	
Heptachlor (ug/l)	2	R	
Iron (ug/l)	3	L	2L
Lead (ug/l)	2	L	
Lindane (ug/l)	1	L	
Manganese (ug/l)	2	L	
Mercury (ug/l)	1	R	
Methoxychlor (ug/l)	2	L	
Nickel (ug/l)	3	L	
Nitrate + Nitrite (mg/l)	1	L	
Oil & Grease (mg/l)	1	L	
Parathion (ug/l)	2	L	
pH	1	R	
Phenolics (ug/l)	1	L	
Radium (pc/l)	1	L	
Residue on Evap. (mg/l)	2	L	1.L
Selenium (ug/l)	1	L	
Silver (ug/l)	1	L	
Silvex (ug/l)	1	L	
Strontium 90 (pc/l)	1	L	
Sulfate (mg/l)	2	L	
Toxaphene (ug/l)	1	L	
Zinc (ug/l)	3	L	
2,4-D (ug/l)	2	L	
COD	1	R	

MMN:mkb:19/4

Illinois Environmental Protection Agency · 2200 Churchill Road, Springfield, IL 62706

DIVISION OF LAND POLLUTION CONTROL

CHEMICAL ANALYSIS FORM (LPC 160)

217/782-6761

CLARIFICATION MEMO #2

January, 1985

This memo will attempt to clarify a number of questions and/or changes concerning DLPC's Chemical Analysis Form (LPC 160). Changes listed below are effective for all reports due July 15, 1985. Contact Monte Nienkerk with any questions.

A. New STORET number for chloride, dissolved mg/l as Cl. U.S. EPA has recently designated a new STORET number for dissolved chloride (00941).

STORET number for chloride, dissolved mg/l as Cl = 00941

STORET number for chloride, total mg/l as CL = 00940

For any chemical analysis form being used to report groundwater quality monitoring data for chloride, change the STORET number from 00940 to 00941.

If the monitoring point number begins with L, S or X, do not change the STORET number for chloride.

If the monitoring point number does not begin with L, S or X, change the STORET number for chloride to 00941.

B. Leachate analysis for iron; new STORET number.

For any chemical analysis form being used to report leachate quality monitoring data (monitoring point number begins with L) for iron, change iron Fe, total ug/l STORET number 01045 to Iron, total (mg/l as Fe) STORET number 74010.

C. Groundwater monitoring well samples that are to be analyzed for cyanide are not to be field filtered.

For any chemical analysis form being used to report groundwater quality monitoring data (monitoring point number beginning with any letter other than L, S or X) for cyanide, change cyanide dissolved ug/l STORET number 00723 to cyanide total mg/l STORET number 00720.

D. Field filtration of groundwater monitoring well samples.

Groundwater samples collected from monitoring wells are to be field filtered through a 0.45 micron pore size filter membrane prior to sample preservation <u>except</u> for samples being collected which are to be analyzed for cyanide, pH, specific conductance, temperature, phenolics, total organic carbon, total organic halogen, microbiological constituents, radionucleides, pesticides, or any other organic constituent. <u>Note</u>: When analyzing for any of these constituents, the sample should be delivered to the laboratory properly preserved (refrigerated) and left to settle. The analyses should be run on only the decanted portion of the sample.

Any analysis report received which indicates the sample was not properly field filtered or not properly preserved will be rejected and a non-compliance letter sent indicating that information was not received for STORET ___________.

E. Field Measurements

Constituents such as pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen change very rapidly when the sample is removed from its natural subsurface environment into another environment of different temperature, pressure, light, substrate or oxygen conditions. Therefore if any of the above listed constituents are required to be tested for, these tests must be made on-site at the time of sample collection.

Any analysis report received which indicates that these constituents were not tested for in the field will be rejected and a non-compliance letter sent indicating that information was not received for STORET ___________.

F. Unless the permit specified otherwise, when sampling a monitoring well the depth to water (measured in feet below land surface) and the elevation of the groundwater surface (measured in feet referenced to mean sea level) is to be reported with each sampling occurrence. The total well depth (measured in feet below land surface) is to be reported at least annually unless specified otherwise in the permit.

G. Expanded use of IEPA LAB (space 29).

The regulated community can use this space to indicate that a second and even third sample has been collected from the same monitor point on the same day. Enter a <u>2</u> to indicate the second sample. Enter a <u>3</u> to indicate the third sample. This can also be useful if you must split your sample to send to different laboratories for different analyses. <u>Example</u>: First sample goes to the first lab for an inorganic analyses (leave space 29 blank); second sample goes to a second lab for organic analyses (enter a 2 in space 29); and third sample goes to a third lab for a radionuclide analyses (enter a 3 in space 29). Note that in this example the analytical results would be submitted to the Agency on 3 separate report forms.

MNN:mkb:19/54