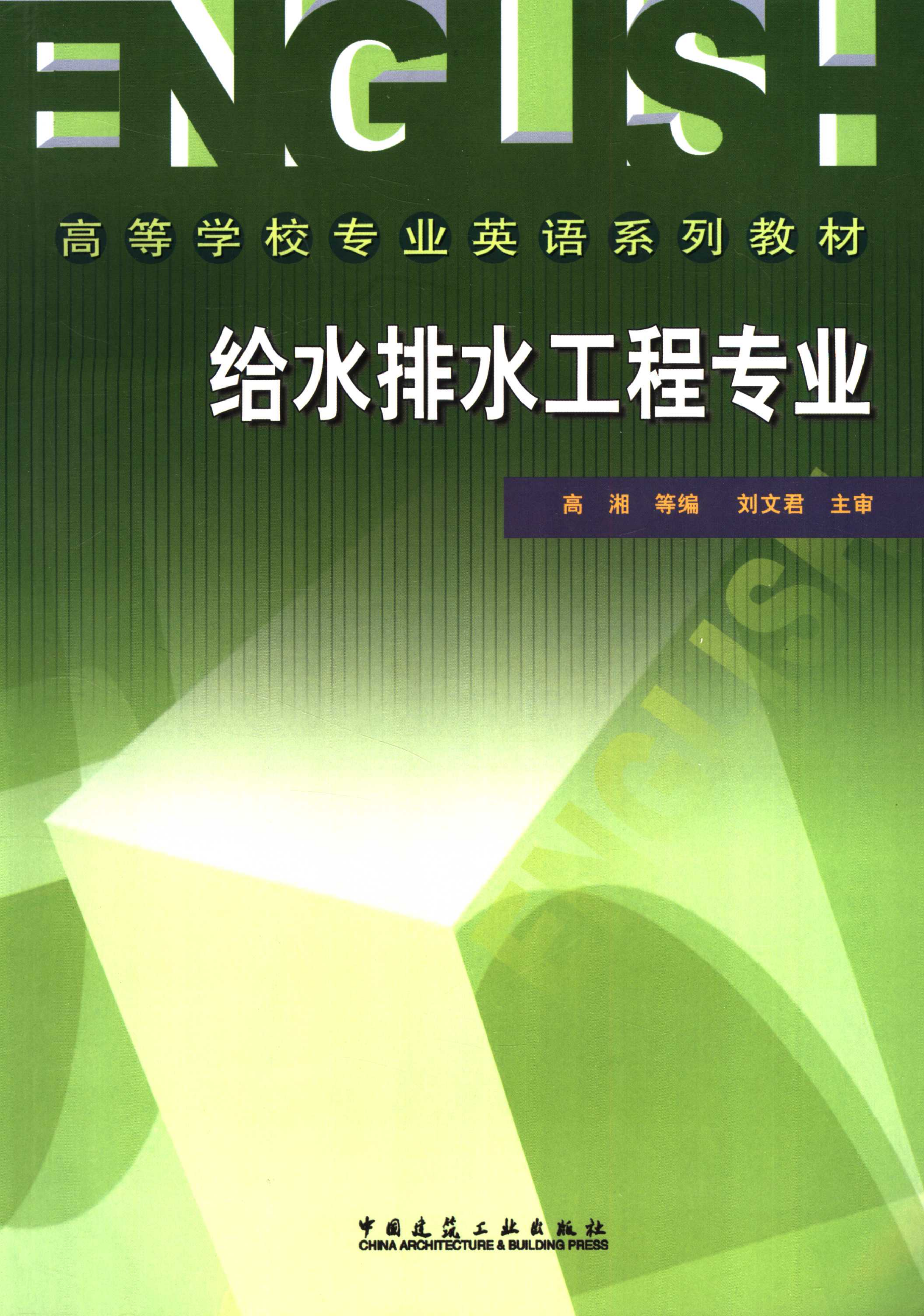
高等学校专业英语系列教材

给水排水工程专业

高　湘　等编　　刘文君　主审



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刘文君 主审
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考虑到给水排水工程专业近年的发展、专业外语课时的限制，为扩大读者获知面，提高读者阅读理解的能力，本教材主要设计了三大部分内容，即水的输送和水处理部分、建筑给水排水部分以及水泵站部分的有关内容，共24课。在编排上，设有课文、阅读材料、单词以及课后简答。课文语言规范，容易理解，阅读材料（Reading Material）主要是课文的拓展部分，收入了一些与课文相关的文章，以加深读者对这些专业理论知识的全面理解。

在内容安排设置上，第1～2课介绍了取水、废水收集、水的输送以及水循环等基础知识，第3～19课主要介绍了水质及其基本检测方法、废水处理基础、废水回用以及生物污泥处理基础、筛滤、混凝、沉淀、过滤、吸附、化学氧化和消毒、离子交换、膜处理、高级氧化、水的生物处理、污泥处理与处置等方面的基本理论及应用，第20～22课介绍了室内的冷热水供应系统的基本知识，第23、24课介绍了泵的基本理论及水泵站设计的相关知识。

本书知识面覆盖较宽，既有基础理论，也有一定的设计和管理知识，适用于给水排水工程专业本科生、硕士研究生的专业英语阅读之用，同时也可作为给水排水工程技术人员、环境工程专业的学生及工程技术人员的参考书。

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前言

随着世界科学技术交流的日趋广泛，增强给水排水工程专业学生的专业外语阅读能力的任务就日趋紧迫与重要。为适应现代教育的发展，同时考虑到当代水处理技术的发展现状，为给水排水工程专业师生以及相关科学技术人员提供一本题材新颖、语言规范、覆盖专业课程主要内容、语言难度适宜的专业英语教材，已成为一种广泛而迫切地需要。

考虑到专业技术的发展、课堂教学的时间以及学生知识结构等多方面因素，本教材主要介绍了三大部分内容，即水的输送和水处理部分、建筑给水排水部分以及水泵站部分的有关内容，共计24课。采用一篇课文带一篇阅读材料的形式，其中阅读材料大多数是课文内容的拓宽或延续，但也有部分阅读材料的内容与课文内容相近或相关。第1、2课主要介绍取水、废水收集、水的输送以及水文循环等基础知识；第3～19课主要介绍水质及其基本检测方法、废水处理基础、废水回用以及生物污泥处理基础、筛滤、混凝、沉淀、过滤、吸附、化学氧化和消毒、离子交换、膜处理、高级氧化、水的生物处理、污泥处理与处置等方面的基本理论及应用；第20～22课介绍室内的冷热水供应系统的基本知识；第23、24课介绍泵的基本理论及水泵站设计的相关知识。在选材上，本教材以世界名校所用教材为主线，结合一定量的设计内容，使得本教材的知识面覆盖较宽，既有基础理论简介，也有一定的设计及管理知识。

本教材共24课，其中1～14课由高湘编写，15～19课由王瑞编写，20～21课由张建锋编写，22课由王涛编写，23、24课由杨玉思编写。

本教材适用于给水排水工程专业本科生、硕士研究生的专业英语阅读，同时也可作为给水排水工程技术人员、环境工程专业的学生及科技人员的参考书。

在本书的编写过程中，得到了齐庆梅编辑的大力支持，正是由于她的努力及勤奋工作才使得本书得以撰写及出版，在此作者表示由衷的谢

意。感谢清华大学刘文君先生在百忙之中对本书进行的认真细致的审校，其中肯、科学的建议使得本书更加完善。同时对其他给予作者支持的人士表示深深的谢意。可以说，本书的完成是那些关心和支持作者的朋友共同努力的结果，真心希望本书能够给广大读者以帮助。

鉴于作者视野和学术能力的局限，在文章选材和编排等方面还存在着不足之处，恳请读者给予批评指正，作者在此表示衷心的感谢。

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LESSON 1

Water Supply

A supply of water is critical to the survival of life, as we know it. People need water to drink, animals need water to drink, and plants need water to drink. The basic functions of society require water: cleaning for public health, consumption for industrial processes, and cooling for electrical generation. In this lesson, we discuss water supply in terms of:

1. Groundwater supplies
2. Surface water supplies

Groundwater Supplies

Groundwater is an important direct source of supply that is tapped by wells, as well as a significant indirect source since surface streams are often supplied by subterranean water.

Near the surface of the earth, in the *zone of aeration*, soil pore spaces contain both air and water. This zone, which may have zero thickness in swamplands and be several hundred feet thick in mountainous regions, contains three types of moisture. After a storm, *gravity water* is in transit through the larger soil pore spaces. *Capillary* water is drawn through small pore spaces by capillary action and is available for plant uptake. *Hygroscopic moisture* is held in place by molecular forces during all except the driest climatic conditions. Moisture, from the zone of aeration cannot be tapped as a water supply source.

In the *zone of saturation*, located below the zone of aeration, the soil pores are filled with water, and this is what we call *groundwater*. A stratum that contains a substantial amount of groundwater is called an *aquifer*. At the surface between the two zones, called the *water table* or *phreatic surface*, the hydrostatic pressure in the groundwater is equal to the atmospheric pressure. An aquifer may extend to great depths, but because the weight of overburden material generally closes pore spaces, little water is found at depths greater than 600m(2000ft). The amount of water that will drain freely from an aquifer is known as *specific yield*.

The flow of water out of a soil can be illustrated using Figure 1. The flow rate must be proportional to the area through which flow occurs times the velocity, or

$$Q = Av \tag{1}$$

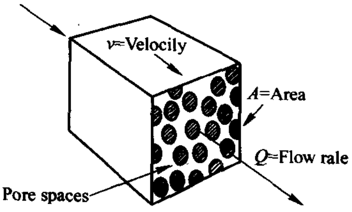

Figure 1 Flow through soil

where Q=flow rate, in m^3/sec
A=area of porous material through which flow occurs, in m^2
v=superficial velocity, in m/sec

The superficial velocity is of course not the actual velocity of the water in the soil, since the volume occupied by the soil solid particles greatly reduces the available area for flow. If a is the area available for flow, then

$$Q=Av=av' \tag{2}$$

where v'=actual velocity of water flowing through the soil
a=area available for flow

Solving for v',

$$v'=\frac{Av}{a} \tag{3}$$

If a sample of soil is of some length L, then

$$v'=\frac{Av}{a}=\frac{AvL}{aL}=\frac{v}{porosity} \tag{4}$$

since the total volume of the soil sample is AL and the volume occupied by the water is aL.

Water flowing through the soil at a velocity v' loses energy, just as water flowing through a pipeline or an open channel does. This energy loss per distance traveled is defined as

$$\text{energy lose}=\frac{\Delta h}{\Delta L} \tag{5}$$

where h=energy, measured as elevation of the water table in an unconfined aquifer or as pressure in a confined aquifer, in m
L=horizontal distance in direction of flow, in m

The symbol (delta) simply means "a change in," as in "a change in length, L." Thus this equation means that there is a change (loss) of energy, h, as water flows through the soil some distance, L.

In an unconfined aquifer, the drop in the elevation of the water table with distance is the slope of the water table in the direction of flow. The elevation of the water surface is the potential energy of the water, and water flows from a higher elevation to a lower elevation, losing energy along the way. Flow through a porous medium such as soil is related to the energy loss using the Darcy equation,

$$Q=KA\frac{\Delta h}{\Delta L} \tag{6}$$

where K=coefficient of permeability, in m/day
A=cross-sectional area, in m^2

The Darcy equation makes intuitive sense, in that the flow rate (Q) increases with increasing area (A) through which the flow occurs and with the drop in pressure, $\Delta h/\Delta L$. The greater the driving force (the difference in upstream and downstream pressures), the greater the flow. The factor, K, is the *coefficient of permeability*, an indirect measure of the ability of a soil sample to transmit water, can be measured by a permeameter shown in Figure 2; it varies dramatically for different soils, ranging from about 0.0005m/day for clay to over 5000m/day for gravel. The coefficient of permeability is measured commonly in the laboratory using *permeameters*, which consist of a soil sample through which a fluid such as water is forced. The flow rate is measured for a given driving force (difference in pressures) through a known area of soil sample, and the permeability calculated.

If a well is sunk into an unconfined aquifer, shown in Figure 3, and water is pumped out, the water in the aquifer will begin to flow toward the well. As the water approaches the well, the area through which it flows gets progressively smaller, and therefore a higher superficial (and actual) velocity is required. The higher velocity of course results in an increasing loss of energy, and energy gradient must increase, forming a *cone of depression*. The reduction in the water table is known in groundwater terms as a *drawdown*. If the rate of water flowing toward the well is equal to the rate of water being pumped out of the well, the condition is at equilibrium, and the drawdowm remains constant. If, however, the rate of water pumping is increased, the radial flow toward the well has to compensate, and this results in a deeper cone or drawdown.

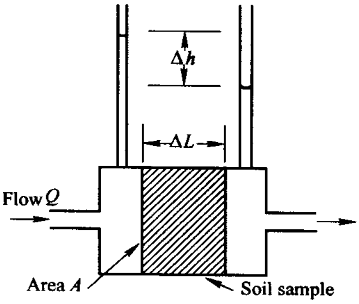

Figure 2 Permeameter used for measuring coefficient of permeability using the Darcy equation

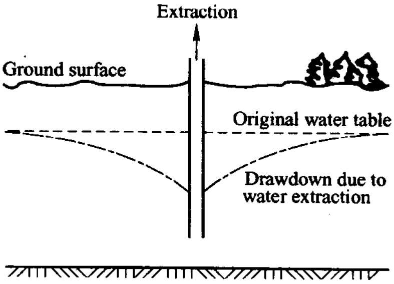

Figure 3 Drawdown in water table due to pumping from a well

Consider a cylinder, shown in Figure 4, through which water flows toward the center. Using Darcy's equation,

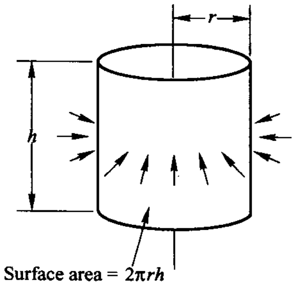

Figure 4 Cylinder with flow though the surface

$$Q=KA\frac{\Delta h}{\Delta L}=K(2\pi rh)\frac{\Delta h}{\Delta r} \tag{7}$$

where r is the radius of the cylinder, and $2\pi rh$ is the cross-sectional surface area of the cylinder. If water is pumped out of the center of the cylinder at the same rate, as water is moving in through the cylinder surface area, the above equation can be integrated to yield

$$Q=\frac{\pi K(h_1^2-h_2^2)}{\ln\frac{r_1}{r_2}} \tag{8}$$

where h_1 and h_2 are the height of the water table at radial distances r_1 and r_2 from the well.

This equation can be used to estimate the pumping rate for a given drawdown any distance away from a well, using the water level measurements in two observation wells in an unconfined aquifer, as shown in Figure 5. Also, knowing the diameter of a well, it is possible to estimate the drawdown at the well, the critical point in the cone of depression. If the drawdown is depressed all the way to the bottom of the aquifer, the well "goes dry" ——it cannot pump water at the desired rate. Although the derivations of the above equations are for an unconfined aquifer, the same situation would occur for a confined aquifer, where the pressure would be measured by observation wells.

Multiple wells in an aquifer can interfere with each other and cause excessive drawdown. Consider the situation in Figure 6, where a single well creates a cone of depression. If a second production well is installed, the cones will overlap, causing greater drawdown at each well. If many wells are sunk into an aquifers, the combined effect of the wells can deplete the groundwater resources and all wells will "go dry".

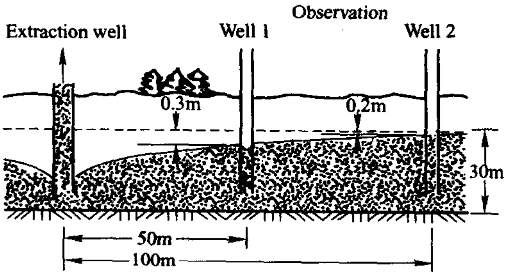

Figure 5 Two monitoring wells define the extent of drawdown during extraction

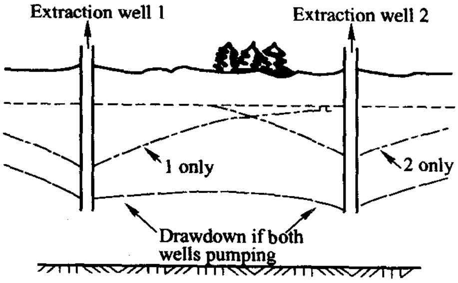

Figure 6 Multiple wells and the effect of extraction on the groundwater table

The reverse is also true, of course. Suppose one of the wells is used as an injection well, then the injected water flows from this well into the others, building up the groundwater table and reducing the drawdown. The judicious use of extraction and injection wells is one way that the flow of contaminants from hazardous waste or refuse dumps can be controlled.

Finally, many assumptions are made in the above discussion. First, we assume that the aquifer is homogeneous and infinite—that is, it sits on a level aquaclude and the permeability of the soil is the same at all places for an infinite distance in all directions. The well is assumed to penetrate the entire aquifer and is open for the entire depth of the aquifer. Finally, the pumping rate is assumed to be constant. Clearly, any of these conditions may cause the analysis to be faulty, and this model of aquifer behavior is only the beginning of the story. Modeling the behavior of groundwater is a complex and sophisticated science.

Surface Water Supplies

Surface water supplies are not as reliable as groundwater sources since quantities often fluctuate widely during the course of a year even a week, and water quality is affected by pollution sources. If a river has an average flow of 10 cubic feet per second (cfs), this does not mean that a community using the water supply can depend on having 10 cfs available at all times.

The variation in flow may be so great that even a small demand cannot be met during dry periods and so storage facilities must be built to save water during wetter periods. Reservoirs should be large enough to provide dependable supplies. However, reservoirs are expensive and, if they are unnecessarily large, represent a waste of community resources.

One method of estimating the proper reservoir size is to use a *mass curve* to calculate historical storage requirements and then to calculate risk and cost using statistics. Historical storage requirements are determined by summing the total flow in a stream at the location of the proposed reservoir and plotting the change of total flow with time. The change of water demand with time is then plotted on the same curve. The difference between the total water flowing in and the water demanded is the quantity that the reservoir must hold if the demand is to be met.

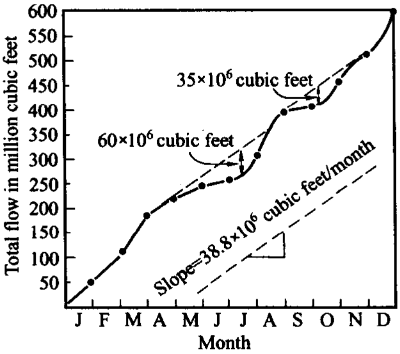

Figure 7 Mass curve for determining required reservoir capacity

A mass curve like Figure 7 is not very useful if only limited stream flow data are available. Data for one year yield very little information about long-term variations.

Long-term variations may be estimated statistically when actual data are not available. Water supplies are often designed to meet demands of 20-year cycles, and about once in 20 years the reservoir capacity will not be adequate to offset the drought. The community may choose to build a larger reservoir that will prove inadequate only every 50 years, for example. A calculation comparing the additional capital investment to the added benefit of increased water supply will assist in making such a decision. One calculation method requires first assembling required reservoir capacity data for a number of years, ranking these data according to the drought severity, and calculating the drought probability for each year. If the data are assembled for n year and the rank is designated by m, with $m=1$ for the largest reservoir requirement during the most severe drought, the probability that the supply will be adequate for any year is given by $m/(n+1)$. For example, if storage capacity will be inadequate, on the average, one year out of every 20 years,

$$m/(n+1)\approx 1/20=0.05 \tag{9}$$

If storage capacity will be inadequate, on the average, one year out of every 100 years,

$$m/(n+1)\approx 1/100=0.01 \tag{10}$$

This procedure is a *frequency analysis* of a recurring natural event. The frequencies chosen for investigation were once in 10 years and once in 5 years, or a "10-year drought" and a "5-year drought", but droughts occurring 3 years in a row and then not again for 30 years still constitute "10-year droughts". Planning for a 30-year drought will result in the construction of a large expensive reservoir; planning for a 10-year drought will result in the construction of a smaller less-expensive reservoir.

New Words and Phrases

specific yield	单位产水量
mass curve	累积曲线
capital investment	投资
recurring natural event	重现历史事件
subterranean	*adj*. 地下的
groundwater	*n*. 地下水
surface water	*n*. 地表水
tap	*n*. 开关、龙头 *v*. 在…上开空(导出液体)
swampland	*n*. 沼泽地
capillary	*n*. 毛细管 *adj*. 毛状的，毛细作用的
hygro-	[词头] 湿(气)，液体
hygroscopic	*adj*. 吸湿的
hygroscopic moisture	吸湿水
stratum	*n*. [地] 地层，[生] (组织的)层
aquifer	*n*. 含水层，蓄水层
saturation	*n*. 饱和(状态)，浸润，浸透，饱和度
hydrostatic	*adj*. 静水力学的，流体静力学的
hydrostatic pressure	静水压力
water table	*n*. 地下水位，[建] 承雨线脚
phreatic surface	*n*. 地下水(静止)水位，浅层地下水面
superficial	*adj*. 表面的，表观的，浅薄的
porosity	*n*. 多孔性，有孔性，孔隙率
unconfined	*adj*. 无限制的，无约束的
permeability	*n*. 渗透性
permeameter	*n*. 渗透仪
clay	*n*. 黏土，泥土
gravel	*n*. 砂砾，砾石
cone of depression	*n*. 下降锥体，下降漏斗
drawdown	*n*. (抽水后)水位降低(量)
integrate	*v*. 求积分
observation well	*n*. 观测井
extraction	*n*. 抽取，取出，提取(法)，萃取(法)
derivation	*n*. 引出，来历，出处，(语言)词源，衍生
deplete	*vt*. 耗尽，使衰竭
refuse	*vt*. 拒绝，谢绝 *n*. 废物，垃圾
dump	*vt*. 倾倒(垃圾)，倾卸 *n*. 堆存处，垃圾堆
unconfined aquifer	*n*. 潜水含水层
confined aquifer	*n*. 承压含水层
homogeneous	*adj*. 同类的，相似的，均匀的，均相的
aquaclude	*n*. 不透水层，难渗透水的地层
offset	*n*. 偏移量，抵消，弥补，分支，平版印刷，胶印，支管，乙字管 *vt*. 弥补，抵消，用平版印刷 *vi*. 偏移，形成分支
sophisticated	*adj*. 复杂的，需要专门技术的

Questions

1. Please give the meaning of *drawdown*.
2. Try to explain the method of estimating the proper reservoir size.

3. Please give the definition of *aquifer*.
4. What is the use of *permeameter*?
5. What is the definition of *porosity* of a soil sample?

Reading Material

Water Circulation

The hydrologic cycle is a useful starting point for the study of water supply. This cycle, illustrated in Figure 8, includes precipitation of water from clouds, infiltration into the ground or runoff into surface water, followed by evaporation and transpiration of the water back into the atmosphere.

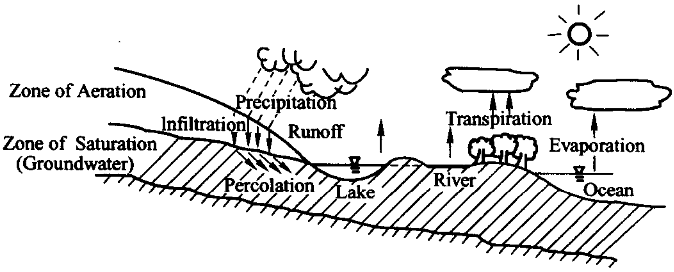

Figure 8 The hydrologic cycle

The rates of precipitation and evaporation/transpiration help define the baseline quantity of water available for human consumption. *Precipitation* is the term applied to all forms of moisture falling to the ground, and a range of instruments and techniques have been developed for measuring the amount and intensity of rain, snow, sleet, and hail. The average depth of precipitation over a given region, on a storm, seasonal, or annual basis, is required in many water availability studies. Any open receptacle with vertical sides is a common rain gauge, but varying wind and splash effects must be considered if amounts collected by different gauges are to be compared.

Evaporation and *transpiration* are the movement of water back to the atmosphere from open water surfaces and from plant respiration. The same meteorological factors that influence evaporation are at work in the transpiration process: solar radiation, ambient air temperature, humidity, and wind speed. The amount of soil moisture available to plants also affects the transpiration rate. Evaporation is measured by measuring water loss from a pan. Transpiration can be measured with a *phytometer*, a large vessel filled with soil and potted with selected plants. The soil surface is hermetically sealed to prevent evaporation; thus moisture can escape only through transpiration. The rate of moisture escape is determined by weighing the entire system at intervals up to the life of the plant. Phytometers cannot simulate natural conditions, so results have limited value. However, they can be used as an index of water demand by a crop under field conditions and thus relate to calculations that help an engineer determine water supply requirements for that crop. Because it is often not necessary to distinguish between evaporation and transpiration, the two processes are often linked as *evapotranspiration*, or the total water loss to the atmosphere.

The direction of our discussion is that sufficient water supplies exist, but many areas are water poor while others are water rich. Adequate water supply requires engineering the supply and its transmission from one area to another, keeping in mind the environmental effects of water transmission systems. In many cases, moving the population to the water may be less environmentally damaging than moving the water. This section concentrates on measurement of water supply, and the following section discusses treatment methods available to clean up the water once it reaches areas of demand.

New Words and Phrases

keep in mind	紧记
concentrate on	集中，全神贯注于
hydrologic	*adj.* 水文的
precipitation	*n.* 沉淀（作用），沉积物，沉降；降水（量）
infiltration	*n.* 渗透
runoff	*n.* 径流（量），流量；流出；流出口；决赛
evaporation	*n.* 蒸发（作用）
transpiration	*n.* 蒸发（物），散发，［生］蒸腾作用，［物］流逸
baseline	*n.* 基线
sleet	*n.* 冰雨，雨夹雪 *vi.* 下雨雪，下冰雹
hail	*n.* 冰雹，致敬，招呼 *vt.* 向…欢呼，致敬，招呼，使像下雹样落下 *vi.* 招呼，下雹
receptacle	*n.* 容器，［植］花托，［电工］插座
meteorological	*adj.* 气象（学）的
ambient	*adj.* 周围的 *n.* 周围环境
humidity	*n.* 湿气，潮湿，湿度
phyto-	［词头］植物
phytometer	*n.* 植物剂、植物蒸腾表
hermetically	*adj.* 密封地，不透气地
simulate	*vt.* 模拟，模仿
evapotranspiration	*n.* 土壤水分蒸发蒸腾损失总量

LESSON 2

Collection Of Wastewater

The "Shambles" is a street or area in many medieval English cities, like London and York. During the eighteenth and nineteenth centuries, Shambles were commercialized areas, with meat packing as a major industry. The butchers of the Shambles would throw all of their waste into the street, where it was washed away by rainwater into drainage ditches. The condition of the street was so bad that it contributed its name to the English language originally as a synonym for butchery or a bloody battlefield.

In old cities, drainage ditches like those at the Shambles were constructed for the sole purpose of moving storm water out of the cities. In fact, discarding human excrement into these ditches was illegal in London. Eventually, the ditches were covered over and became what we now know as *storm sewers*. As water supplies developed and the use of the indoor water closet increased, the need for transporting domestic wastewater, called *sanitary waste*, became obvious. In the United States, sanitary wastes were first discharged into the storm sewers, which then carried both sanitary waste and storm-water and were known as *combined sewers*. Eventually a new system of underground pipes, known as sanitary sewers, was a constructed for removing the sanitary wastes. Cities and parts of cities built in the twentieth century almost all built separate sewers for sanitary waste and stormwater.

Estimation Wastewater Quantities

Domestic wastewater (sewage) comes from various sources within the home, including the washing machine, dishwasher, shower, sinks, and of course the toilet. The toilet, or water closet (WC), as it is still known in Europe, has become a standard fixture of modern urban society. As important as this invention is, however, there is some dispute as to its inventor. Some authors credit John Bramah with its invention in 1778; others recognize it as the brainchild of Sir John Harrington in 1596. The latter argument is strengthened by Sir John's original description of the device, although there is no record of his donating his name to the invention. The first recorded use of that euphemism is found in a 1735 regulation at Harvard University that decreed, "No Freshman shall go to the Fellows'John."

The term *sewage* is used here to mean only domestic wastewater. Domestic wastewater flows vary with the season, the day of the week, and the hour of the day. Note the wide variation in flow and strength. Typically, average sewage flows are in the range of 100 gallons per day per person, but especially in smaller communities that