Remediation of Contaminated Ground Water

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Abstract— **"Water is the driving factor of all nature." The addition of undesirable substances to groundwater caused by the activities of human is considered to be contamination. Groundwater contamination is extremely difficult to clean it up. There are groundwater contamination issues that potentially affect public water supplies over a large area. It will cause serious health issues to people due to contamination. In recent years, the increasing threat to groundwater quality due to the activities of human has become a matter of great concern. Rapid urbanization and industrialisation in India has resulted in the increase of generation of wastes. Due to the lack of adequate resources and infrastructure the waste is not properly collected disposed and treated that leads to the accumulation causing groundwater contamination. Remediation is the only way to clean up the contamination groundwater and soil. A variety of techniques for environmental remediation have been compiled and summarized. The paper is intended to provide an overview of remediation methods currently utilized at various hazardous waste sites.**

Keywords- Remediation, Contamination, Treatment, Pollution, Enviromment,Physical And Chemical Treatment..

I. INTRODUCTION

Groundwater remediation is the process that is used to treat polluted groundwater by removing the pollutants or converting them into harmless products. Groundwater is water present below the ground surface that saturates the pore space in the subsurface. Globally, between 25 per cent and 40 per cent of the world's drinking water is drawn from boreholes and dug wells.[1]Groundwater is also used by farmers to irrigate crops and by industries to produce everyday goods. Most groundwater is clean, but groundwater can become polluted, or contaminated as a result of human activities or as a result of natural conditions. The many and diverse activities of humans produce innumerable waste materials and by-products. Historically, the disposal of such waste have not been subject to many regulatory controls. Consequently, waste materials have often been disposed of or stored on land surfaces where they percolate into the underlying groundwater. As a result, the contaminated groundwater is unsuitable for use.

Current practices can still impact groundwater, suchastheoverapplicationof fertilizer or pesticides, spills from i ndustrial operations, infiltration from urban runoff, and leaking from landfills. Using contaminated groundwater causes hazards to public health through poisoning or the spread of disease, and the practice of groundwater remediation has been developed to address these issues. Contaminants found in groundwater cover a broad range of physical, inorganic chemical, organic chemical, bacteriological, and radioactive parameters. Pollutants and contaminants can be removed from groundwater by applying various techniques, thereby bringing the water to a standard that is commensurate with various intended uses.

. The problem is more severe in large cities and also various clusters of industries. In many of these areas groundwater is only source of drinking water and so large population is exposed to risk of consuming contaminated water. In this background Central Pollution Control Board with the help of its Zonal offices, the National Institute of Hydrology (NIH) and the Pollution Control Research Institute (PCRI) of Bharat Heavy Electricals Ltd. (BHEL) gave a detailed survey of groundwater quality in problem areas of industries and cities of India. Similar to air quality, water quality can be improved by two functions: proactive (water pollution control) or reactive (remediation of polluted water). Examples of water remediation/purification technologies are: Conventional water treatment plants - having different complexity based on the level of contamination of the water. Treatment processes include screening/straining, agulation/flocculation, chlorination and coagulation etc. The activities related to groundwater pollution with respect to the land use are as follows in the table1.

TABLE I
GROUND WATER POLLUTION W.R.T. LAND USE

Land Use	Activities related to groundwater contamination
Rural area	Irrigation using wastewater
Coastal areas	Salt water intrusion
Industrial and Commercial	Landfill disposal and hazardous wastes
Residential	Land and stream discharge of sewage
Mining	Mine drainage discharge

The laws and guidelines specify acceptable concentrations of different contaminants in water meant for alternate purposes. For example, the contaminant concentrations in drinking water will be much lower for the concentrations in water to be used for irrigation purposes.

II. SOURCES OF GROUND WATER CONTAMINATION

Ground water can become contaminated from natural sources or numerous types of human activities. Residential, municipal, commercial, industrial, and agricultural activities can all affect quality of ground water. Contaminants may reach ground water from activities on the land surface, such as releases or spills from stored industrial wastes; from sources below the land surface but above the water table, such as septic systems or leaking underground petroleum storage systems; from structures beneath the water table, such as wells; or from contaminated recharge water. Some other are:

- Industrial chemical spills
- Badly managed landfill
- Drainage of household chemicals
- Extensive use of Pesticides, herbicides and fertilizers

A. Natural Sources

Some substances found naturally in rocks or soils, such as iron, manganese, arsenic, chlorides, fluorides, sulphates, or radio nuclides, can become dissolved in ground water. Other naturally occurring substances, such as decaying organic matter, can move in ground water as particles. Whether any of these substances appears in ground water depends on local conditions. Some substances may pose a health threat if consumed in excessive quantities; others may produce an undesirable odour, taste, or colour. Ground water that contains unacceptable concentrations of these substances is not used for drinking water or other domestic water uses unless it is treated to remove these contaminants.

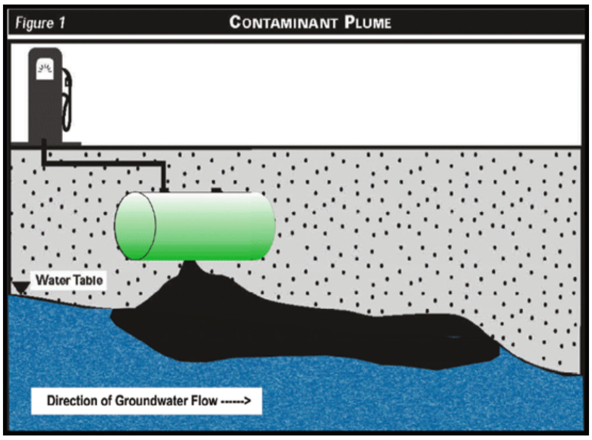

Fig 1. Improper Disposal of Hazardous Waste

Hazardous waste should always be disposed of properly, that is to say, by a licensed hazardous waste handler or through municipal hazardous waste collection days. Many chemicals should not be disposed of in household septic systems, including oils (e.g., cooking, motor), lawn and garden chemicals, paints and paint thinners, disinfectants medicines, photographic chemicals,swimming pool chemicals. Similarly, many substances used in industrial processes should not be disposed of in drains at the workplace because they could contaminate a drinking water source. Companies should train employees in the proper use and disposal of all chemicals used on site. There are many different types and the large quantities of chemicals used at industrial locations make proper disposal of wastes especially important for ground water protection.

III. REGULATIONS TO PROTECT GROUNDWATER

Several federal laws help protect ground water quality. The Safe Drinking Water Act (SDWA) established three drinking water source protection programs: the Wellhead Protection Program, Sole Source Aquifer Program, and the Source Water Assessment Program. It also called for regulation of the use of underground injection wells for waste disposal and provided EPA and the states with the authority to ensure that drinking water supplied by public water systems meets minimum health standards. The Clean Water Act regulates ground water that is shown to have a connection with surface water. It sets standards for allowable pollutant discharges to surface water. The Resource Conservation and Recovery Act (RCRA) regulates treatment, storage, and disposal of hazardous and nonhazardous wastes. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) authorizes the government to clean up contamination or sources of potential contamination from hazardous waste sites or chemical spills, including those that threaten drinking water supplies. CERCLA includes a “community right-toknow” provision. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates pesticide use. The Toxic Substances Control Act(TSCA) regulates manufactured chemicals.

IV. DIFFERRENT METHODS OF GROUNDWATER REMEDIATION

A. Pump And Treat Test

It is a primary technique for groundwater and soil remediation.Here, groundwater is pumped to the surface, and contaminants are removed by a variety of treatment methods , including air-stripping, ultraviolet or ozone treatment, precipitation and biodegradation. This technique is carried out through one or more pumping wells, with the water being treated by any one of physical and biological methods or their combinations. Pump and treat systems are relatively easy to design, install and operate using standard engineering practices. For successful remediation, surface treatment of pumped groundwater must be in consistence with the type and concentration of contaminants. It is typically used for contaminants that are dissolved in groundwater. The pumping systems can accomplish rapid mass-removal from areas of the groundwater plume where contaminants are most heavily concentrated. Nevertheless, pump-and-treat is not so effective in area with low permeability soils as clays and soil.

B. Soil Vapor Extraction

Extraction uses vapor extraction wells to remove volatile contaminants from the soil. Vacuum blowers are often installed to supply the driving force by inducing airflow through the soil matrix. The extraction wells are prepared within the contaminated area. The screened pipe is placed in a permeable packing; the unscreened section is sealed in a cement/bentonite grout to prevent a short-circuited air flow direct to the surface. The pumped air strips the volatile compounds from the soil and carries them to the screened extraction well. Gases are collected in perforated pipe wells or trenches and transported above-ground to a vapor-liquid separator, where entrained water is separated and contained for subsequent treatment. The contaminant vapors are moved by a vacuum blower for the vapor treatment process. Vapors produced by that process are conventionally treated by carbon adsorption . Other methods including condensation, biological degradation, and ultraviolet oxidation have been applied thought to a limited extent. In some cases, air-injection wells are installed in-situ. These wells may enhance the process efficacy by actively using forced airflow.

The system must be designed in a way Remediation Techniques for Soil and Groundwater - X.H. Zhang ©Encyclopedia of Life Support Systems (EOLSS) that any air injected into the system does not allow the escape of volatile organic compounds to the atmosphere. Steam is often can be used in extraction to remove volatile and semi-volatile hazardous contaminants from soil and groundwater. It is injected into the ground to raise the soil temperature and drive off volatile contaminants. Steam injection can form a displacement front by its condensation to displace

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groundwater. Steam can enhance the stripping of volatile contaminants from soil and be used to displace contaminated groundwater under some conditions.

C. Physical Remediation

What makes a biological remediation method legitimate is that it utilizes microorganisms. These little helpers help through bioventing, biosparging, or bioaugmentation. In biological water remediation, biologic materials Water purification starts on a physical level, with the removal of the largest particles and obstructions that plague the water you are treating. Air sparging is one physical remediation method that's used, which involves using pressurized air to strip water clean. A more common method is to pump water directly, with filters stripping away and large gravel or rock materials, and then letting the water be further filtered biologically or chemically to ensure that it's in the best shape.

D. Biological Remediation

It help to break down unwanted chemicals that aren't easily separated from the water, particularly in industrial waste that forms in groundwater. A plus side to this method is that physically pumping groundwater out is not required to treat it.

E. Chemical Remediation

This is most costly type of water purification, and it can also take the longest to accomplish. Chemical remediation can be achieved through a variety of methods, including carbon absorption, ion exchange, oxidation, and chemical precipitation. Chemical remediation is often used alongside physical water treatment to achieve the best results, and can help achieve the cleanest groundwater after the fact.

TABLE II
GROUND WATER CONTAMINATION AND TREATMENT OPTIONS

Typical Groundwater Contaminants And Their Treatment Options

Contaminant	Main Source	Treatment Technology
Trichloroethylene (TCE)	Degreasing of Metal and Electronic parts, Extract for oil and waxes, fumigant, carries in paints and adhesives	•Pump and Treat •Activated Carbon •Thermal and Biological
MTBE	MTBE can be released to groundwater by leaking underground storage tanks and piping, atmospheric deposition, spills during transportation, and leaks at refineries	•Air Sparging •In-Situ oxidation (H_2O_2 and Fe) •Bioremediation/Bioaugmentation •Pump and Treat.
EDC (DNAPL)	From EDC and VCM Plants, storage tanks, pipelines etc.	•In-situ Bioremediation.
Gasoline (LNAPL)	Gasoline and other petroleum fuels tanks, petrol stations, storage tanks and pipelines.	•In-situ Bioremediation •Vapor extraction
Ammonia	Ammonia Storage Tanks, Landfill leaks, Waste stockpile, etc.	•Pump and Treat •Combination of Air Stripping, Nitrification, Ion Exchange.

V. CONCLUSION

The challenges to be overcome in the management of contaminated sediments are multifaceted, and there are no easy solutions. The problem is not intractable, however, as long as two key issues are addressed: forging partnerships to replace adversarial relationships; and changing laws, regulations, and practices.To provide a framework for the committee's specific proposals, a number of general observations can be made based on the analysis presented in this report. Most important, there is no simple solution, although many people may assume there is, and there is no breakthrough technology on the immediate horizon for treating large volumes of contaminated sediments effectively and economically. Although in situ and handling technologies have been used with some degree of effectiveness, ex situ decontamination technologies are generally not affordable except when sediment volumes are small or when the benefits to public health or the environment are expected to be extremely high. Thus, near-term improvements in sediment management are likely to come from changes in the decision-making processes that will speed the implementation of solutions, improve the political acceptability of the management strategy and decisions, and apply systems engineering to reduce overall costs. In other words, there is no reason to delay urgent projects in anticipation of new technological solutions; decision makers should continue to try to make incremental improvements in the overall management process. Some impediments to effective remedial action are legal and regulatory in nature. In some cases, the problems stem from how laws and regulations are interpreted rather than their original intent; but even these difficulties can impede the decision-making process. Some barriers could be removed through revisions.

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