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Chapter 25. Recharge Areas Protection

Recharge areas are those areas that provide the primary means of replenishing groundwater. Good natural recharge areas are those where good quality surface water is able to percolate through the sediments and rocks to the saturated zone, which contains groundwater. If recharge areas cease functioning properly, there may not be sufficient groundwater for storage or use. Protection of recharge areas requires a number of actions based on two primary goals. These goals are (1) ensuring that areas suitable for recharge continue to be capable of adequate recharge rather than covered by urban infrastructure, such as buildings and roads; and, (2) preventing pollutants from entering groundwater to avoid expensive treatment that may be needed prior to potable, agricultural, or industrial beneficial uses.

Protection of recharge areas is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. However, protecting recharge areas by itself does not provide a supply of water. Recharge areas only function when aquifer storage capacity is available, and when regional and local governments and agencies work together to secure an adequate supply of good quality water to recharge the aquifer. Protecting existing and potential recharge areas allows them to serve as valuable components of a conjunctive management and groundwater storage strategy.

The Water Plan includes three resource management strategies related to recharge areas protection; 1) Conjunctive Management and Groundwater Storage (Chapter 8); 2) Groundwater and Aquifer Remediation (Chapter 15); and 3) Urban Runoff Management (Chapter 19). Management of a natural resource such as water requires integration of all management efforts.

In simple terms, a groundwater system consists of three component parts—recharge areas where surface water moves to groundwater, storage media consisting of aquifers that store groundwater, and discharge areas consisting of wells, springs, and rivers. As with all natural systems there is an almost infinite variety in the way these components relate to each other in the real world.

PLACEHOLDER Box 25-1 Terminology

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

Managed Recharge Areas in California

The first documented artificial recharge program in California began in Los Angeles basin in 1889. Beginning in the early 1900s, water agencies operated recharge areas in the San Joaquin Valley. Additional areas for artificial recharge were established later in Southern California and San Francisco Bay Area. While a certain amount of recharge takes place in many areas, the areas that were chosen by water management agencies were those areas that met three conditions. First, the sediment is coarse enough to allow surface water to infiltrate at a higher rate than through finer sediments. Second, there is hydraulic continuity between the recharge area, the aquifer in which the groundwater is stored and transported, and the discharge area where wells are built to extract the groundwater. Third, a local agency had access to the land on which these first two conditions existed.

Recharge occurs instream, offstream, and through injection wells. Instream recharge allows water to percolate through the stream bed itself. Offstream recharge uses suitable sites outside the streambed. In some operations, the water must be pumped some distance from its source to the offstream recharge area. Injection wells are used at locations where the cost of large tracts of land would be prohibitive.

Each method has pros and cons. Instream and offstream spreading basins eventually become clogged by suspended fine-grained material carried in the surface water. As a result the rate of recharge declines considerably, making the basin much less effective. Those fines must somehow be removed. In addition, in urban areas the cost of land necessary for spreading basins is often prohibitive. Injection wells are expensive to build but they may be feasible in urban areas where the cost of land is high. However, they are also subject to clogging unless the water is treated and turbidity is minimal, and air is not entrained.

These areas may be hydrogeologically suited for use as recharge areas if they meet the three conditions cited above—coarser sediments, hydraulic continuity between the recharge area and the discharge area, and local agency ownership. Contamination of these areas would lead to contamination of the groundwater in the aquifer.

Table 25-1 shows current sites in California that are managed for artificial recharge. The State Water Resources Control Board (State Water Board) has compiled a Hydrogeologically Vulnerable Areas Map showing the areas of California where published reports indicate there is a hydrogeologic vulnerability between the ground surface and groundwater (SWRCB, 2009).

PLACEHOLDER Table 25-1 Recharge Sites in California

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

The size of existing recharge areas and the amount of groundwater that is artificially recharged annually is substantial, but there is no procedure in place to compile that number. The total amount of land devoted to spreading basins and offstream and instream recharge probably exceeds 50 square miles. The actual area is difficult to determine, partially because many diversion ditches and creeks are active artificial recharge sites during some periods of the year. These active recharge areas and other areas should be protected for recharge purposes.

For purposes of analysis and planning, actual and potential recharge areas can be assigned to one of three categories.

- Category 1. Areas that are active recharge areas at the present time under the control of water management agencies. These areas are listed in Table 25-1 above. The infiltration rate at these areas is high and they are carefully managed to maintain that high infiltration rate and to protect the quality of the water that is being recharged. Most of these sites monitoring activities track groundwater levels, rate of movement of the recharged water into the aquifer and chemical changes.

- Category 2. Areas that are known to have a fairly high infiltration rate, but that are not under the control of a water management agency. There may be little or no monitoring. Programs should be considered that monitor recharge, prevent potential contaminating activities, and educate the public about the importance of protecting the quantity and quality of their water supply.
- Category 3. Areas with a lower infiltration rate that makes the area much less suitable for an artificial recharge program managed by a local water agency. These areas may be subject to a lower degree of monitoring and management of potential contaminating activities.

The Drinking Water Source Assessment and Protection (DWSAP) Program administered by the California Department of Public Health (CDPH) defines areas of protection for individual wells. The program can easily be expanded to include larger areas within the watershed. While the DWSAP requires assessment of these issues, amendments to the federal Clean Water Act do not require implementation of a protection program.

Other Methods of Enhancing Recharge

Two other methods of enhancing recharge and reducing runoff are flood water retention basins and reduced hardscape.

In the first half of the 20th Century the US Army Corps of Engineers, in conjunction with local flood control agencies, built detention dams in the canyons at the foot of southern California mountain ranges. The purpose of these detention dams was three-fold. First, when storms dropped large amounts of water high in the mountains the dams stopped the uncontrolled rush of the resulting frog chokers into downstream residential areas. Second, some of the water stored behind the detention dam infiltrated into the coarse sediment in the bottom of the detention area and recharged the local aquifer. And third, the dam was designed to release a smaller amount of water into the flood control channels and streams so that the water would not cause damage downstream. Many of these facilities are still functioning and some provide significant recreational opportunities during the dry season.

In the last half of the 20th century a different type of detention basin has been built in a number of urban areas. These detention basins, excavated so that they are lower than the surrounding land surface, serve as grass-covered parks during most of the year. During the winter they can fill with runoff from storms. Again, their purpose is three-fold. First they are used as recreational facilities during the non-storm season. Second they fill with storm runoff during the wet season, thereby reducing flood risk. And third, some or all of the water stored in these basins during the wet season recharges the local unconfined aquifer, while some of these basins may be located in the recharge area for a confined aquifer. In any such operation using urban runoff, adequate control must be exercised to prevent contamination of the aquifer by petroleum products and other urban contaminants.

A third method to increase recharge and reduce runoff is being implemented by TreePeople, a non-governmental organization. TreePeople has been working with local government to retrofit playgrounds, school grounds, parking lots, and other parcels of land, to collect, treat, and funnel storm water to “dry” wells or other small scale infiltration facilities. Such wells are called Class V injection wells. While the goal of TreePeople is to reduce hardscapes and reduce runoff, the use of dry wells for disposal of the urban runoff can affect groundwater quality. To avoid contamination of the aquifer, certain best

management practices are recommended. Those best management practices include: low-flow basins for runoff from industrial areas and other areas that could provide a high level of chemical contamination: pre-treatment for runoff: monitoring of water quality: evaluation of the data: and corrective action as necessary (Ben-Horin, 2007; Tree People, 2009).

Additionally, a fourth method to increase groundwater recharge is to utilize low impact development (LID) or best management practice features for stormwater capture and reuse. Per California Water Code, Section 10561(e), "stormwater, properly managed, can contribute significantly to local water supplies through onsite storage and reuse, or letting it percolate into ground to recharge groundwater, therefore increasing available supplies of drinking water."

California's 58 counties are required by the California Water Code to regulate any type of water-related well, including injection wells, but the effectiveness of that program varies considerably depending upon the county. Class V injection wells are further regulated for groundwater quality purposes by the US Environmental Protection Agency in accordance with the Underground Injection Control program authorized by the federal Safe Drinking Water Act.

Potential Benefits of Recharge Areas Protection

The primary benefit of protecting recharge areas is that those recharge areas can be used by water managers to store water in aquifers as part of a program to provide a sustainable and reliable water supply of good quality. In some cases diversion of flood water to recharge facilities may benefit both flood control efforts and maintenance of a local water supply. The availability of a sustainable and reliable water supply may lessen the need to purchase alternative water supplies at greater expense. Efforts to prevent the release of contaminants will reduce CO2 emissions related to groundwater remediation. Protection of recharge areas does not make a water supply available: a supply of water to recharge the aquifer depends on coordination of regional and local governments and water management agencies.

Additional benefits of recharging groundwater include some removal of microbes and chemicals while the water moves through the unsaturated zone to the saturated zone, an increase in the amount of groundwater in storage that can later be extracted for local use or for export, and in some cases, use of the aquifer itself as the conveyance system from the recharge area to the point of extraction and use. In some cities, recharge basins are combined with flood control basins to reduce the amount of urban runoff. However, this practice may introduce contaminants, especially hydrocarbons, nitrates, and solvents into the aquifer unless pre-treatment is provided that removes the contaminants.

Potential Costs of Recharge Areas Protection

Some of the costs that may be associated with protecting recharge areas are:

- Purchase or lease price of the land that is to be used for a recharge area.
- Design and construction of facilities
- Land that is reserved for recharge areas cannot be used for other purposes that might provide a significant income for the landowner and tax revenues for the government
- If a local government agency owns the land, there is no tax income for the county

- Well field monitoring to warn of contamination.
- Groundwater remediation used to control contaminant releases near recharge areas.

By not protecting recharge areas, water supply can be lost. The growth of urban areas, with roads, freeways, parking lots, and large warehouse type buildings, means that many areas no longer allow runoff to infiltrate into the ground. Instead, the runoff flows rapidly into streams which peak more quickly and at higher flow rates than before the urban facilities were built. This runoff may create flood flows and is lost to groundwater recharge and may require the expense of other facilities to provide a substitute for that lost recharge. In a few urban areas, injection wells have been built to take the place of recharge areas that were lost to urban development. Injection wells are expensive, require careful technical control, and are not always successful, but they may be cost effective in the face of the high cost of urban land in many cities.

Many potentially contaminating activities have routinely been allowed in recharge areas and contaminants have been carried into the aquifers. Because groundwater processes and the potential for contamination are not well understood by the public, many of these practices continue today. Remediation of contaminated aquifers can take decades, cost millions or billions of dollars, and increase the rate of global climate change due to CO2 emissions from remediation systems. Groundwater remediation will never remove the contaminant completely from the aquifer. In such cases, the extracted groundwater must be treated at the wellhead at significant expense before it is suitable for potable and other uses.

A lack of protection of recharge areas could decrease the availability of usable groundwater. Recent studies by the US Geological Survey show contaminants present in recharge areas for aquifers in the Los Angeles area. Because of the low velocity of groundwater movement through the aquifer, contamination that occurs today may not arrive at down-gradient wells for 10 years or longer. In 10, 20, or 40 years, those contaminants may have been transported with the water flowing into the aquifer and the groundwater may require treatment before it can be used, thereby increasing the cost of water to the users. Protection of recharge areas now will help to prevent costs from escalating astronomically in the future. If we protect recharge areas by retaining those areas for recharge and by preventing contamination today, we are reducing future costs. Restoration of recharge areas will also help to keep future costs lower.

Major Issues Facing Recharge Areas Protection

Climate Change

Mitigation

[Content is under development**.]**

Adaptation

[Content is under development**.]**

Zoning

Zoning can play a major role in recharge areas protection by amending land-use practices so that existing recharge sites are retained as recharge areas. Some areas that would provide good rates of recharge have been paved over or built upon and are no longer available to recharge the aquifer. Local governments often lack a clear understanding of recharge areas and the need to protect those areas from development or contamination. Land use zoning staff does not always recognize the need for recharge area protection for water quantity and water quality.

Vector and Odor Issues

Standing water in recharge ponds or spreading basins is an attraction for mosquitoes, dragonflies, and other insects whose egg, larval, and pupal stages mature underwater. Dragonflies eat insects they catch on the fly, but mosquitoes can be vectors for a number of serious or deadly diseases. Existing recharge programs use large numbers of "mosquito" fish which feed on the mosquito larvae in the water. Odors can be generated by growth and decay of algae and other water-borne vegetation. Both vectors and odors must be addressed in any recharge program that involves standing water.

Potential Impacts

Protection of recharge areas can remove land from availability for other uses.

Recommendations to Promote Protection of Recharge Areas

The State can help promote additional protection of recharge areas by acting on the following recommendations:

1. Increase State funding for proposals to identify and protect recharge areas including incentives for the location and proper destruction of abandoned water wells, monitoring wells, cathodic protection wells and other wells that could become vertical conduits for contamination of the aquifer.
2. Provide funding and staff for the CDPH to initiate a program that would provide guidance and funding for Tribes, local governments and agencies to implement source water protection measures that are logical outgrowths of the Drinking Water Source Assessment and Protection Program.
3. Expand research into surface spreading as a means of groundwater recharge and the fate and transport of chemicals and microbes contained in the recharge water.
4. Develop a statewide program to identify actual and potential recharge areas throughout the state and provide that information to Tribal, city, and county governments. [NOTE: This is essentially done with the Hydrogeology Vulnerability Map, however Tribal, city, and county governments were not contacted directly. The map is available on the Water Boards' GAMA website available at: http://www.waterboards.ca.gov/water_issues/programs/gama/docs/hva_map_table.pdf.]
5. Amend State law to prohibit local decision-makers from developing land for other purposes until it is known if that land is needed for recharge as a part of the local agency's groundwater management program. [NOTE: This recommendation appears to be implemented with the provisions of CWC Section 10755.2, if so it should be deleted.]

6. Engage the public in an active dialogue using a value-based decision-making model in planning land use decisions that involve recharge areas.
7. Adopt a State-sponsored media campaign to increase public awareness and knowledge of groundwater and the importance of recharge areas.
8. Establish a "Water" element in the General Plan process that specifically requires a discussion by local government of the cost and values of protecting recharge areas versus the cost of non-protection. Eminent domain should not be allowed to convert potential recharge areas to other uses. For a fuller discussion of the proposed water element in a General Plan, please refer to "Planning for a Demanding Water Future: The Legal Requirements for Long-Term Land Use and Water Planning in California, and an Analysis of a Water Element in the General Plan as a Means to Improve the Connection," found in Volume 4.
9. Ensure that federal and State programs regulating subsurface disposal in accordance with the federal Safe Drinking Water Act's Underground Injection Control program and the California Clean Water Act's waste discharge requirements are fully funded and staffed.
10. Require local governments to provide protection of recharge areas for aquifers that have been identified as "sole source aquifers" pursuant to the Safe Drinking Water Act of 1974 and Amendments.
11. Develop educational programs for public works officials and other officials of local agencies and governments that allow them to develop programs that realistically deal with the interaction of groundwater, surface water, storm water, recycled water, other surface flows, and the affect of contaminants in surface flows on contaminant levels in the aquifers.
12. Require that source water protection plans include an element that addresses recharge areas if groundwater is a part of the supply.
13. Convene a statewide panel to recommend changes to public schools and higher education curricula relating to groundwater. Encourage an integrated academic program on one or more campuses for protection of groundwater quantity and quality and why recharge areas are critical components.
14. Develop a uniform method for analyzing the economic benefits and cost of recharge areas and provide guidance and assistance for economic feasibility analyses that could be used by project planners and funding agencies to assess recharge areas as compared with long-term reduction of water supplies, wellhead treatment, injection wells, or conversion to other land uses.
15. Develop a signage program, modeled on such programs in other states, to notify people that they are entering an area of critical recharge for the groundwater they use daily, and that improper disposal of wastes can contaminate their drinking water.
16. Support implementation and research for stormwater LID and BMP techniques for groundwater recharge under the provisions of the Stormwater Resource Planning Act (Wat. Code §10560 et. Seq)
17. Support leak prevention protocols for stored contaminants to mitigate most CO2 emissions related to groundwater remediation.

Recharge Areas Protection in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions aren't consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy isn't discussed in the rest of Update 2013), there is no need for this section to appear.]

References

References Cited

Bachman, SB; Groundwater Resources Association of California. 1997. California Groundwater Management. Sacramento (CA): Groundwater Resources Association of California. 145 p.

Ben-Horin, E; TreePeople. 2007. Rainwater as a Resource: A Report on Three Sites Demonstrating Sustainable Stormwater Management. Beverly Hills (CA): TreePeople. 56 p. Available at: http://www.treepeople.org/sites/default/files/images/about/Rainwater_as_a_Resource.pdf

Blomquist, WA; Schlager, E; Heikkila, T. 2004. Common waters, diverging streams; linking institutions and water management in Arizona, California, and Colorado. Washington (DC): Resources for the Future. 205 p.

California Department of Public Health. 1999. Drinking water source assessment and protection program. [Internet]. Sacramento (CA): California Department of Health Services. [cited: 2009 Nov 16]. 209 p. Available at: http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DWSAP.aspx

California Department of Water Resources. 2003. California's groundwater update 2003. Sacramento (CA): California Department of Water Resources. (Bulletin 118). 246 p. Available at: http://www.groundwater.water.ca.gov/bulletin118/update2003/

[California SDWA of 2008]. Safe Drinking Water Act of 2008. Bond initiative (SBx2 and SBx6) died on file - not submitted to voters. (2008).

[CDPH]. California Department of Public Health. Drinking Water Source Assessment Program. [Internet]. 2009. Sacramento (CA): California Department of Public Health. [cited: 2009 Nov 16]. Available at: http://www.cdph.ca.gov/certlic/drinkingwater/pages/dwsap.aspx

[CWA]. federal Clean Water Act. Title 33 United States Code section 1251 et seq. (1972).

Driscoll, FG; UOP Inc., Johnson Division. 1986. Groundwater and wells. 2nd ed. St.Paul (MN): Johnson Filtration Systems. 1089 p.

Dunne, T; Luna, LB. 1978. Water in environmental planning. San Francisco: W.H. Freeman and Co. 818 pp.

Fetter, CW. 1994. Applied hydrogeology. 3rd ed. Englewood Cliffs (NJ): Prentice-Hall Inc. 691 p.

Focazio, MJ; Reilly, TE; Rupert, MG; Helsel, DR. 2002. Assessing ground-water vulnerability to contamination: providing scientifically defensible information for decision makers. Washington (DC): US Dept. of the Interior, US Geological Survey. 33 p. Circular 1224. Available at: http://purl.access.gpo.gov/GPO/LPS47220

Freeze, RA; Cherry, JA. 1979. Groundwater. Englewood Cliffs (NJ): Prentice-Hall Inc. 604 p.

Health and Safety Code, section 115700. Abandoned wells that are potential vertical conduits for contamination of the aquifer shall be destroyed.

Heath, R. 1983. Basic ground-water hydrology. Washington (DC): US Geological Survey. 84 p. Water-Supply Paper 2220.

Madrid, C. 1989. Artificial ground water recharge in Northern California. In: Johnson, AI; Finlayson, D, editors. Artificial recharge of ground water: proceedings of the International Symposium. 1988 Aug 23-27; Anaheim (CA). Reston (VA): American Society of Civil Engineers.

[SDWA]. federal Safe Drinking Water Act of 1974. Public Law 93-523. Title 42 United States Code section 300f et seq, as amended (1974).

Sherman, LK; Musgrave, GW. 1942. Infiltration. In: Meinzer, OE; Baver, LD, editors. Hydrology. 1st ed. New York: McGraw-Hill. (Physics of the Earth; vol. IX).

[SWRCB]. State Water Resources Control Board. GAMA – Groundwater Ambient Monitoring & Assessment Program. [Internet], Hydrogeologically Vulnerable Areas Map. 2009. Sacramento (CA): State Water Resources Control Board. [cited: 2009 Nov 16]. Available at: www.waterboards.ca.gov/gama

Tree People. [Internet]. 2009. Beverly Hills (CA): TreePeople. [cited: 2009 Nov 16]. Available at: http://www.treepeople.org/

University of California, Water Resources Center, editor. 2001. Managing California's Groundwater: the Challenges of Quality and Quantity; Abstracts from the 23d Biennial Groundwater Conference. Biennial groundwater conference and annual meeting of the Groundwater Resources Association of California abstracts; 2001 Oct 30-31; Sacramento (CA). 83 p.

US Geological Survey. 2002. U.S. Geological Survey Artificial Recharge Workshop, Sacramento. In: Aiken, GR; Kuniansky, EL, editors. Artificial recharge workshop proceedings. Artificial Recharge Workshop; 2002 Apr 2-4; Sacramento, (CA). Washington (DC): US Geological Survey. 1-92. Available at: http://water.usgs.gov/ogw/pubs/ofr0289/

Winter, TC; Harvey, JW; Franke, OL; Alley, WM. 1998. Ground water and surface water, a single resource. Washington (DC): US Geological Survey. 79 p. Circular 1139. Available at: http://purl.access.gpo.gov/GPO/LPS22428

Additional References

Personal Communications