

# CHAPTER 7

## SHALLOW GROUND WATER

### STUDY TEAM

#### *Objective*

*“What are the shallow ground water issues of concern and what needs to be done?”*

#### **Introduction**

The Shallow Ground Water Study Team (Team) was formed to evaluate the influence of the shallow ground water aquifer on the Las Vegas Wash (Wash). The Team accomplished this by determining the shallow ground water contribution to the Wash, and by defining options to potentially treat and/or reduce flows that degrade water quality in the Wash.

Shallow ground water is present in the central and southeast part of the Las Vegas Valley (Valley), and is typically characterized as ground water present at less than thirty feet below land surface with a total dissolved solids (TDS) concentration ranging from 1,500 to greater than 7,000 milligrams per liter (mg/L). The hydrogeology of the shallow ground water system and proximity to the urban environment makes the aquifer particularly vulnerable to contamination that could result from a variety of human-related activities including the over-irrigation of landscapes, leaking underground storage tanks and improper surface disposal of contaminants. In addition, influences from past industrial activities in the southeast part of the Valley have been shown to impact water quality in the Wash. One recent example was the discovery of low levels of ammonium perchlorate (a salt used as an oxidizer in munitions and a component of fertilizer) in Lake Mead. The identification of its source as shallow ground water that is seeping into the Wash has heightened concerns for the protection of the Wash and Las Vegas Bay.

Additionally, over the last several years, the surfacing of shallow ground water in commercial and residential areas located in the southeast part of the Valley has raised concerns ranging from geotechnical, health/safety, and aesthetic issues (SEA Incorporated Consulting Engineers, 1994). It is

believed that shallow ground water levels are rising due to increased irrigation resulting from the growing Valley population. Consulting work completed for the City of Henderson in 1999 indicted a direct correlation between single-family irrigation and rises in shallow ground water levels.

## The Process

The Shallow Ground Water Study Team (Team), includes local wastewater dischargers (Clark County, City of Henderson, and City of Las Vegas), regulatory agencies, as well as hydrologists from stakeholder entities.

Understanding that the hydrogeology of the shallow ground water system is complex with many aspects still unknown, the Team set out to evaluate current and past conditions, and make informed recommendations for reducing the impact of the ground water flows on the Wash.

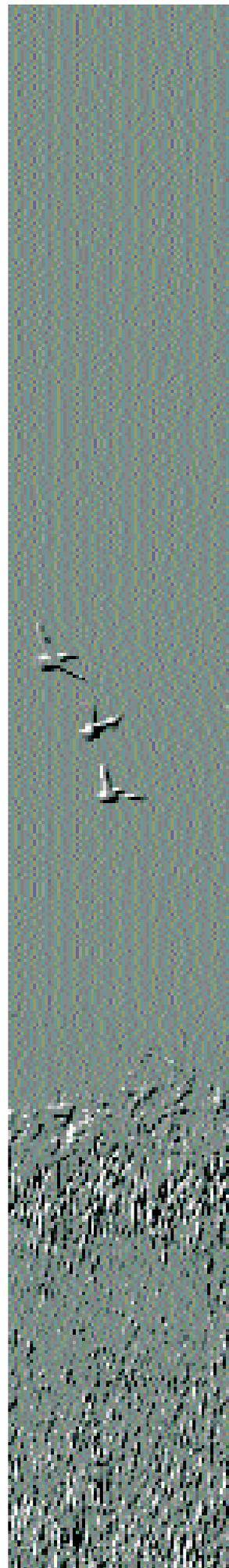
To begin to address the set of issues surrounding the shallow ground water system, the Team defined their objective as answering the questions, “What are the shallow ground water issues of concern and what needs to be done?” From this objective they began to research the shallow ground water system and assess the data available for flow quantity and quality. Stemming from the examination of the shallow ground water system, the Team developed two goals to accomplish their objective.

- Goal One -** Define and minimize the impact of the shallow aquifer on the Las Vegas Wash and Lake Mead water quality to the extent practical.
- Goal Two -** Establish a mechanism to address current and future shallow ground water quality issues of concern.

## Background

Shallow ground water reaches the Wash in one of two ways. First, construction activities in the central and southeastern part of the Valley often encounter shallow ground water during excavation. In most cases, the company is issued a temporary dewatering permit by the Nevada Division of Environmental Protection (NDEP) and is allowed to discharge the water into the storm drain system, which eventually reaches the Wash via one of the tributaries. In many cases, shallow ground water is still a concern for buildings with foundations below the shallow ground water table. In these cases, the NDEP issues a dewatering permit that is renewable every five years for discharge to the Wash or one of the tributaries.

Shallow ground water also reaches the Wash when water levels intercept land surface. This is believed to be the case at several locations along the Wash and in some sections of the tributaries to the Wash that have not been engineered for flood control (i.e., concrete lined channels).

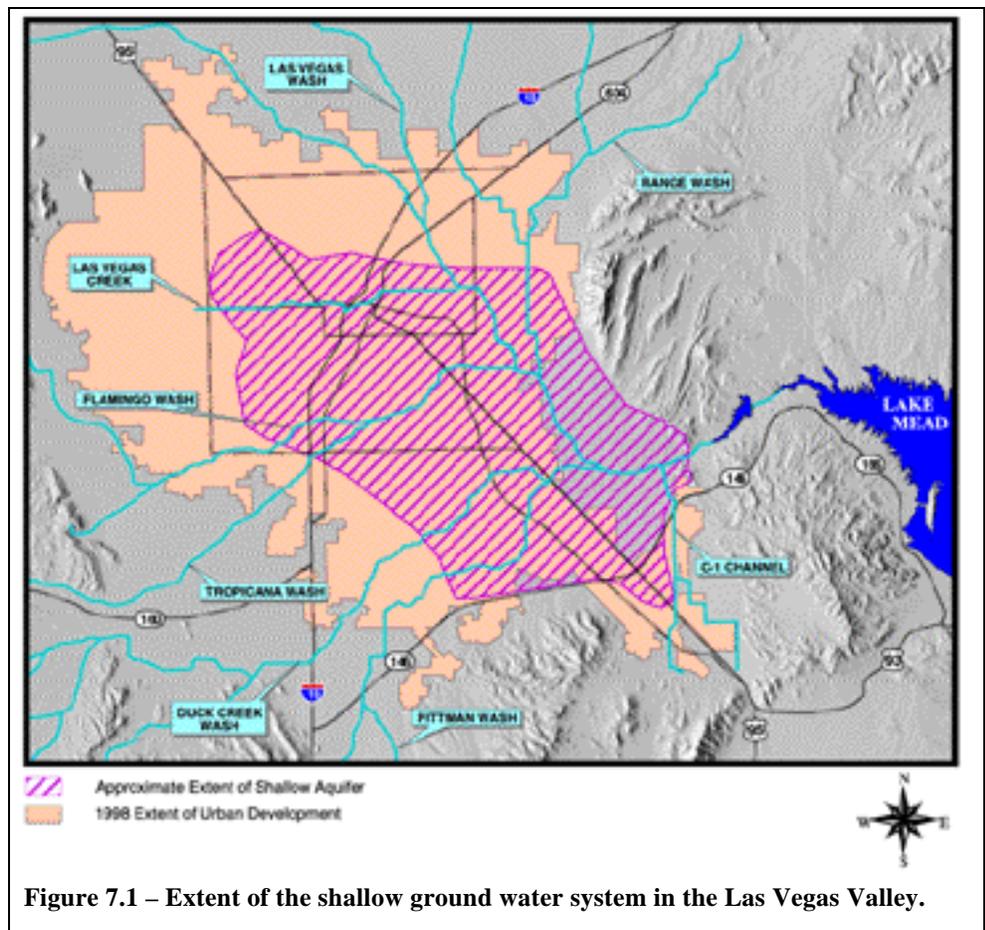


## Characteristics of Shallow Aquifer

Shallow ground water in the central and southeast part of the Valley appears within the first few feet of land surface and is typically characterized as ground water less than 30 feet below land surface. Figure 7.1 shows the approximate extent of the shallow system in the central and southeast part of the Valley. Recharge to the shallow aquifer system can be a result of a positive upward gradient from the deeper aquifers and from downward percolation of excess irrigation water not consumed by plants or evaporation. Most of the irrigation water that has not been used by plants, or has not entered the storm drain and tributary drainage channels, percolates to the shallow water table where it's downward migration is stopped by a layer of clay or caliche (calcium-carbonate cementation), which act as confining layers. The shallow zone is composed primarily of silts and clays and poorly sorted sands and gravels of low transmissivity. The general flow gradient of the shallow system is southeast, toward the Wash.

## Water Quality

Shallow ground water tends to be of poor quality as measured by total dissolved solids (salinity). Total dissolved solids (TDS) concentrations in the shallow system range from 1,500 mg/L in the central part of the valley to greater than 7,000 mg/L in the south-east Valley. The high salinity levels present in the shallow system can be attributed to two factors: 1) over-irrigation of landscapes and the associated evapotranspiration resulting in concentration of salts, and 2) the presence of gypsum deposits and the subsequent dissolution of the minerals by the shallow ground water. Figure 7.2 presents a salinity contour map highlighting the range of TDS values and showing the increase of salinity in the down-gradient, southeastern direction.



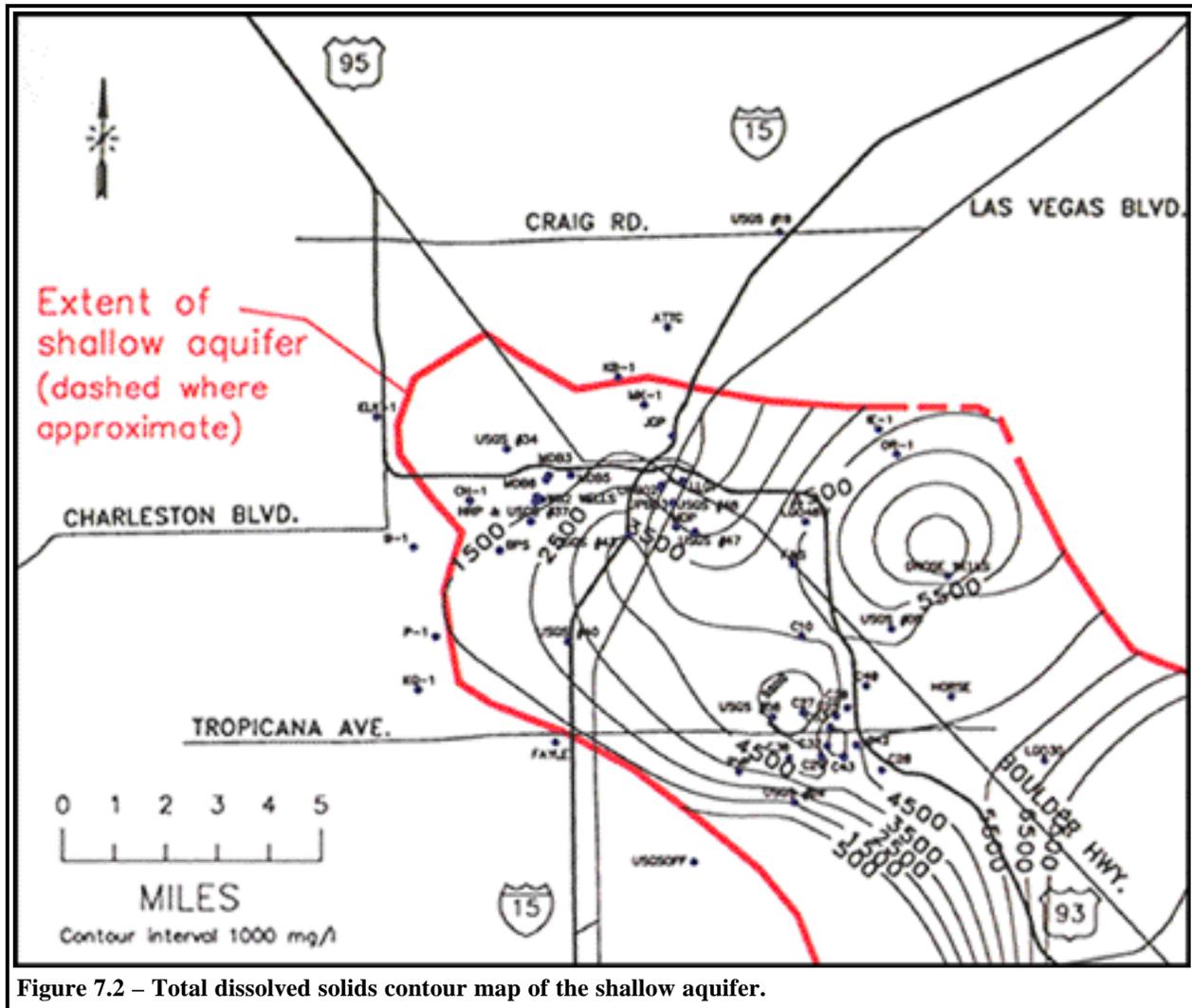


Figure 7.2 – Total dissolved solids contour map of the shallow aquifer.

Other concerns regarding water quality in the shallow aquifer, and its potential to reach the Wash as intercepted ground water, stem from land use practices ranging from the use of urban chemicals such as pesticides and herbicides to past industrial activities.

### Urban Chemicals

The U.S. Geological Survey (USGS), as part of the National Water-Quality Assessment Program (NAWQA), has collected and analyzed water quality samples from various shallow ground water (not used for drinking water) monitoring wells in the Valley. A 1998 USGS report states that at least one pesticide was detected at low levels (below the maximum contaminant level established for drinking water) in 28 percent of the shallow monitoring wells sampled. The report concludes that urban activities in the Valley have been a primary source of these organic compounds found in the shallow aquifer.

## Perchlorate

Perchlorate, a salt with the chemical structure of  $\text{ClO}_4^-$ , was manufactured by Kerr-McGee and American Pacific (formerly Pepcon) at the Basic Management, Incorporated industrial complex near Henderson from the 1950s until 1997. Most of the perchlorate produced was used as an oxidizer component for rockets and missiles, but it was also used in the production of fireworks, matches, pyrotechnics and analytical chemistry. Perchlorate was also used in high concentrations (400-600 milligrams per liter) to treat Graves Disease patients for hyperthyroidism during the 1950s and 1960s.

Advancement in technology has lowered the detection limit for perchlorate from 400 parts per billion (ppb) to four ppb and has resulted in perchlorate being detected at low levels (less than 18 ppb) in the raw and finished drinking water supply from Lake Mead. The Nevada Division of Environmental Protection (NDEP) has determined that the source of perchlorate in Lake Mead is intercepted shallow ground water in the Wash. High levels of perchlorate have been discovered in shallow ground water surrounding and down gradient from the two companies that manufactured perchlorate in the Valley.

While the U.S. Environmental Protection Agency has not established an “action level” for perchlorate, the California Department of Health Services has established an 18 ppb action level. The California action level has been informally adopted by the NDEP. Since testing began in Lake Mead in late 1997, southern Nevada’s water supply has not exceeded the 18 ppb threshold.

The NDEP has been actively working with the responsible parties to facilitate the removal of perchlorate from the shallow ground water system, which will result in a decrease of values seen in the Wash and Lake Mead. One of the more difficult tasks associated with the remediation has been understanding the hydrogeology of the shallow system in this part of the Valley and the subsequent identification of any “preferred pathways” that may exist that may allow for a more effective cleanup. One recent discovery was the presence of a shallow ground water seep of about 350 gallons per minute that, based on mass balance calculations, is estimated to contribute about fifty percent of the total perchlorate load into the Wash. The NDEP has required the responsible parties to focus on this site by intercepting the flow and removing the perchlorate before it reaches the Wash.

## **Recommended Actions**

The issues surrounding the shallow ground water system include: 1) quantity, in terms of shallow ground water entering the Wash due to dewatering



for construction activities, and the amount of ground water reaching the Wash due to rising water levels resulting in an increasing gradient and volume; and 2) quality, in terms of the influence of shallow ground water on water quality in the Wash and Lake Mead.

The Team developed the following recommendations to facilitate understanding the shallow aquifer, its impact on the Wash and the subsequent need of interagency coordination to effectively manage the Wash.

**Action 1: Develop a Central Database**

*Entities: Las Vegas Wash Management Entity, Nevada Division of Environmental Protection, Southern Nevada Water Authority U.S. Bureau of Reclamation, U.S. Geological Survey, University of Nevada Las Vegas*

Currently numerous agencies, entities, and private companies have monitoring wells throughout the Valley, each group monitoring for constituents and parameters specific to their own need. Until this point there has been relatively little sharing of data because there is not a procedure in place for data accessibility and sharing by all agencies.

The Team recommended that a central database be developed to include all known data on the shallow system. The database should include, but not be limited to:

- Well Construction
- Location (GPS coordinates)
- Water Level
- Water Quality
- Aquifer Test Data

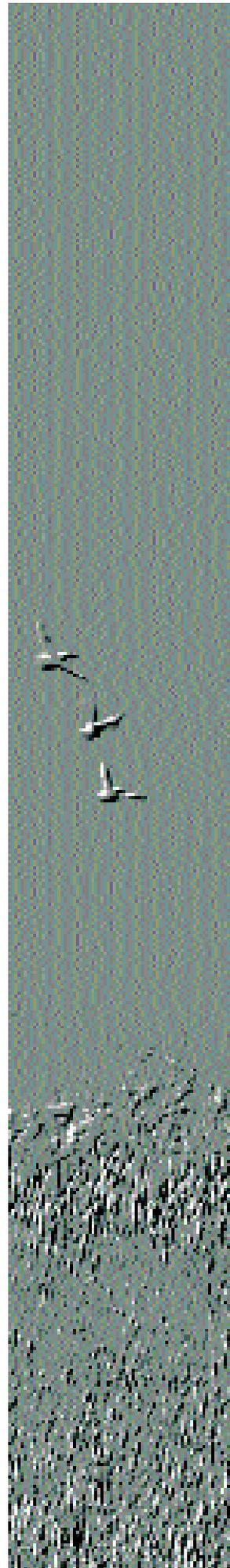
The Las Vegas Wash Project Coordination Team (LVWPCT) has begun this effort by reviewing more than one hundred reports produced by the Basic Management, Inc. (BMI) companies and submitted to the Nevada Division of Environmental Protection. Pertinent data has been extracted from these reports and entered into a database. There are still many reports from a variety of sources to identify and review.

The Team recommended that this database be made available to all entities with an interest in shallow ground water.

**Action 2: Locate and Inventory Existing Shallow Monitoring Wells**

*Entities: Las Vegas Wash Management Entity, Nevada Division of Environmental Protection, Southern Nevada Water Authority*

The Team recommended that all shallow monitoring wells be located using global positioning system technology and that this information be stored in the central database. The SNWA and the LVWPCT have physically located more than 200 wells located at the BMI site using GPS technology.



Additional well locating is underway as more information is learned from reviewing the reports.

**Action 3: Identify Issues of Concern**

*Entities: Las Vegas Wash Management Entity, Nevada Division of Environmental Protection*

An important step in minimizing the impact of the shallow aquifer on the Wash is to identify the issues of concern through characterization of both the quantity and the quality of the shallow ground water. Table 7.1 summarizes the issues of concern identified by the Team considering data that currently exists and was readily available for the Team's review. The Team agreed that additional review and research is necessary to make this list more complete.

ISSUES OF CONCERN	
Issue	Source / Location
Perchlorate	Industrial practices
TDS	Evapotranspiration, soils
Inorganics	Urban and industrial practices
Organics	Urban and industrial practices
Increased aerial extent of system	Over irrigation of landscapes

Table 7.1 - Shallow ground water issues of concern.

**Action 4: Develop a Long-Term Monitoring Program**

*Entities: Las Vegas Wash Management Entity*

The Team recommended that development and implementation of a long-term monitoring plan be overseen by the designated Las Vegas Wash Management Entity. The monitoring plan should be developed with input from the entities that currently collect water quality or hydrogeologic data. The Team pointed out that the development of the monitoring plan should consider any monitoring currently being conducted by other entities to avoid duplication of efforts.

The goals and individual components of the long-term monitoring program should include the following:

- Measure water quality.
- Conduct aquifer testing.
- Identify contribution of shallow ground water inflow.
- Identify data gaps and the need for additional monitoring wells.
- Develop monitoring timeframes to ensure sufficient data collection.



- Understand role of land use practices on shallow ground water quality.
- Review of historical photos for past land use practices.

Development of the long-term monitoring program should also consider frequency of sampling, data interpretation, database maintenance, and types of data to collect.

The LVWPCT and the Southern Nevada Water Authority have conducted a significant amount of shallow ground water research that includes water quality, water level and aquifer testing. This extensive set of data is in the process of being incorporated into a central database.

The Team recommended that this data be stored in the central database for access by interested parties.

**Action 5: Develop a Method to Identify the Potential for Future Contaminant Discovery**

*Entities: Las Vegas Wash Management Entity, Nevada Division of Environmental Protection*

The Team recommended that once a method was in place to collect and analyze the shallow ground water data, the next step should be to develop a method to identify potential concerns.

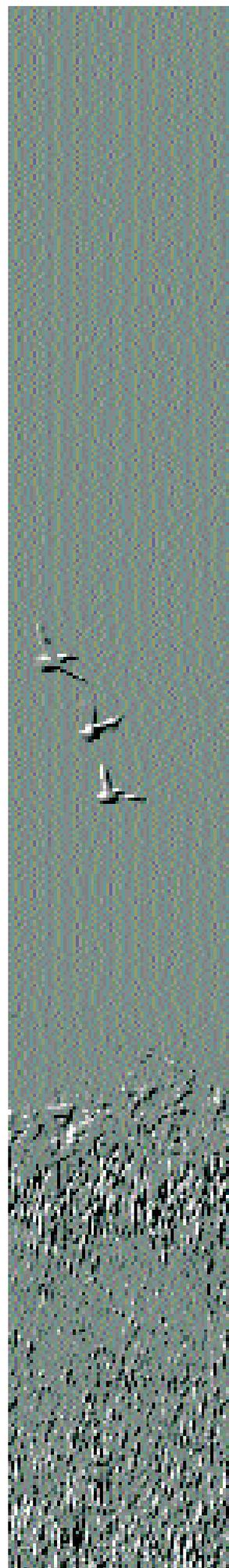
**Action 6: Develop and Implement a Notification Plan**

*Entities: Las Vegas Wash Management Entity, Nevada Division of Environmental Protection*

In order to provide a mechanism to address the identified current and future shallow ground water quality issues of concern, the Team recommended the development and implementation of a notification plan. The plan would provide a Summary Report that would include the identification of contamination sources, site characterization

NOTIFICATION PLAN	
1.	<p><b>Identify Contaminant</b></p> <ul style="list-style-type: none"> <li>• Name of person/entity filing report</li> <li>• Date sampled</li> <li>• Name of contaminant</li> <li>• Chemical formula of contaminant</li> <li>• Amount of contaminant detected</li> <li>• Site(s) contaminant located</li> <li>• Description of site(s)</li> </ul>
2.	<p><b>Notification</b></p> <ul style="list-style-type: none"> <li>• Designate coordinating agency</li> <li>• Notify affected agencies</li> <li>• Notify Public Outreach Study Team</li> <li>• Begin public notification, if necessary</li> </ul>
3.	<p><b>Coordinate Water Sampling Efforts and Data to Characterize Range and Extent of the Problem</b></p>
4.	<p><b>Implement Action</b></p>

Table 7.2 - Example outline of Notification Plan.



and flow path identification and the design/implementation of any monitoring and remediation plan required by the regulatory agency responsible for oversight. The report should be distributed to the effected or potentially-effected entities. Refer to Table 7.2 for an example outline.

**Action 7: Promote Interagency Coordination**

*Entities: Las Vegas Wash Management Entity, Nevada Division of Environmental Protection, Southern Nevada Water Authority, U.S. Bureau of Reclamation, U.S. Geological Survey, University of Nevada Las Vegas*

The shallow ground water issues associated with the Wash transcend multiple jurisdictional authorities and have prompted the need for interagency coordination.

The Team recommended that the Las Vegas Wash Management Entity establish a method of notifying and seeking input from interested parties regarding shallow ground water issues of concern. In addition, the Team felt that creating this open-communication forum would promote opportunities for entities to work together to develop innovative solutions to reduce the impact of shallow ground water on the Wash.

**Action 8: Develop a Bibliography**

*Entities: Las Vegas Wash Management Entity*

The Team has compiled a bibliography of some existing reports and/or data available for the shallow ground water, but realized the list is not an exhaustive search of available information. See Appendix 7.1 for the bibliography developed by the Team. The Las Vegas Wash Project Coordination Team has compiled a bibliography from over 100 reports that companies at the BMI facility produced as a requirement from the NDEP. In addition, bibliographies from several reports have been compiled into one source. See Appendix 7.2 for the bibliography developed by the Las Vegas Wash Project Coordination Team.

The Team recommended that a complete bibliography be developed and made available to all interested parties.

**Appendices**

- 7.1 Shallow Ground Water Study Team Available Data Form
- 7.2 Bibliography of Existing Reports and/or Data Available



## References

SEA Incorporated Consulting Engineers (1994). Hydrogeologic and Geochemical Investigation of Shallow Ground Water, Henderson, Nevada.

