GROUNDWATER MANAGEMENT PLAN

JAMES IRRIGATION DISTRICT AND THE CITY OF SAN JOAQUIN

DATE SIGNED:____________________

AUGUST 2010

PREPARED BY:

EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

TABLE OF CONTENTS

Figures

Attachments

Tables

Appendices

List of Abbreviations

AB	Assembly Bill
ACWA	Association of California Water Agencies
AF	Acre-feet
AWMC	Agricultural Water Management Council
bgs	below ground surface
BMO	Basin Management Objective
CVP	Central Valley Project
DBCP	dibromochloropropane
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EC	Electrical Conductivity
EPA	Environmental Protection Agency
ET	evapotranspiration
EWMP	Efficient Water Management Practices
FKC	Friant-Kern Canal
FWA	Friant Water Authority
FWUA	Friant Water Users Authority
GAC	Groundwater Advisory Committee
GMP	Groundwater Management Plan
GPS	Global Positioning System
HSA	Hydrologic Study Area
ID	Irrigation District
IRWMP	Integrated Regional Water Management Plan
JID	James Irrigation District
KRCD	Kings River Conservation District
KRWA	Kings River Water Association
MOU	Memorandum of Understanding
MVWD	Mid Valley Water District
NRCS	Natural Resources Conservation Service
RCWD	Raisin City Water District
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SCIC	Stinson Canal and Irrigation Company
SCS	Soil Conservation Service
SLDMWA	San Luis and Delta-Mendota Water Authority
TDS	total dissolved solids
TID	Tranquillity Irrigation District
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WHPA	Wellhead Protection Area
WWD	Westlands Water District

1 - INTRODUCTION

This Groundwater Management Plan (GMP or Plan) is a joint effort between the City of San Joaquin (San Joaquin or City) and the James Irrigation District (JID or District). The two agencies are preparing this integrated GMP to better coordinate efforts, share data, and improve regional management of groundwater resources. Hereafter, the two agencies will be called the 'Plan Participants' and the area covered by the GMP will be called the 'Plan Area'. This Plan is the first effort by the City of San Joaquin to develop a GMP. This Plan is also an update to JID's GMP prepared in 2001, and this GMP satisfies new requirements for GMPs created by the September 2002 California State Senate Bill No. 1938, which amended Sections 10753 and 10795 of the California Water Code. This Plan also addresses recommended components for a Groundwater Management Plan described in Appendix C of Department of Water Resources Bulletin 118 (2003 Update).

1.1 - Background Information on Plan Participants

Following is general information on the Plan Area, followed by specific information on the City of San Joaquin and James Irrigation District.

Climate

The climate in the Plan Area is characterized by cool, mild winters and hot dry summers. Temperatures in the summer often exceed 100 degrees F. Fog occurs for long periods in the winter, with low temperatures typically in the mid 30's F; occasionally dropping into the 20's F. Average annual precipitation is about 7 inches, with 80 percent of the rainfall occurring from December through April. Precipitation is inadequate to meet crop water needs, except during the rainy season for some crops. Crops are sustained by irrigation during the summer. The growing season is typically 250 days per year.

Topography

Land in the Plan Area is relatively flat. It generally slopes westward and northward at a rate of about 3 to 4 feet per mile towards the topographic axis of the San Joaquin Valley, with local variations caused by remnants of slough channels. Elevations range from 160 to 180 feet above sea level.

City of San Joaquin

Below is a summary of the geography, demographics, water demands and water facilities in the City of San Joaquin.

Geography and Demographics

The City of San Joaquin was founded in 1920. The City is located in Western Fresno County about 11 miles southwest of the City of Kerman (see **Figure 1**). The City is an enclave in James Irrigation District. The City currently covers approximately 1 square mile. In 2010, the City had a population of 4,166. The population growth is expected to be 2.6% per year for the next ten years. Most of the population is employed in the agricultural industry.

Currently, rural dwellings in JID are not commonly being built. Old houses are being torn down and people are moving to San Joaquin or other urban areas. This could lead to more growth in San Joaquin. San Joaquin plans to expand to the east with an area of about one square mile. Specifically, San Joaquin expects to see the construction of about 300 new homes in the next five years.

Water Demand

Water usage in San Joaquin from 2005 to 2009 is summarized in Table 1.1.

Table 1.1 – City of San Joaquin Water Usage

Year	Volume	
	Million gallons	Acre-feet
2005	222	681
2006	221	678
2007	242	742
2008	259	795
2009	257	789

In 2008, the City's per capita water usage was 181 gallons per day per capita (gpdpc), which is close to the national average (ConSol 2009). About 60% of the water is used for outdoor landscaping. Fluctuations in gpcpd from year to year can be explained by a variety of economic, demographic, and climate factors. The per capita water use is not expected to increase, but may reduce with the implementation of conservation measures.

Facilities

The City is serviced by three groundwater wells. Combined, these wells have a maximum capacity of 3,500 gallons per minute (gpm) and 5 million gallons per day (gpd). In 2008, 49% (1,723 gpm) of the maximum groundwater well capacity was used during peak consumption for the City. The City hopes to construct one well in the near future to replace one of the older existing wells. The City does not use or import any surface water. The City also operates three stormwater basins that provide stormwater retention and incidental groundwater recharge. The City has no recharge basins or reservoirs, but has plans to construct a reservoir tank within the next few years.

Based on current analysis, the City is not expected to outstrip its supply capacity or lose ability to meet peak demands over the next ten years, unless one of the wells ceases to operate. This is a concern for the City since some of their wells are old.

The City has about 950 service accounts. Residential accounts are not metered. About 5 percent of the accounts are commercial, and about 20% of the commercial accounts are metered.

James Irrigation District
Below is a brief description of the origin, physiography, geology, water supplies and facilities in JID.

<u>Location</u>
The James Irrigation District (JID or District) was organized in 1920 under the California Water Code. The District covers 26,392 acres wholly within Fresno County, California. The San Joaquin Valley Farmlands Company, successor to the James Ranch, granted to JID a perpetual right to pump and import groundwater from beneath lands east of the District, up to 200 cfs in capacity. This GMP covers the area within the JID boundaries and deeded groundwater area, but the physiography and geology of neighboring lands are also discussed. The District is situated in the central San Joaquin Valley of California and is approximately thirty miles southwest of the City of Fresno. The City of San Joaquin lies near the middle of the District, but is excluded from the District's boundary. State Highways 145, 180 and 33 are in close proximity. Adjacent agricultural water agencies include the Tranquility Irrigation District (TID), Westlands Water District (WWD), Stinson Canal and Irrigation Company (SCIC), Mid Valley Water District (MVWD), Reclamation District 1606, and the Raisin City Water District (RCWD). A location map for the District is included as **Figure 1**, and a vicinity map of the District within the Kings Groundwater Basin is included as **Figure 2**.

<u>Land Use</u>
When JID was formed in 1920, agricultural development of its lands was well underway. As irrigation facilities were constructed, use of the land gradually converted from grasslands to cultivated crop land. District lands are now essentially fully developed for agriculture. Cropping data for 1993 to 2007 is included on **Attachment 1**. Typically, about 23,000 acres are irrigated and prevalent crops include cotton, wine grapes, corn, almonds and alfalfa. Other significant crops include tomatoes, sugar beets, wheat, and onions. Currently, the principal irrigation method is furrow irrigation, with smaller amounts of drip, level basin, and micro-sprinkler irrigation. There is a trend towards planting permanent crops and converting to modern irrigation methods.

<u>Facilities</u>
Figure 3 is a map illustrating the major facilities in the District. JID's conveyance system consists of three major components: Eastside Canals, the Main Canal, and the Lateral Canals. The Eastside Canals consist of two canals, the Kerman Line Pump Canal (a.k.a. Lassen Canal) and the Coalinga Line Pump Canal (a.k.a. McMullin Grade Canal). These canals collect and convey groundwater pumped from about 35 JID wells, which lie outside of the District's boundaries, into the district. The Eastside Canals merge together and connect near the south end of the Main Canal by flowing through twin 60-inch diameter reinforced concrete pipelines that cross under the Fresno Slough

Bypass (also called the James Bypass). These 60-inch pipelines are called 'the siphon'. In 1992, 3.25 miles of the Eastside Canals were piped with smooth interior corrugated polyethylene pipe, and the remaining 12.25 miles were concrete lined; the pipeline and canal lining were financed through a DWR sponsored loan.

The JID Main Canal operates as a lift canal for surface water that is pumped from the Mendota Pool. Groundwater and diverted Kings River flood releases feed by gravity into the Main Canal from the south and flow northwesterly. The system also includes 17 lateral canals that are mostly unlined earthen ditches.

The District also has about 63 groundwater extraction wells and about 20 monitoring wells. A summary of well attributes is provided as **Attachment 2**. In 2004, JID completed construction of the 220-acre K-Basin Recharge Project. The project includes six wells to recover some of the recharged water.

The proposed JID Water Augmentation Project will include new facilities for storing and recharging water, with the goal of reducing JID's dependence on surface water. The project will include improvements to basins and construction of new recovery wells and conveyance facilities. The project will provide facilities for regulation storage, floodwater storage, groundwater recharge, and groundwater banking. It is estimated that the project will allow JID to capture and recharge an average of 4,740 AF/year of Kings River floodwater. Five recovery wells will have the capacity to extract 30 AF/day. The project is currently being designed and construction is expected to be completed by the end of 2011.

JID has also prepared a Water Banking Prospectus for the Water Augmentation Project. JID is actively seeking an agency that wants to bank water in JID using the proposed facilities. As a condition of any banking agreement at least 10% of the banked water must be left behind. This will contribute to local recharge and higher groundwater levels while the water is banked. The volume of water that will be banked still has to be negotiated with a potential banking partner.

<u>Groundwater Supplies</u>

The District owns and operates about 63 irrigation wells. The well locations are shown on **Figure 3**. About 28 of these are within the District boundary and about 35 are east of the District boundary within their deeded groundwater easement area. The current estimated yield for each well is shown on **Attachment 2**. Well yields range from 950 to 3,400 gpm, with an average of about 1,500 gpm. The total well pumping capacity is about 210 cfs. Most of JID's wells are between 500 and 600 feet deep, and extend to the top of the Corcoran Clay (a local confined aquifer). A few of JID's older wells are 700 to 900 feet deep and penetrate the confined aquifer. Two privately owned irrigation wells are inside of JID's boundary.

An enormous aquifer system lies beneath the Kings Groundwater Sub-basin and extends the length and breadth of the San Joaquin Valley. The valley is a broad structural trough, with the Sierra Nevada mountains on the east and the Coast Range mountains on the west. The Sierra basement rock extends from the foothills on the east, sloping downward to the southwest at 4^{o} - 6^{o}. Consolidated and unconsolidated continental and marine deposits from both the Sierra and the Coast Range mountains overlie this basement complex. Unconsolidated alluvial deposits make up most of the basin's freshwater aquifer (Croft, 1972).

Interspersed within the unconsolidated deposits that comprise the usable aquifer in the region are a number of clay layers that can act as confining beds. The confining bed that has greatest significance to the District is known as the Corcoran Clay, or E-clay. The E-clay underlies the entire District. Two other clay layers also partially underlie the District.

JID now primarily uses the unconfined aquifer lying above the E-clay. The top of this clay occurs at a depth of around 500 feet below ground level within the District. Originally, most District wells constructed in the 1910's and 20's tapped the aquifer below the E-clay. Many of these wells initially exhibited artesian flow.

Surface Water Supply

CVP Schedule 2 water (informally called 'Riparian water') is delivered without charge as a settlement of the District's water rights claims in Fresno Slough – during normal and wet years 9,700 acre-feet is available, during dry years 7,600 acre-feet is available. The contract requires that the District take delivery of this water according to a predetermined schedule. In practice, the United States Bureau of Reclamation has allowed some flexibility on when this water is taken.

In addition, JID has a Central Valley Project (CVP) contract (No. 14-06-200-700A) for up to 35,300 acre-feet of water each year. Other water used by the District includes spillwater from the Fresno Irrigation District and Kings River floodwater.

In the past during wet years the USBR has made surplus water available to JID, which is above its normal contract deliveries. The source of this water may be either imports from the Delta via the Delta Mendota Canal, or San Joaquin River flood releases (called Section 215 water by the USBR).

Water Demands

Water demand in the District slowly increased over the years as land was brought into production. Since full agricultural development has now occurred, change in demand is largely the result of changing cropping patterns. **Attachment 3** is a 2009 Water Delivery Report for JID. The table also provides general water supply data for 1994 to 2009. Between 1994 and 2009, JID pumped an average of 29,500 AF/year of groundwater (39% of total supply), and imported an average of 46,600 AF/year of surface water (61% of total water supply). JID has a goal to reduce their overall water demands through water conservation and water management efforts.

For more general information on JID refer to the James Irrigation District Water Conservation Plan – 2009 Update.

1.2 - Goals and Objectives of Groundwater Management Plan

The overall purpose of this GMP is to develop a coordinated and comprehensive approach to the evaluation and management of groundwater resources within the City of San Joaquin, James Irrigation District, and the James Irrigation District "East Side Wellfield" which is outside the District boundaries. Specific goals of this plan include the following:

1. Develop a consensus among agency staff and stakeholders on the current groundwater conditions, need for proactive groundwater management, and problems that need to be addressed.
2. Document goals and objectives for sustaining existing efforts and improving groundwater management.
3. Develop practical solutions for addressing groundwater issues, especially groundwater overdraft.
4. Improve communication between the City of San Joaquin and JID, and increase awareness of each agencies groundwater management concerns, programs and goals.
5. Provide a realistic and feasible implementation plan for short-term and long-term groundwater management efforts.

This GMP documents the existing groundwater management efforts in the Plan Area and planned efforts to improve groundwater management. Specific groundwater management goals documented in this GMP include:

1. Preserve and enhance the existing quality of the area's groundwater.
2. Preclude surface or ground water exports that would reduce the long-term supply of groundwater.
3. Coordinate groundwater management efforts between regional water users.
4. Maintain local management of the groundwater resources.
5. Implement a groundwater-monitoring program to provide an "early warning" system to future problems.
6. Stabilize groundwater levels in order to minimize pumping costs and energy use, and provide groundwater reserves for use in droughts.
7. Maximize the use of surface water, including available flood water, for beneficial use.

In addition, the Plan Participants will take a proactive role in the legislative process, participate in developing sound legislation concerning groundwater management if it becomes necessary, and take an active role in opposing any legislation that is detrimental to local groundwater management efforts.

1.3 - Statutory Authority for Groundwater Management

The City of San Joaquin and James Irrigation Districts are both public agencies with the authority to manage groundwater and prepare Groundwater Management Plans. California Assembly Bill 3030, as chaptered, (California Water Code, Division 6, Part 2.75, SEC. 10750-10753.9) grants specified "local agencies" authority to undertake groundwater management. AB 3030 also confers upon local agencies the powers of a water replenishment district. These authorities remained unchanged with the amendments to the law provided by California Senate Bill No. 1938, which was passed in 2002 and outlines additional requirements for GMPs. Agencies adopting a GMP are authorized to enter into agreements with other local agencies or private parties to manage mutual groundwater supplies, including those existing in overlapping areas.

1.4 - Lower Kings Basin Groundwater Management Plan

The Kings River Conservation District has developed a regional GMP that includes the area covered by James Irrigation District and the City of San Joaquin. The GMP is called the '*Lower Kings Basin Groundwater Management Plan*' (Regional GMP) and was prepared in April 2005. The GMP is compliant with Senate Bill 1938 and discusses regional geography, geology and hydrogeology, regional groundwater problems, and regional basin management objectives. The Regional GMP includes several study areas and JID and the City are included in study 'Area A'. One important goal in the Regional GMP is the development of an improvement district for all of Area A to jointly fund regional studies, projects and monitoring.

JID and the City did not participate in the development of the Regional GMP. However, JID found many of the goals and objectives in the regional GMP to be compatible with their needs and beneficial for JID and the region. As a result, JID passed a District Resolution (No. 2007-03) supporting the Regional GMP. As a result, JID will have two GMPs: this document and the Regional GMP. This document will help guide local and regional groundwater management, and the Lower Kings Basin GMP will help guide regional groundwater management.

1.5 - Groundwater Management Plan Components

This GMP includes the required and voluntary components for a GMP as identified in California Water Code Section 10753, et. seq. This Plan is also consistent with the recommended elements for a GMP as identified in DWR Bulletin 118 (2003), Appendix C. **Table 1.2** identifies the location within this document where each of the components is addressed.

Table 1.2 – Location of Groundwater Management Plan Components

Description	Plan Section(s)
California Water Code Mandatory Requirements (10750 et seq.)	
1. Documentation of public involvement	1.5, Appendix A
2. Groundwater basin management objectives	1.2, 3
3. Monitoring and management of groundwater elevations, groundwater quality, land subsidence, and surface water	5
4. Plan to involve other agencies located in the groundwater basin	4.3
5. Monitoring protocols	5.3
6. Map of groundwater basin and agencies overlying the basin	**Figure 2**
California Water Code Voluntary Components (10750 et seq.)	
7. Control of saline water intrusion	6.3
8. Identification and management of wellhead protection areas and recharge areas	6.2, 7.2
9. Regulation of the migration of contaminated groundwater	6.3, 6.4
10. Administration of well abandonment and well destruction program	6.1
11. Mitigation of overdraft conditions	7.1, 7.2
12. Replenishment of groundwater extracted by water users	7.2
13. Monitoring of groundwater levels and storage	5.1, 9.2
14. Facilitating conjunctive use operations	7.3
15. Identification of well construction policies	8.1
16. Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	6.4, 7, 8.2
17. Development of relationships with state and federal regulatory agencies	4.2, 4.3
18. Review of land use plans and coordination with land use planning agencies	9.1
Additional Components Recommended by DWR (App. C of Bulletin 118)	
19. Advisory committee of stakeholders	4.1
20. Description of the area to be managed under the Plan	1.1, 2
21. Descriptions of actions to meet management objectives and how they will improve water reliability	4 - 9
22. Periodic groundwater reports	9.2
23. Periodic re-evaluation of Groundwater Management Plan	9.4

1.6 - Adoption of Plan

Refer to **Appendix A** for documentation on the adoption of the GMP and the public process that was followed.

Public Participation in Plan Development

The public was invited to participate in the development of the updated GMP through newspaper notices and public hearings described below.

Preparation of Integrated Plan with City and JID

JID began to update their GMP in 2009. JID contacted several local agencies to solicit their input on the GMP. The City of San Joaquin was the only agency that expressed interest in the local groundwater management, and requested that the two agencies prepare a joint integrated Groundwater Management Plan. In April 2010, the two agencies singed a Memorandum of Understanding to cooperate on local groundwater management (see **Appendix E**) and prepare a joint GMP.

Groundwater Advisory Committee

The City of San Joaquin and JID used their City Council and Board of Directors, respectively, as groundwater Advisory Committees during preparation of this GMP. The two agencies plan to form a joint GAC for implementing the GMP after it is adopted. The JID Board of Directors is comprised of local farmers, and the City Council is comprised of local residents. Both of these groups represent and speak for local residents, and therefore were considered suitable for serving as the GAC. Several special sessions on groundwater issues were held at JID Board of Directors and City Council meetings. The GAC were also given a draft copy of the GMP to review. The GAC provided several insightful and useful comments for managing groundwater that were incorporated into the GMP.

As required by the California Water Code Section 10753.2 (a), JID and the City published a series of public notices, held public meetings, and adopted resolutions required for preparing and adopting this GMP. No comments were received from the public other than those offered by the Groundwater Advisory Committees. These public outreach efforts are summarized in Table 1.3 below.

Table 1.3 – Public Participation in Groundwater Management Plan Adoption

Phase of Public Noticing	Description	James Irrigation District	City of San Joaquin
Intent to prepare GMP	Notice of hearing published	12-31-08/1-7-09	???
	Hearing held. Resolution adopted.	1-13-09	5-12-10
	Resolution published	4-8-09/4-15-09	7-7-20/7-14-09
GMP Adoption	Notice of hearing published		
	Hearing held. Resolution adopted.		
	Resolution published		

2 - GEOLOGY AND HYDROGEOLOGY

This section discusses the geology and hydrogeology of the City of San Joaquin, JID, JID eastside well field, and the surrounding area. The purpose of this section is to provide general background information on the local geology, hydrogeology and water chemistry that will aid in selecting and implementing groundwater management programs. Most of the information in this section was derived from City of San Joaquin records, JID records, USGS Professional Paper 1401-C, USGS Water Supply Paper 1999-H, and a report prepared by the United States Bureau of Reclamation for Tranquillity Irrigation District.

The following sections include technical discussions on the plan area's groundwater. These are intended to provide geologists, engineers, and water managers a greater understanding of the area's stratigraphy, groundwater conditions, and hydrogeologic parameters. Less technical discussions on groundwater management programs are provided in Sections 3-9 of this document.

2.1 - Regional Geology

The San Joaquin Valley is the southern part of a large, northwest-to-southeast trending asymmetric trough of the Central Valley, which has been filled with up to six vertical miles of sediment. This sediment includes both marine and continental deposits ranging in age from Jurassic to Holocene (recent). The San Joaquin Valley lies between the Coast Ranges on the west, the Sierra Nevada on the east, and extends northwestward from the San Emigdo and Tehachapi Mountains to the Delta near the City of Stockton. The San Joaquin Valley is 250 miles long and 50 to 60 miles wide. The relatively flat alluvial floor is interrupted occasionally by low hills.

The San Joaquin Valley is divided into several geomorphic land types including dissected uplands, low alluvial fans and plains, river floodplains and channels, and overflow lands and lake bottoms. The alluvial plains cover most of the valley floor and comprise some of the most intensely developed agricultural lands in the San Joaquin Valley. In general, alluvial sediments of the western and southern parts of the San Joaquin Valley tend to have lower permeability than eastside deposits. The lower permeability in material along the western and southern portions of the valley is mainly attributed to the fine-grained nature of the parent material from which the alluvium is derived. The sediments are predominately marine in origin and consist of the thick sequences of mudstone, claystone, and siltstone that make up the Coast Ranges. Upon weathering and transport down slope along alluvial fans, these sediments readily decrepitate into fine-grained materials consisting mainly of silt and clay found along the axis of the valley trough.

Near the valley trough, fluvial deposits of the east and west sides grade into fine-grained deposits termed Flood-basin deposits by Page (1986) or Basin Sediments by USBR (1955). The San Joaquin Valley has several thick, fine-grained, lacustrine deposits. The Corcoran Clay Member of the Tulare Formation is the most notable fine-grained deposit in the San Joaquin Valley affecting groundwater quality and creates confined groundwater conditions below. The Corcoran Clay was deposited about 600,000 years ago in the Tulare Lake. This clay bed, which is found in the western and southern portions of the valley, separates the upper semi-confined to unconfined aquifer from the lower confined aquifer. The clay bed covers approximately 5,000 square miles and is up to 160 feet thick beneath the present bed of Tulare Lake and thins with distance from the center of origin.

Regional Hydrogeologic Setting

An enormous aquifer system lies beneath the Kings Basin and extends the length and breadth of the San Joaquin Valley. The valley is a broad structural trough, with the Sierra Nevada Mountains on the east and the Coast Range mountains on the west. The Sierra basement rock extends from the foothills on the east, sloping downward to the southwest at 4^{o} - 6^{o}. Consolidated and unconsolidated continental and marine deposits from both the Sierra and the Coast Range mountains overlie this basement complex. Unconsolidated alluvial deposits make up most of the basin's freshwater aquifer (Croft, 1972).

Interspersed within the unconsolidated deposits that comprise the useable aquifer in the region are a number of clay layers that can act as confining beds or perching layers. The confining bed that has greatest significance to the Plan Area is known as the Corcoran Clay, or 'E' Clay. The 'E' Clay underlies the entire Plan Area (**Figure 5**). **Figure 9** is a generalized cross section of the Plan Area. Two other significant clay layers also partially underlie the Plan Area. However, neither the 'C' Clay on the extreme northern edge of the District, nor the 'A' Clay have as a significant impact on the Plan Participants use of the aquifer as the Corcoran clay. However, recent studies completed by JID for the K-Basin recharge project indicates that there, the ‘C’ Clay may be present, extending the ‘C’ Clay several miles southeast as mapped by USGS (1972).

JID wells primarily tap the unconfined aquifer lying above the 'E' Clay. The top of this clay occurs at a depth of around 500 feet below ground level within the District. Originally, most District wells constructed in the 1910's and 20's tapped the aquifer below the E-clay. Many of these wells initially exhibited artesian flow, reflecting the confined groundwater conditions below the Corcoran clay. The use of wells within District boundaries which tap the confined aquifer below the E-clay was slowly phased out due to its poorer water quality, generally lower yields, and more expensive well construction costs. However newer wells are constructed on a case by case basis, and built to recover the highest quality water at a given location, whether that is above or below the Corcoran clay. As a result, some wells tapping the confined aquifer are now constructed.

Groundwater in the plan area is divided into three separate non-marine, water bearing zones. These include the lower water-bearing zone, upper water-bearing zone, and the perched or shallow zone, as discussed below.

- The **lower water-bearing zone** contains fresh water in the lower section of the Tulare Formation from the base of the E-clay (Corcoran Clay) to the base of fresh water or the top of connate, saline marine water. USBR (1955) terms the base of the fresh water aquifer as the base of the effective ground-water reservoir. The depth to the base of fresh water is from about 1,000 feet to 1,400 feet beneath the Plan Area (Page, 1973).

- The **upper water-bearing zone** is from the top of the Corcoran Clay to the upper sections of the Tulare Formation, often considered the bottom of the A-clay.

- The **shallow or perched zone** underlies the portion of the Plan Area from the City of San Joaquin and northward, from the top of the A-clay, if it is present, to the perched groundwater table which is often within 10 feet or less of the ground surface. DWR Bulletin 118-03 uses 25 feet below ground surface (bgs) as a general vertical depth limit for the base of the perched zone.

Subsidence

Land subsidence in the San Joaquin Valley has been studied extensively in the past by the USGS and DWR. A State-Federal committee on subsidence was formed in the early 1950's and performed research and measured subsidence until 1970. By 1970, 5,200 square miles in the Valley had subsided more than 1 foot. Land subsidence of up to 16 feet has been experienced in the southern portions of the San Joaquin Valley basin. Between 1926 and 1970, a maximum of 29.7 feet of subsidence was measured at a point southwest of Mendota. The compacting forces caused by groundwater level decline squeezed more than 15.6 million AF of water storage space out of valley sediments during the same period.

There are two types of land subsidence due to groundwater withdrawals; elastic and inelastic. Elastic subsidence is not permanent and is largely reversible, if water levels recover to above historic lows. Recent studies indicate that current subsidence west of the plan area is primarily elastic in nature, and will likely not be inelastic until water levels fall below historic lows. Inelastic subsidence is permanent and occurs when water is removed from a confined aquifer for the first time, and is sometimes referred to as virgin subsidence. Between the mid-1920's to about 1980, the San Joaquin Valley experienced inelastic, non-recoverable subsidence.

The most recent reports on land subsidence in the San Joaquin Valley were completed by R. L. Ireland of the USGS in 1986 and Arvey A. Swanson of DWR in 1995. Ireland (1986) states that "*Land subsidence to groundwater withdrawal in the San Joaquin Valley that began in the mid-1920's and reached a maximum of 29.7 feet in 1981 has been halted by the importation of surface water through major canals and the California Aqueduct in the 1950's through 1970's*." This was generally true at the time, because large scale regional subsidence had halted, but smaller-scale local subsidence continued in many areas.

Poland et al. (1975) estimated that cumulative non-recoverable land subsidence from 1926 to 1972 in the vicinity of the Plan Area was on the order of 4 feet. A land subsidence contour map shows lowering of the land surface due to land subsidence was exacerbated west of the Plan Area and cumulatively, for the period of record, was as much as 8 feet in this area.

As land subsidence is a function of groundwater pumpage and recharge, it is linked to drops in groundwater levels. **Appendix C** shows hydrographs for wells monitored by DWR in the Plan Area. The DWR hydrographs show periodic increases in water levels, but the overall trend is a steady decline in water levels from the 1960's to today. Other hydrographs in the area prepared for KRCD's 2005 Lower Kings Basin Groundwater Management Plan Update and JID's 2001 GMP show continued decreases in water levels. Recent drops in groundwater levels are likely a result of low precipitation years, and the increased reliance on groundwater in the area to supplement surface water supplies.

Poland et al. (1975) show a direct correlation between subsidence and pumpage. In a 1996 draft memo, DWR indicated that from 1975 to 1992 subsidence occurred primarily in drought years when groundwater supplies replaced surface water supplies. The most recent record of land subsidence in the area is from Swanson (1995), were he indicates that 2 feet of subsidence occurred along the Outside Canal near Mendota Dam between the years of 1970 and 1994. However, it is not known how much of the 2 feet of subsidence reported by Swanson was residual subsidence, continued from pre-surface water delivery pumpage west of the Plan Area. Data from 6 extensometers located west of the Plan Area indicates that subsidence there has been elastic since about 1977.

With the recent reductions in surface water supplies for CVP contractors, the demand on the regional aquifer system's groundwater will likely increase. A link between land subsidence and pumpage is well established west of the District. Therefore, studies should be conducted to determine the susceptibility of subsurface deposits to land subsidence with increasing groundwater demand, especially if newly constructed wells tap the confined aquifer.

<u>2.2 - Groundwater Basin</u>

The James Irrigation District and City of San Joaquin are in the Kings Groundwater subbasin (Kings Basin) in the San Joaquin Valley Groundwater basin of the Tulare Lake Hydrologic Region (DWR 2003). See **Figure 2** for a map of the regional groundwater sub-basins. The Kings subbasin has been identified by the DWR as a basin with boundaries appropriate for ground water management purposes (DWR Bulletin 118-80). These boundaries were identified on the basis of geological and hydrological conditions, as well as political boundary lines. There are 19 court adjudicated basins in California, most of them in Southern California or coastal regions of California. The Kings Groundwater Subbasin is not included in the list of adjudicated basins, however DWR Bulletin 118-03 identifies eleven basins in California as being in critical conditions of over draft and the Kings Basin is included on the list.

Geography
The Kings Basin covers 976,000 acres. The Kings Basin extends from the Sierra Nevada foothills on the east to the San Joaquin Valley trough on the west, and from the San Joaquin River on the north to roughly the Fresno County line on the south. The Kings Basin also includes small portions of Kings and Tulare counties. The Plan Participants lie in the northwest portion of the Kings Basin and is bounded to the west by the southern extension of Delta-Mendota subbasin (**Figure 2**). The Westside Groundwater Subbasin borders the southwest portion of the District. The San Joaquin and Kings Rivers are the two principal rivers within or bordering the Kings Basin. There are no hydrogeologic features that would prevent groundwater from flowing between the Kings Basin to the Delta-Mendota or Westside Sub-basins, located to the west.

Tulare Lake Hydrologic Region
The Kings Basin (DWR subbasin No. 5-22.08) lies within the Tulare Lake Hydrologic Region, which covers approximately 10.9 million acres (17,000 square miles) and includes all of the Kings and Tulare Counties and most of Fresno and Kern Counties. The region has 12 distinct groundwater basins and 7 sub-basins of the San Joaquin Valley Groundwater Basin.

Groundwater has historically been important to both urban and agricultural uses, accounting for 41 percent of the Hydrologic Region's total annual supply and 35 percent of all groundwater use in the State. The aquifers are generally quite thick in the San Joaquin Valley subbasins with groundwater wells commonly exceeding 1,000 feet in depth. The base of fresh groundwater in the region, at an average of about 1,200 feet below ground surface, is considered to be the maximum effective depth of the basin in terms of pumping and recharge. According to Bullettin118-2003, well yields average 500 to 1500 gpm, with a maximum of 3,000 gpm (this agrees with data for JID wells).

Groundwater Quality for the Tulare Lake Hydrologic Region
In general, groundwater quality throughout the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high total dissolved solids (TDS), nitrate, gross alpha, arsenic and organic compounds. The areas of high TDS content are primarily along the west side of the San Joaquin Valley and in the trough of the valley. High TDS content of west-side water is due to recharge of stream flow originating from marine sediments in the Coast Range. High TDS content in the trough of the valley, especially in water close to the surface, is the result of concentration of salts because of evaporation and poor drainage. According to DWR Bulletin 18-2003, TDS in groundwater in the Kings Basin ranges from 40 to 2,000 mg/L with an average of 200-700 mg/L. Groundwater quality specific to JID and the City of San Joaquin is discussed in detail in Section 2.6 below.

Groundwater Budget

According to the DWR Bulletin 118-03, in the Tulare Lake Hydrologic Region the San Joaquin Valley Basin only has two subbasins ranked as a Type "C" groundwater budget; Kings and Westside. A Type C budget indicates that there are not enough data to provide either an estimate of the basin's groundwater budget or groundwater extraction from the basin. This suggests a low level of knowledge exists on groundwater inflow, outflow, or storage information in the Kings basin. The C budget type is for the whole subbasin, not just the Plan Area, so it will take collaboration to get information needed to bring the subbasin to a budget type classification of A, which is based on actual groundwater budgets or models, or B which is a use-based estimate of groundwater extraction (using evapotranspiration demand). The Kings Subbasin was determined in DWR Bulletin 118-80 to be a "*critically overdrafted*" basin. This designation was not reevaluated when the bulletin was updated in 2003.

2.3 - Stratigraphy

The following discussion focuses on significant hydrogeologic units that have an impact on the groundwater resources within the Plan Area. From the surface to the base of the effective groundwater reservoir, about 1,200 feet bgs, important hydrogeologic units are topsoil, alluvial fan deposits of eastside origin, basin sediments, the A-, C-, and E- (Corcoran) clays, and alluvial deposits below the E clay, and to a lesser extent alluvial deposits of Westside origin. Depth to bedrock is too deep under the Plan Area to impact groundwater conditions and therefore will not be discussed here.

Topsoils

Soils in the District and vicinity range from coarse sands to heavy clays. In the middle and western portions of the Plan Area the soils generally have a higher clay content. These soils developed on sediments deposited in the valley trough during flood periods. The parent material of these soils is flood basin deposits and fine-grained alluvium of mixed granitic and sedimentary origin from both the Sierra Nevada and Coast Range Mountains. Soils in the eastern portion of the Plan Area and the JID eastside wellfield generally have higher sand content and are derived mostly from granitic Sierra Nevada sediments deposited on alluvial fans. The increase in sandier materials to the east extends into the subsurface and partially explains why more wells are located in the eastern side of JID than the western side. Soils throughout the vicinity of the Plan Area are stratified, with interspersed sandy and clayey streaks. **Figure 4** is a composite of United Stated Department of Agriculture soil survey maps which cover the Plan Area.

Subsurface Geology

The USBR (1955) provides the most focused and detailed descriptions of the subsurface geology in the Plan Area. While the USBR report was prepared for Tranquillity Irrigation District, it also covers the Plan Areas and east to R.17E/R.18E section line (approximately 2 miles east of the eastern JID border). The following discussion on subsurface geology is based on the descriptions found in USBR's report. Surface deposits, as mapped by the USBR, include eastside inactive alluvial fan deposits that cover the Plan Area east of James Bypass. From about the James Bypass westward surface deposits are composed of Basin Sediments deposited in the axis of the valley during wet climatic cycles. Beneath these sediments lies the Corcoran clay, a regional lacustrine clay that causes confined groundwater conditions below it. Below the Corcoran clay, Sierran alluvial sediments dominate to depths greater than 3,000 feet bgs. These sediments are considered part of the Tulare Formation and are discussed in further detail below. Within the Tulare Formation seven lacustrine clays are mapped to varying extent in the San Joaquin Valley. In the Plan Area the A-clay, C-clay and E-clay or Corcoran clay are the most important of the mapped clay lacustrine clays. Several geologic cross sections passing through JID, the JID Eastside Wellfield, and the City of San Joaquin are included in **Appendix B**. The locations of the cross sections are shown on **Figure 4**.

Alluvial Fan Deposits of Eastside (Sierran) Origin

Surficial deposits of eastside origin are roughly found east of the James Bypass. The alluvial fan deposits above the Corcoran clay are predominately of eastside (Sierran) origin and comprise lenticular beds of sands and silts derived primarily from granitic rocks with rare clay laminae. These sediments probably represent deposits of former Kings River and San Joaquin River distributaries and are geographically higher than alluvium deposits of the active fans. They are slightly wind modified and soils that form on them tend to be saline; developed under conditions of high water table and little sedimentation. USDA-SCS soil classification for soils that formed on the inactive alluvial fans are sandy loam to fine sandy loam, with the finer grained soils dominating near James Bypass (**Figure 4**). Beneath the topsoil the sands vary from fine to medium-grained sizes and coarse sands and gravels are rare. The deposits generally fine westward; grading into the Basin sediments discussed below. Fine-grained deposits dominate in the western portion of the area where they finger into the Basin sediments. This alluvial sequence occurs from the surface to depths of 500-550 feet bgs. Most of the wells in the JID eastside well field are completed in these deposits. These sediments, while all Sierran fluvial, represent three distinct environments of deposition. Clays and silt/clay mixtures represent deposition in lakes or marshes, well sorted sands and silts represent deposition in water with current such as streambeds or lake beaches, and poorly-sorted silt and clay fractions indicate floodplain origins.

Basin Sediments

West of the alluvial fan deposits of eastside origin (roughly James Bypass) surface deposits are comprised of Basin sediments. The Basin sediments are along the trough of the valley and consist of material of mixed Sierran and Coast Range origin. The Basin sediments are fine sands, silts, and clays. Soils that formed on the Basin Sediments are classified by the USDA-SCS as clay loam and clay. Under natural conditions these deposits are poorly drained, frequently flooded, and ponded or marshy. These sediments grade westward into inactive alluvial fan deposits of Westside (Coast Range) origin.

The A-clay is one of seven recognized lacustrine clay beds in the San Joaquin Valley (**Figure 6**). It was deposited in a widespread lake and is found almost continually beneath the topographic axis of the valley. While not comprised of alluvium of eastside origin or Basin Sediments, stratigraphically it is located within these units, and thus is discussed here. The top of it is often the base of the perched or shallow ground water zone. The A-clay, as mapped by Croft (1972), extends under the Plan Area from the City of San Joaquin northwestward (**Figures 6**). The base is about 60 to 75 feet beneath the land surface and generally it is between 5 to 70 feet thick. Structure contours drawn on the base of the A-clay indicate that it is relatively flat beneath the northern portions of JID. The A clay is an aquitard, not yielding significant water to wells, and in fact is a perching layer stopping the downward migration of water from the surface.

The C-clay is another of one of the seven recognized lacustrine clay beds in the San Joaquin Valley. In the JID area its extent is similar to the A-clay, but it was not mapped with the same level of certitude by Croft (1972) as the overlying A clay or the underlying E-clay. Recent subsurface investigations by JID for the K-Basin recharge project indicate that the C-clay is likely present there at a depth of 235 to 253 feet bgs. These depths correspond to Croft's mapping of the C clay where, in the northern portions of the District, it is roughly 240 to 260 feet bgs. The Report of Findings for Potential Banking Facilities (Provost and Pritchard, 2005) indicates that, based on the results of pump tests at the Lateral K Basin, there is only a small hydraulic connection between groundwater in strata above and below the C-clay.

Alluvial Deposits Beneath The Corcoran Clay
Beneath the Corcoran clay a series of granitic sands, silts, and occasional clays extends to depths greater than 1,200 feet. These sediments were deposited by alluvial fans debauching from the Sierra Nevada Mountains and resemble beds of similar origin above the Corcoran clay, but are texturally coarser grained. While most of the recently built wells, as of 2003, are completed in the alluvial deposits above the Corcoran, two wells built around 1950 were completed to depths below the Corcoran clay. Of these two wells one is abandoned and records indicate that the other is no longer in use. This unit contains the base of the effective groundwater reservoir, as described below. Water quality in this zone is discussed below but generally is of much better quality than water above the Corcoran clay. Currently the District designs and constructs wells based on site specific conditions and wells may be perforated above or below the Corcoran clay.

Corcoran Clay
The Corcoran Clay, also known as the E-clay, is a lacustrine clay bed of lake or swamp origin that effectively underlies the entire Plan Area. The Corcoran clay has long been recognized as the most significant subsurface deposit in the San Joaquin Valley confining water beneath it. It is the upper most boundary of the confined aquifer and the lower most boundary of the unconfined aquifer. The easterly extent of the E-Clay is shown on **Figure 5**. Structure contours drawn on the bottom show it to be about 560 to 620 feet beneath the surface in the plan area (Croft, 1972). Page (1986) provides structure contours to the top of the Corcoran clay. Based on Page's interpretation, the depth to the top is between 500 to 550 feet over the majority of the area with a

thickness of 20-40 feet. The structure contours reveal the structure of the clay as a southerly dipping anticline with about 50 feet of relief from the north to south beneath the JID area. On well completion reports it is commonly described as blue or green clay, claystone, or siltstone. The Corcoran Clay has also been described as greenish-grey, dense, compact, and non-laminated claystone or siltstone. The bottom 20 feet is usually silty and it is a characteristic marker on E logs. A few scattered sand lenses exist and in the eastern portions of the area can make up as much as 30 percent of the clay sequence.

Alluvial Deposits of Westside Origin

The Plan Area, being near but east of the axis of the valley, has for the most part been dominated by deposition from the Sierra Nevada. However, there is some indication that subsurface deposits west of JID originated from the Coast Ranges. Contemporaneous deposition from eastside and westside sources is shown in a drill hole located in 15S/16E, Section 17E (about 1 mile west of the Plan Area) at depths of 22 feet where westside deposits overlie eastside deposits. This indicates that the sediments from the two sources occur and overlap west of the Plan Area. USBR (1955) indicates that the westside deposits thin and pinch out easterly. While these sediments probably form a minor component of the area's useable aquifer, water originating from these sediments to the west could have a great impact on water quality.

2.4 - Aquifer Characteristics

Specific Yield

In order to establish the storage capacity of the underground reservoir it is necessary to derive estimates of the specific yield of the sediments. USBR (1955) derived estimates of specific yield for the upper water-bearing zone within JID. These values are based on specific yield estimates from two separate studies done in similar geologic settings. The USBR report defined the upper water-bearing zone as the depth interval between the 1948 static water level in shallow wells and the top of the Corcoran clay (about 30 feet to 500 to 550 feet bgs). USBR computations show specific yield for JID ranges from as high as 22 percent to as low as 6 percent for the sediments above the Corcoran clay. Specific yield contours show a tongue of higher specific yield extends southwestward across the northern portions of the JID area corresponding to eastside alluvial sediments. The higher specific yields are associated with this tongue of coarser grained sediments of Sierran origin.

Based upon estimates of specific yield by the USGS and the DWR, the average specific yield of the unconfined aquifer was estimated to be about 11 percent for the District and about 12 percent for the Eastside well field area. Findings from the KRCD Groundwater Management Plan Update (2005) indicate that specific yield in JID is 11.3 to 12 percent.

Safe Yield

Safe yield, or perennial yield, is difficult to quantify because of the shared nature of the aquifer and uncertainty in defining the term. In this analysis perennial yield is defined as the amount of pumping that can be supported over an average hydrologic base period that will not result in a long-term decline in water levels. The base period must be long enough to include both wet and dry hydrologic cycles.

One factor complicating the estimate of perennial yield for JID is that the District and Eastside well field region is not a "closed" ground water basin. That is, groundwater in the region is hydraulically connected to groundwater in adjacent areas within both the "Kings Basin" and the "Tulare Lake Hydrologic Region". If groundwater management activities substantially raised static water levels subsurface inflow would decrease, subsequently decreasing perennial yield.

A previous analysis performed by Provost & Pritchard Consulting Group, Inc. investigated the safe yield using the hydrology from 1975 to 1993. The analysis concluded that the perennial yield for JID is approximately 1,000 AF per year less than the District's estimated average annual pumping of 12,500 AF from within the District, and about 2,700 AF per year less than the average annual pumping from the Eastside well field. This results in an estimate of perennial yield of 11,500 AF per year for JID. Total average annual pumping for the Eastside well field area is unknown as the District's wells account for just a portion of the region's pumpage. Private irrigation wells pump an unknown additional amount. However, the total average annual amount pumped in the study period (1975-1993) appears to be around 2,700 AF per year more than the perennial yield.

<u>Storage Capacity</u>
If it is assumed that the useable ground water reservoir is the unconfined aquifer lying above the E-clay, an estimated ground water storage capacity can be calculated. The elevation of the base of the E-clay averages about 400 feet below sea-level within the District, with an average thickness of around 80 feet. The average ground surface elevation in the District is about 175 feet, resulting in an average total depth for the unconfined aquifer of about 495 feet. Assuming that it is undesirable to have the water table less than ten feet from the ground surface, the average thickness of the useable aquifer is around 485 feet. Applying an average specific yield of 0.11, and multiplying by the total District area of 26,392 acres results in an estimate of total unconfined aquifer storage capacity of 1,400,000 AF.

<u>Groundwater Quantity</u>
The entire District and surrounding lands overlie portions of an enormous aquifer. For water quality reasons most of the ground water pumping occurs along the Fresno Slough and eastward. The District currently operates about 60 turbine pumps which tap this aquifer.

The combined capacity of the wells in 2008 was approximately 93,310 gallons per minute (gpm), or around 208 cubic feet per second (cfs). The locations of the District wells are shown on **Figure 3**. As of 2007 there were only two known private in JID wells being used to supplement District water supplies.

Under the authority of a groundwater deed recorded on September 1, 1920, JID pumps a large portion of their ground water supply from outside the District. The area encumbered by the ground water deed is shown on **Figure 3**. The District operates a wellfield east of the Fresno Slough Bypass consists of about 35 wells feeding two canals; the Lassen Avenue Canal and the McMullin Grade Line (**Figure 3**). From 1986 to 1994, which was largely a drought period, the eastside wells supplied an average annual supply of about 21,000 AF. This was a little more than half of the District's total ground water pumping, which averaged around 42,000 AF per year through the same period.

JID generally uses surface water to the extent it is available and supplements it as necessary with groundwater. In years of average surface water supply total ground water pumping can be expected to be around 25,000 to 35,000 AF, with 15,000 to 20,000 AF coming from the eastside wellfield.

<u>Transmissivity</u>
Transmissivity data for the Plan area is sparse. Schmidt (2004) derived transmissivity values from a 5-day pumping test performed on Well C-81 at the K Basin. Schmidt notes that the transmissivity values are valid for the aquifer below the C-clay at that location. The perforated interval of the well from 250 to 500 feet bgs indicates that this well taps the aquifer between the C-clay and the Corcoran clay. Transmissivity values from that pumping tests ranged from 73,000 gpd/ft to 48,000 gpd/ft.

A study by Davis et al., (1964) summarized numerous regional specific capacity values from Pacific Gas & Electric pump tests performed across the San Joaquin Valley. Using data from field tests in the JID area, they calculated specific capacities ranging from 57 to 85 gpm per foot. Driscoll (1986) provides an approximate relationship between specific capacity data and transmissivity. Using this method, transmissivity values for the northern part of JID range from 106,500 to 127,500 gpd/ft, and range from 85,500 to 86,000 gpd/ft in the southern portion of the District. These values of specific capacity and transmissivity are probably valid for the unconfined aquifer, as at the time of the report most wells drilled in the area were most likely completed above the E-clay.

The City of San Joaquin performed pump tests in their Well No. 5 in July 2003. Estimated specific capacities ranged from 10.7 to 11.0 gpd/ft. Drawdown measurements from a step-drawdown test indicated a transmissivity of 43,000 gpd/ft, and for a constant discharge test indicated 39,000 gpd/ft.

<u>Wells Yields and Depths</u>
Well yields in JID range from around 400 to 2,000 gallons per minute (gpm), with most around 1,000 to 1,500 gpm (**Attachment 2**). Wells in the east side wellfield have yields ranging from about 800 to 2,300 gpm, with the typical well producing about 1,500 gpm. Well depths in the East-Side Well Field and along the James Bypass average about 500 feet deep ranging from 365 to 808 feet.

The characteristics of the three wells in the City of San Joaquin are shown in **Table 2.1** below.

Table 2.1 – City of San Joaquin Wells

Description	Well No. 3	Well No. 4	Well No. 5
Total Depth	510 ft	500 ft	495 ft
Perforated Interval	210-510 ft	300-500 ft	300-435 ft
Year Constructed	1968	1978	2003
% of City water in 2009	50	8	42
Yield	1,200 gpm	1,200 gpm	1,100 gpm

2.5 - Groundwater Levels

Regional Groundwater Levels

Figure 7 is a map showing regional groundwater levels (this map represents the best available depiction of regional groundwater depth, despite being slightly dated). Groundwater depths range from about 40 to 150 feet bgs in the Plan Area. Groundwater generally flows from northwest to southeast, and there is a considerable groundwater depression east of the Plan Area in the Raisin City Water District.

Historical Ground Water Levels

Appendix C includes a collection of hydrographs for indicator wells in JID. Groundwater level data is not available for the City of San Joaquin, but groundwater levels in the City are assumed to be similar to those shown on regional map (**Figure 7**).

Prior to development of JID, regional groundwater levels were typically within ten feet of the ground surface, and wells tapping the aquifer below the E-clay initially exhibited artesian flow. As land was brought into agricultural production, and with the advent of deep well turbine pumps, groundwater levels began to decline. By about 1950 water levels had begun a sharp decline that continued into the mid-1970's. In this period a significant portion of the unconfined aquifer was dewatered, and a large cone of depression developed outside of JID in the Raisin City area.

Beginning in the mid-1970's and continuing to the present, is a trend of much slower ground water decline. Water levels have continued to fluctuate in response to drought and flood years but have not exhibited nearly as strong a downward trend. This slowing in groundwater level decline probably resulted from increased groundwater inflow induced by the large cone of depression that has formed in the region, as well as groundwater recharge projects implemented by JID.

Water levels in wells tapping the confined aquifer in the region west of JID, (below the E-clay) also declined precipitously through the 1950's and 60's. However, due to the confined nature of the aquifer, these declines track the piezometric or pressure surface of the ground water, and therefore do not indicate a physical reduction of water in storage in the confined aquifer. This downward trend reversed dramatically in the mid-1960's in response to initiation of delivery of imported surface water from the USBR's Central Valley Project (CVP). This surface water supply resulted in decreased pumping from beneath the E-clay in regions west of JID. Water levels in wells pumping from the confined aquifer once again began to decline steeply in the early 1990's when imported water supplies declined as a result of an extended drought.

The Lower Kings Basin GMP provided an evaluation of regional groundwater levels in the Kings Basin. The GMP concluded that there has been a significant regional decline in groundwater levels between 1950 and 2000 and estimate a continued decline. The construction and operation of Pine Flat Dam, while helping to address groundwater issues by providing surface water, has not completely mitigated overdraft conditions in the Lower Kings Basin. According to the GMP, the average annual rate of groundwater overdraft in the Lower Kings Basin is 68,000 AF/year. Groundwater levels are expected to decline in the future if current groundwater management practices remain unchanged.

2.6 - Groundwater Quality

Overall ground water quality has not appeared to change significantly over the years. Ground water quality is generally better on the east side of the District, although salt plumes caused by the unregulated discharge of oil-field brines have degraded ground water in the District's east side wellfield. The poorer quality ground water on the west side of the District is apparently now advancing further into JID.

Ground water pumped by the District is generally of poorer quality (higher salt content and more sodic) than its surface water supply. However, most of the ground water supply is still of good to fair quality for irrigation. The relatively high sodium content of the water has caused infiltration problems in some areas of the District. **Appendix D** includes total dissolved solids measurements for wells in JID from 1977-2009. **Appendix F** includes groundwater quality graphs and a summary of groundwater quality in different regions on JID. In general, groundwater quality is the best in the southern part of JID, and northern parts of the eastside well field, and is worst in the central part of the wellfield. Refer to the groundwater quality maps and tables in **Appendices D** and **F** for more detail.

Oil wells in the area have always brought up brackish water (exceeding 60,000 ppm in salts) with the oil. Prior to the mid-1950's this brackish water was disposed in unlined pits and was allowed to percolate into the ground water. This led to degradation of groundwater in the Eastside well field due to disposal of saline waters in the Raisin City Oilfield. Unlined pits are now illegal, and deep well injection is used to dispose of the brackish water.

Surface Water Quality

Surface water in JID comes primarily from the Kings River and Delta Mendota Canal (through Fresno Slough and Mendota Pool, respectively). Kings River water is of excellent quality for irrigation. Salt content, measured as total dissolved solids (TDS), typically runs around 50 parts per million (ppm) and boron content is generally less than 0.1 ppm. Infiltration problems sometimes occur due to the purity of the water. Beneficial calcium ions tend to be leached from the soil, reducing permeability. Water supplied from the Delta-Mendota Canal to the District is of good quality for irrigation. TDS for the water is generally around 400 ppm and boron content is typically less than 0.5 ppm.

City of San Joaquin

Groundwater quality in the City is very good, possibly as a result of JID importing significant quantities of pure surface water into the area. Surface water treatment is currently limited to wellhead treatment with chlorine. However, the City is concerned about the migration of poorer quality groundwater from outlying areas, and would like to monitor the encroachment of these water sources.

3 - BASIN MANAGEMENT OBJECTIVES

The Plan Participants have adopted the following five Basin Management Objectives:

1. **Stabilize Water Levels.** Stabilize average long-term groundwater levels by 2015 to prevent the loss of groundwater reserves, and prevent the need for well deepening, and reduce the new for installing new wells.

2. **Increase Groundwater Storage.** Increase groundwater storage capabilities through the development of groundwater banking projects including the JID Water Augmentation Project.

3. **Prevent Further Land Subsidence.** Prevent further land subsidence that can cause a reduction in groundwater storage space and damage water infrastructure. Prevent land subsidence caused by groundwater withdrawals through efficient use of groundwater supplies and full utilization of surface supplies.

4. **Prevent Groundwater Degradation.** Prevent groundwater degradation by protecting groundwater through proper well construction and abandonment, proper use of agricultural amendments, importing clean high quality surface water, and preventing intrusion of poor quality groundwater from neighboring areas.

5. **Improve Coordination between the City of San Joaquin and James Irrigation District.** Improve integrated groundwater management between the City and JID through better coordination, data sharing, joint projects, and annual coordination meetings.

6. **Improve Water Conservation.** Improve water conservation as an alternative to developing new water supplies or increased groundwater pumping. Conservation measures include urban and agricultural best management practices such as metering, plumbing retrofits, efficient irrigation systems, and educational programs.

7. **Increase Knowledge of Local Geology and Hydrogeology.** Increase knowledge of the local geology and hydrogeology through technical studies, and subsurface investigations. Gain a better understanding of regional groundwater quality and flow conditions, and potential impacts from surrounding water sources with poor water quality. Seek funding for these investigations through State and Federal grant programs.

More specific goals related to these BMOs are found in following sections. All existing and on-going activities described in Sections 4-9 will be maintained, unless stated otherwise. (In Sections 4-9 the Existing Activities are not repeated under Planned Actions, even though they will be continued in the future). All new policies and projects described in Sections 4-9 will be pursued, but their implementation will be subject to available funding and staff time.

4 - STAKEHOLDER INVOLVEMENT

4.1 - Groundwater Advisory Committee

The purpose of a Groundwater Advisory Committee (GAC) is to oversee the creation, updating and implementation of a Groundwater Management Plan. Preferably, the Committee should be comprised of a broad cross section of interests in the Plan Area. James Irrigation District initially invited the public to participate but no local residents expressed interest. JID also invited several local agencies to participate in the Groundwater Advisory Committee but the City of San Joaquin was the only party showing interest. Eventually, JID and the City agreed to jointly prepare a GMP. As a result, both the San Joaquin City Council and JID Board of Directors served as temporary Groundwater Advisory Committees for overseeing the development of the GMP. These two GACs offered several useful and insightful comments that were incorporated into this GMP. After adoption of this GMP, a GAC comprising members of both agencies will be formed to assist with implementing the GMP. The GAC will include two to three members from each agency and will meet annually.

Existing Activities

Assisted with the development of this GMP.

Planned Actions

The Committee will attempt to meet annually, or more frequent if deemed appropriate, and will have the following responsibilities:

- Review trends in groundwater levels and available information on groundwater quality;
- Evaluate the effectiveness of current groundwater management policies and facilities;
- Discuss the need for new groundwater supply/enhancement facilities;
- Educate landowners on groundwater management issues;
- Assess the overall progress in implementing the programs outlined in the Groundwater Management Plan;
- Recommend updates or amendments to the Groundwater Management Plan;
- Identify regional and multi-party groundwater projects; and
- Review and comment on Annual Groundwater Reports.

4.2 - Relationships with Other Agencies

The Plan Area is located in the Kings Groundwater sub-basin and San Joaquin Valley Groundwater basin, which extend beyond many political boundaries and includes other municipalities, irrigation districts, water districts, private water companies, and private water users (see **Figure 2**). This emphasizes the importance of inter-agency cooperation, and the District and City have historically made efforts to work conjunctively with many other water management agencies.

The City of San Joaquin and James Irrigation District have strengthened their working relationship by collaborating on this GMP and signing a Memorandum of Understanding (MOU). The MOU outlines a plan for the two agencies to share information, meet regularly, and collaborate on groundwater management and water conservation projects (see **Appendix E**).

Below is a list of some other agencies that the District or City have worked with in managing local groundwater resources**:**

- Kings River Conservation District
- Kings River Water Association
- United States Bureau of Reclamation
- Department of Water Resources
- McMullin Recharge Group
- San Luis and Delta-Mendota Water Authority
- Association of California Water Agencies
- Agricultural Water Management Council
- Tranquillity Irrigation District
- Mid-Valley Water District

Following is a brief discussion on the relationships between these agencies and the Plan Participants.

Kings River Conservation District
KRCD is a legislatively defined special district that supports local interests in water planning and management, develops projects, collects groundwater data, and prepares an annual report of groundwater conditions; however, KRCD does not have the legislative authority to manage groundwater. The District has recently passed a resolution in support of the KRCD's *"Lower Kings Basin Groundwater Management Plan Update"*.

Kings River Water Association
JID is a member of the Kings River Water Association (KRWA), a 28-member group of water agencies that was formed in 1927 to administer and manage water uses on the Kings River. The benefits of KRWA membership include conflict resolution mechanisms and improved coordination among member agencies. The KRWA opens lines of communication so that members can work together effectively to utilize, trade, and transfer waters from the Kings River.

USBR/DWR
JID currently participates in the Semi-annual Groundwater Measurement Program administered by the USBR. This program requires JID to take water level measurements from specified wells two times a year and share the data with USBR. USBR shares this data with the DWR.

McMullin Recharge Group

The McMullin Recharge Group (Group) is comprised of James Irrigation District, Mid-Valley Water District, Raisin City Water District, Tranquillity Irrigation District, Terranova Management Co, LLC., and Kings River Conservation District. The Group works cooperatively to investigate groundwater recharge projects in the area of the McMullin Grade, just east of the James Irrigation District, adjacent to the Eastside Well Field. The group members share information and JID has acquired valuable knowledge of the local geology as a consequence of their participation.

San Luis and Delta-Mendota Water Authority

James Irrigation District is a member agency of the San Luis and Delta-Mendota Water Authority (SLDMWA), an umbrella organization for 32 water agencies in the Central Valley. The SLDMWA was established in 1992 and represents approximately 2,100,000 acres of federal and exchange water service contractors within the western San Joaquin Valley, San Benito and Santa Clara Counties. The JID General Manager is on the Board of Directors at SLDMWA and is a member of its Water Resources Committee.

The SLDMWA serves the information and representation needs of its members by developing, providing, and disseminating information to legislative, administrative and judicial bodies concerning a variety of issues such as: Sacramento and San Joaquin Delta exports, water supply, water quality, water development, conservation, distribution, drainage, contractual rights, surface and groundwater management, and any other common interest of the member agencies. The SLDMWA also works with other governmental and public agencies to promote the common welfare of the landowners and member water agencies.

The SLDMWA prepared a regional water management plan in 2005 entitled "*Westside Integrated Water Resources Plan*". The Plan provides guidance for JID and other water agencies on regional priorities and multi-agency projects.

Association of California Water Agencies

JID is an active member of the Association of California Water Agencies (ACWA). ACWA fosters cooperation among all interest groups concerned with stewardship of the state's water resources. JID attends the ACWA annual meeting and benefits from the educational and informational services that ACWA offers.

<u>Agricultural Water Management Council</u>
JID is a member of the Agricultural Water Management Council (AWMC or Council). The AWMC was formed in 1996, following the work of an advisory committee formed by Assembly Bill (AB) 3616, Agricultural Efficient Water Management Act of 1990. The Council consists of members of the agricultural and environmental communities and other interested parties with the expressed goal for water suppliers to voluntarily develop Water Management Plans and implement Efficient Water Management Practices (EWMPs) to further advance water use efficiency while maintaining and enhancing economic, environmental and social viability and sustainability of soil and crop production. Members sign a Memorandum of Understanding that includes a comprehensive methodology by which each and every Efficient Water Management Practice is analyzed and provides a consistent analysis by all participating water suppliers.

<u>Tranquillity Irrigation District</u>
JID had a long-term relationship with the neighboring Tranquillity Irrigation District. The two Districts have collaborated on SCADA monitoring projects in the Fresno Slough, and have discussed developing interties between the districts to provide better service to their growers.

<u>Mid-Valley Water District</u>
In 1999 and 2000, the Mid-Valley Water District, with the cooperation of James Irrigation District and Reclamation District No. 1606, evaluated the feasibility of a groundwater recharge basin near the James Bypass between Manning Avenue and American/Placer Avenues.

Existing Activities

- On-going involvement with the agencies and associations listed above.

Planned Actions

- When relevant to JID, implement the multi-agency projects identified in the Westside Integrated Water Resources Plan.

<u>4.3 - Plan to Involve the Public and Other Agencies</u>

The District and City of San Joaquin are already involved with many neighboring and regional agencies on groundwater management projects. Nevertheless, the Plan Participants are always interested in building new relationships with other agencies that share the same groundwater basins, and will also strive to involve the public in groundwater management decisions. Additional cooperative relationships can be achieved through the data sharing, inter-agency committees, interagency meetings, memorandums of understandings, formal agreements, and collaborations on groundwater projects. Furthermore, the development of this integrated GMP will foster cooperation between the City and JID.

Existing Activities

- Conducted public hearings to discuss the content of this GMP prior to its adoption.

Planned Actions

- Hold annual Groundwater Advisory Committee meetings with representatives from JID and the City.
- Provide copies of the JID annual groundwater reports to the public at their request. Notify the public of the availability of the annual reports in the JID District newsletter.
- Publish information on groundwater management accomplishments in the JID newsletter and City website.

5 - MONITORING PROGRAM

This section discusses monitoring of groundwater levels, groundwater quality, land surface subsidence, and surface water. Monitoring is considered critical to future management decisions, and the proposed monitoring program is intended to:

1. Provide warning of potential future problems;
2. Use data gathered to generate information for water resources evaluations;
3. Develop meaningful long-term trends in groundwater characteristics; and
4. Provide data comparable from place to place in the Plan Area.

JID prepared a Groundwater Quality Monitoring and Mitigation Plan in 2010 (see **Appendix F**). The plan includes a discussion on the District's existing groundwater quality, monitoring well network, groundwater level and monitoring program, and recommendations for protecting and mitigating groundwater quality. The plan enhances the discussion provided below on groundwater monitoring in JID.

5.1 - Groundwater Level Monitoring

The District regularly measures spring and fall water levels in District wells and a few private wells in cooperation with a valley-wide monitoring program coordinated by the USBR and the DWR. In addition, groundwater levels are monitored monthly in some shallow wells. **Figure 3** illustrates the location of wells that are monitored. **Attachment 2** includes a list of attributes for these wells. The City of San Joaquin does not regularly measure groundwater levels in their wells, but relies on the regional data collected by JID. However, the City will be installing three monitoring wells at their wastewater treatment plant in 2010 or 2011, which will be monitored on a regular basis.

The purpose of a groundwater level monitoring program is to provide information that will allow computation of the change in ground water storage. Contour maps depicting groundwater levels in the District and surrounding area will be prepared annually, along with estimates of changes in groundwater storage.

Existing Activities

- Measurement of groundwater levels in shallow monitor wells each month
- Measurement of groundwater levels each spring and fall in active and abandoned JID production wells
- Share groundwater level data with USBR and DWR

Planned Actions

- Periodically review the monitoring network to determine if it provides sufficient areal coverage to evaluate groundwater levels.
- Protect wells in monitoring program from being abandoned.
- Encourage landowners and developers to convert unused wells to monitoring wells.
- Prepare annual groundwater reports, which will include groundwater contour maps and detailed evaluations of groundwater level trends (see Section 9.2).
- Work with KRCD in the development of a Kings Basin Groundwater Data Center
- Perform a Well Canvass to collect detailed information and precise coordinates on each production well, monitoring well and abandoned well in the Plan Area (see **Appendix F** for more details on the proposed well canvass).
- Investigate the feasibility of installing a SCADA/telemetry system to monitor and operate production wells in JID. If available seek funding to assist with expenses.

5.2 - Groundwater Quality Monitoring

The City performs groundwater quality monitoring as required by the State of California. JID test each well for electrical conductivity annually and performs agricultural suitability analyses on all new wells.

The aforementioned groundwater quality monitoring efforts have one or more of the following objectives:

1) Spatially characterize water quality according to soils, geology, surface water quality, and land use;
2) Establish a baseline for future monitoring;
3) Compare constituent levels at a specific well over time (i.e. years and decades);
4) Determine the extent of groundwater quality problems in specific areas;
5) Identify groundwater quality protection and enhancement needs;
6) Determine water treatment needs;
7) Identify impacts of recharge and banking projects on water quality;
8) Identify suitable crop types that are compatible with the water characteristics; and
9) Monitor the migration of contaminant plumes.

Existing Activities

- Measure electrical conductivity in JID production wells on an annual basis.
- Perform agricultural suitability analysis on all newly constructed wells.

Planned Actions

- Regularly collect new water quality information from other agencies and review it to identify any impending groundwater quality problems.

- Protect wells in monitoring program from being abandoned.
- Prepare groundwater quality maps when sufficient information is available with the aid of a qualified hydrogeologist. Attempt to characterize groundwater quality with depth and provide the information to growers so they can use it when designing and installing wells.
- Work with KRCD in the development of a Kings Basin Groundwater Data Center.
- Perform Agricultural Suitability Analysis every 5 years (2015, 2020, 2025, etc.) in selected wells in areas of concern. This will be timed with the submission of 5-Year Water Management Plans to the USBR.
- Test for Additional Constituents in Wells near the City of San Joaquin. If funding from the City of San Joaquin is available, perform more detailed water quality sampling in JID wells near the City of San Joaquin. This information could be useful in determining the quality of groundwater that may be migrating toward the City. Constituents that could be tested include arsenic, gross alpha, Total Organic Carbon, and other constituents important to drinking water quality.
- Regularly calibrate the hand-held TDS meter used to test wells each year, to help ensure that measurements are accurate and trends are properly identified.

5.3 - Groundwater Monitoring Protocols

Monitoring protocols are necessary to ensure consistency in monitoring efforts and are required for monitoring evaluations to be valid. Consistency should be reflected in factors such as location of sample points, sampling procedures, testing procedures, and the time of year when the samples are taken. Without such common ground, comparisons between reports must be carefully considered. Consequently, uniform data gathering procedures will be practiced by the Plan Participants.

The District has developed new water level and water quality monitoring protocols, which can be found in **Appendix G**. The District has also adopted protocols prepared by a local laboratory, Fruit Growers Laboratory of Visalia, California. These are included as **Attachment 4** and supplement the protocols described above. The City has not adopted specific protocols, but will follow JID's protocols until they adopt their own.

Existing Activities

None

Planned Actions

- The District will work with KRCD to establish uniform protocols that are used basin wide.

- The City will review JID's protocols and adopt them or develop their own protocols.

5.4 - Surface Water Monitoring

Surface water sources in the Plan Area include the Fresno Slough and Fresno Slough Bypass. In addition, the Mendota Pool is located near JID and is a source of surface water.

Existing Activities

- Monitor flowrates in the Fresno Slough Bypass.
- Monitor surface water quality in the Mendota Pool at P Booster.

Planned Actions

None

5.5 - Land Surface Subsidence Monitoring

Land subsidence results from excessive groundwater pumping beneath laterally extensive confining clay layers. The removal of groundwater from a confined aquifer causes increased pressure on the aquifer skeletal system below the confining layer. This causes compaction of the fine-grained layer at depth, and is evident at the ground surface as land subsidence. Land subsidence has been monitored throughout the San Joaquin Valley. The most serious subsidence occurred north of the Districts and monitoring efforts have declined in recent years.

A State-Federal committee on subsidence was formed in the early 1950's and performed research and measured subsidence until 1970. By 1970, 5,200 square miles in the Valley had subsided more than 1 foot. Between 1926 and 1970, a maximum of 28 feet of subsidence was measured at a point southwest of Mendota. The compacting forces caused by groundwater level decline squeezed more than 15.6 million acre-feet of water storage space out of the sediments during the same period. From 1975 to 1992, subsidence occurred mostly in drought years when groundwater pumping replaced unavailable surface water supplies. The Department of Water Resources has continued to measure subsidence along the California Aqueduct in the winter of 1993-1994. Very little quantitative data has been collected since 1970 by others. In neighboring Tranquillity Irrigation District, there is a benchmark on Lift Station No. 1 that is periodically resurveyed to check for land subsidence.

It is likely that some of the local land subsidence has been arrested with the importation of large volumes of surface water since the District established its surface water contracts. However, there is often a time delay in subsidence after groundwater withdrawals, so the Plan Area may still be experiencing residual subsidence. In addition, groundwater levels can drop appreciably in extended droughts, which could also lead to further subsidence. Lands within the Plan Area will be observed for land subsidence, and, if land subsidence becomes a problem, this Plan will be amended to include preventative and mitigative measures.

Existing Activities
None

Planned Actions
- Periodic resurvey of control points and local benchmarks to check for land subsidence. The control points and local benchmarks will be checked relative to High Precision Geodetic Network benchmarks.

6 - GROUNDWATER RESOURCES PROTECTION

6.1 - Well Abandonment

Existing State and Fresno County law requires that owners or lessees properly destroy their abandoned wells. Proper destruction of abandoned wells is necessary to protect groundwater resources as abandoned or improperly destroyed wells can result in water of different chemical qualities from different strata mixing, and useable groundwater being degraded. This is especially important because part of the Plan Area has a confined aquifer.

The administration of a well construction, abandonment and destruction program has been delegated to the Counties by the State legislature. Fresno County has adopted a permitting program consistent with Department of Water Resources Bulletin 74-81 for well construction, abandonment, and destruction.

The Plan Participants will properly abandon their own wells when they are no longer useful. In addition, they will encourage landowners and developers to properly abandon their own wells, or preferably, convert unusable wells to monitoring wells so that they can become a part of JID's groundwater monitoring program.

Existing Activities
None

Planned Actions

- When possible, convert unusable production wells to monitoring wells.
- Destroy any District or City owned wells that have no use according to County and State standards.
- Seek funding to perform a survey of all inactive wells and properly abandon those that have no potential for rehabilitation or use them as monitoring wells.

6.2 - Wellhead Protection

The Federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land use controls, usually applied at the local level in California, and other preventative measures can protect groundwater.

A Wellhead Protection Area (WHPA), as defined by the 1986 Amendments, is "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPA's can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates and aquifer characteristics.

Under the WHPA, States are required to develop an EPA-approved Wellhead Protection Program. To date, California has no state-mandated program, but instead relies on local agencies to plan and implement programs. This is one of the factors that prompted the State Legislature to enact AB 3030. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

Essential to any wellhead protection program are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources. Wells constructed by the Plan Participants will be designed and constructed in accordance with DWR Bulletin 74-81. In addition, landowners will be encouraged to follow the same standards for privately owned wells. DWR Bulletin 74-81 provides specifications for the following:

- Methods for sealing wells from intrusion of surface contaminants;
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism;
- Site grading to assure drainage is away from the well head; and
- Set-back requirements from known pollution sources.

Existing Activities

- Provide wellhead protection on all newly constructed wells according to County and State standards.

Planned Actions

- Encourage local growers to incorporate proper wellhead protection into all new wells, and retrofit old wells with proper wellhead protection.

6.3 - Saline Water Intrusion

Saline water intrusion is a concern in two portions of the Plan Area. The first is a generalized condition on the west side of JID. The groundwater in the western portion of the District is significantly saltier than in the eastern portion. Additionally, given the direction of ground water flow is in a southeasterly direction, this poorer quality water is encroaching on many of the District's wells.

The second area of concern, the Raisin City Oil Field salt plumes, lies outside the District boundaries but affects the District's east-side wellfield. These plumes formed when brines pumped from oil wells were disposed in surface ponds. It is believed that these plumes currently impact JID wells, even though the practices that created them were halted over three decades ago.

Currently, the District strives to prevent the importation of saline surface waters that could ultimately degrade the groundwater. When alternative water sources are available for importation, the District considers not only the cost but also the quality, including salinity, of the water. The District will evaluate all possible alternatives, and, when practical and feasible, select water sources with acceptable levels of salinity.

Existing Activities
None

Planned Actions
- Review available water quality data to identify areas with the potential for saline water intrusion.

6.4 - Migration of Contaminated Groundwater
Ground water contamination can originate from many sources or activities. Groundwater contamination can be human induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairies, improper application of agricultural chemicals, septic tanks, industrial sources, stormwater runoff, and disposal sites.

Clean-up of contaminated ground water is a complex and expensive task generally involving a number of organizations. Agencies with roles to play in mitigating ground water contamination include the California Regional Water Quality Control Board (RWQCB), the California Department of Toxic Substances Control (DTSC) and the U.S. Environmental Protection Agency (EPA). Each agency has its own set of regulatory authorities and expertise to contribute. The degree to which they participate depends on the nature and magnitude of the problem. If JID or the City identify a ground water contamination problem, they will refer the information to the appropriate regulatory agency.

According to the Lower Kings Basin GMP, the migration of contaminated groundwater is a secondary concern for the area. Contaminated plumes are relatively small and localized in the Lower Kings Basin. Furthermore, the Plan Participants do not know of any contaminant plumes in their service area, aside from salinity from the Raisin City Oilfields. Nevertheless, the Plan Participants recognize that migration of contaminated groundwater is always possible. The City and District will continue to monitor groundwater quality and remain cognizant of the possibility of contaminated groundwater migration into the Plan Area.

Existing Activities

- Regularly review data and reports from regulatory agencies on contaminant plumes to provide warning of potential future problems.
- Construct wells with adequate seals between the formations to prevent the downward migration of poor quality water.

Planned Actions

- Seek to locate recharge basins next to areas with water quality problems to blend water supplies and create a hydraulic barrier to impede movement of contaminant plumes.

6.5 - Groundwater Quality Protection

The City relies exclusively on groundwater and JID cannot support all of their crop demands with their surface water supplies. Clearly, groundwater is a very important resource in the area. The groundwater, however, will have limited or no use if it has poor quality. Therefore, protecting the quality of the groundwater is a cardinal component of this GMP. Groundwater quality can be protected through proper use of pesticides, herbicides and fertilizers, stormwater quality management, septic system management, and water vulnerability planning and management.

JID has outlined several existing and proposed methods for protecting and mitigating groundwater quality. These are document in their Groundwater Quality Monitoring and Mitigation Plan (**Appendix F**)

Existing Activities

- Educate staff on proper use of herbicides used in JID canals.

Planned Actions

- Seek funding to improve security at water facilities and reduce the potential for contamination from acts of vandalism or terrorism.

- Educate growers on the proper use of pesticides, herbicides and fertilizers in the District newsletter.
- Implement groundwater mitigation methods documented in **Appendix F**.

7 - GROUNDWATER SUSTAINABILITY

Between 2000 and 2009, groundwater has comprised about 45% of the water used in JID in a typical year, but has comprised up to 78% of water supplies. During years with low surface water allocations, groundwater is essential to prevent the loss of permanent crops. The City of San Joaquin relies exclusively on groundwater and has no surface water rights or facilities to accept surface water. Therefore, preserving the sustainability of groundwater is essential for the economic well being of the District growers and City residents.

7.1 - Issues Impacting Groundwater Sustainability

The James Irrigation District relies on both surface and groundwater for irrigation demands. **Table 7.1** shows surface and groundwater usage from 2000-2009.

Table 7.1 – James Irrigation District Surface and Groundwater Use (2000-2009)

	Surface Water		Groundwater	
Year	Volume (AF)	%	Volume (AF)	%
2009	15,900	22	55,100	78
2008	21,300	27	56,900	73
2007	34,300	42	48,200	58
2006	67,400	91	6,300	9
2005	50,300	69	22,500	31
2004	38,600	47	43,000	53
2003	39,000	51	37,400	49
2002	37,400	43	48,700	57
2001	26,400	35	48,600	65
2000	35,400	49	36,400	51
Avg	36,600	48	40,300	52

Table 7.1 shows that for typical years, groundwater constitutes about 50% of the District's water use. In almost all years the District's surface water supply is fully utilized, and groundwater is pumped to supplement the surface water. Typically, groundwater pumping begins in the middle of the irrigation season and groundwater is often the only water source available at the end of the irrigation season (August to October).

2005 and 2006 were not typical years since flood waters were released down the Kings River. When this was available JID used the flood water instead of their CVP supply, and saved their CVP supply for a later date. This permitted for a larger and longer supply of surface water which allowed for decreased groundwater pumping, and groundwater recharge as a result of diverting flood flows. A two year supply of flood water only occurs occasionally and cannot be relied upon.

The District's surface water supplies are sporadic, unreliable and unpredictable. In addition, due to recent regulatory actions, surface water supplies from the Central Valley Project have become less dependable and shortages occur more frequently. This has caused the District's available surface supplies to be reduced causing more reliance on pumping groundwater. Furthermore, the acquisition of new water contracts or substantial water transfers in the future is unlikely. In summary, groundwater supplies are vital to the JID and consequently the District considers the proper management of their groundwater resources to be imperative.

The City of San Joaquin relies exclusively on groundwater. When local and regional groundwater supplies are stressed, such as during droughts, this can impact groundwater supplies in the City. It is unlikely that the City can secure a long-term surface water contract, and therefore they must protect and preserve the local groundwater resources.

7.2 - Overdraft Mitigation

Overdraft of the groundwater supply can lead to a variety of problems, including subsidence and increased pumping costs. Additionally, if overdraft continues unchecked, the groundwater supply may be unreliable when surface water is scarce, as in a time of extended drought. Groundwater overdraft is considered the principal groundwater problem in the Plan Area.

Groundwater Overdraft Estimates

JID estimates overdraft using historical groundwater levels during a hydrological base period. This base period must extend for a long enough time that both wet periods and droughts are covered, and the water supply conditions approximate the average. The term overdraft is used here to indicate a long-term water-level decline in an area during an average hydrologic base period. It is not used to describe short-term water-level declines during droughts.

The procedure to estimate overdraft from groundwater levels uses many measurements over a long period of time. In the Plan Area, measurements are made in the winter or early spring, following a period of minimal pumping, and again in the fall, following a period of heavy pumping. The complete water-level data record can be used to prepare well water-level hydrographs and to determine long-term water level changes. A well water-level hydrograph is a plot of depth to water versus time for a particular well.

After the well water-level hydrographs are prepared, the trends in the water levels in the base period are closely examined. In most agricultural areas the annual low values are in the late summer or early fall, at the end of a long irrigation season, and annual high values are in the winter or early spring, just before pumping begins for the next growing season. Linear regressions are then performed on the data within the base period that appear valid and representative of the water-level conditions. The slope of these "best-fit" lines are then used as the long-term average annual changes in ground water level.

JID calculated overdraft during the period from 1975 to 1993, but has not performed any more recent analyses. The hydrographs created indicate gradual long-term water-level declines in both the District and the east side wellfield for the chosen hydrologic base period. In order to determine the change in ground water storage, a parameter known as the "specific yield" was multiplied by the average water-level change during the period evaluated. Specific yield is the ratio of the volume of water which will drain freely from a material to the total volume of the formation. Based upon estimates of specific yield by the USGS and the DWR, the average specific yield of the unconfined aquifer was estimated to be about eleven percent for the District and about twelve percent for the east side wellfield area. Using these specific yields, the ground water overdraft was calculated to be about 1,000 AF per year for the District, and around 2,700 AF per year for the eastside wellfield for the chosen hydrologic base period.

Overdraft could be a significant concern if the Plan area experiences increased pumping, reduced recharge, and/or increased ground water outflow. Periodic analyses of ground water overdraft, perhaps every five years, are needed to reassess the need for overdraft mitigation.

<u>Mitigation Measures</u>

Groundwater overdraft is due to an imbalance in the rates of extractions and replenishment. There are several methods to correct this imbalance. The first is to decrease the extraction to match the rate of replenishment. The second is to increase groundwater replenishment to match the extraction rate. The third method is a combination of the first two, to balance replenishment and extraction. Each of the methods are applied over an extended period, making use of the storage capacity of the aquifer. Extractions can exceed replenishment in drought periods as long as replenishment equally exceeds extractions in wetter periods.

Factors that will affect the future rate of overdraft include surface water supplies available to JID through the Central Valley Project and future water demands in the District.

The District utilizes both surface water and groundwater conjunctively to meet the water needs of its growers. The Plan Participants understand that the existing condition of overdraft is regional in nature and correction and mitigation of the problem will need to be addressed not only by the District and City, but also by neighboring agencies.

Groundwater Recharge

Mitigation measures to negate current overdraft and contribute to lessening future overdraft conditions rely on the importation of additional surface supplies. Increasing JID's surface water supply would rely on improving the District's ability to use excess Kings River flows. Flood water appears adequate on the Kings River to mitigate the overdraft condition if sufficient recharge capacity can be developed. JID already recharges water in the K-Basin Recharge Project and plans to recharge additional flood waters with their proposed Water Augmentation Project (see Section 7.4).

Mitigative measures to reduce demands can include conversion to more efficient irrigation systems, and urban conservation measures discussed in Section 7.5. Demand reduction can also be achieved by cropping changes or land fallowing, but these would have adverse economic impacts and therefore are not considered.

Water Transfers

In 2001 the JID Rules and Regulations were amended to restrict the transfer of surface and groundwater supplies outside of the District. The purpose of this amendment was to prevent further groundwater overdraft. Specifically, the Rules and Regulations state:

> "*Any transfer of surface water which is replaced by increased groundwater pumping would therefore exacerbate groundwater overdraft....Similarly, if a Water User were to pump groundwater within the District and export it, the same effect would occur*." (pg 8)

Such exports are only allowed under certain circumstances; for example, surface water exports are allowed if the land that would have used the water is fallowed. Refer to the Rules and Regulations for more details on this policy. Clearly, the District recognizes the gravity of their groundwater overdraft problem and this amendment illustrates their commitment towards preserving their groundwater resources.

Limitations on Pumping

The California Water Code gives water and irrigation districts the power to limit or suspend groundwater extractions. However, such limits will only be implemented if the Plan Participants determine through study and investigation that groundwater replenishment programs, or other alternative sources of water supply, have proved insufficient or infeasible to lessen impacts to groundwater. In the unlikely event that it becomes necessary to reduce groundwater extractions, the District intends to accomplish such reductions under a voluntary program, which would include suitable incentives to compensate users for reducing their groundwater pumping. The District will not attempt to restrict or otherwise interfere with any landowner or water user exercising a valid right to pump and utilize groundwater.

Economic Inducements
The District recognizes that management of water supplies should reflect water conservation and the protection of groundwater resources. The District currently provides an indirect economic inducement by establishing water rates high enough to promote water conservation yet low enough to compete with groundwater pumping costs. This pricing system encourages the use of surface water to meet irrigation demands when available, thereby preserving the underlying groundwater resource.

Existing Activities

- Restrict groundwater exports from the District.
- Set surface water rates low enough to be competitive with groundwater pumping costs.

Planned Actions

- Urban water conservation measures (see Section 7.5)
- Seek funding to prepare a Drought Preparedness Plan that will identify triggers and response measures for droughts.

7.3 - Groundwater Replenishment

Replenishment of ground water is an important technique to manage a groundwater supply and mitigate a condition of overdraft. The estimated overdraft for the Plan Participants and the east side wellfield can probably be offset with recharge projects that would use excess Kings River flows (flood releases from Pine Flat Reservoir).

The types of groundwater replenishment include the following:

- Direct groundwater recharge
- Incidental groundwater recharge
- Injection wells
- In-lieu recharge
- Groundwater banking
- Canal seepage
- Pipeline seepage
- Flood flow seepage
- Deep percolation from precipitation
- Deep percolation from irrigation

Direct Groundwater Recharge. Two recharge projects are currently in operation in JID. The first involves the diversion of Kings River flood water from the Fresno Slough Bypass (James Bypass) into basins in the upland areas of the Bypass between the two outer flood channels. The Bypass area has fairly permeable soils and provides a modest opportunity for ground water replenishment. This project may have potential for expansion. The second project includes the 220-acre K-Basin Project. Some of this water is recovered with wells and some of the water remains underground for recharge. The District is also developing recharge capability with the Water Augmentation Project, described in Section 7.4

Incidental Groundwater Recharge. Incidental groundwater recharge occurs in the three stormwater basins operated by the City of San Joaquin, located at Colorado Avenue, California Avenue and Cherry Lane. Flows to these basins are not measured and there are no current estimates of the volume of incidental recharge.

Injection Wells. Injection wells pump water directly into the groundwater basin and are primarily used in urban areas, where land is at a premium. Capital costs are high and include conveyance, treatment and well construction. Some injection well projects have been denied by the Regional Water Quality Control Board due to water quality issues, especially disinfection byproducts in the source water. Given the high cost of injection wells, regulatory hurdles and the presence of more viable and lower costs options for recharging water, this option was removed from further consideration.

In-lieu recharge. The District views in-lieu deliveries as the most practical and effective means of groundwater replenishment. In-lieu deliveries, also called indirect deliveries, involve the delivery of surface water to landowners and water users who would otherwise have pumped groundwater, thus leaving water in the aquifer for future use. From 2000 to 2006, JID imported between 26,000 and 67,000 AF/year of surface water, and, as a result, JID is performing a significant amount of in-lieu recharge.

Groundwater banking. Groundwater banking agreements often require that a portion of the banked water be left in the aquifer as a payment to the banking agency. JID is planning to develop a groundwater bank through the Water Augmentation Project. Water banking partners will be required to leave 10% of their water behind for District recharge.

Canal seepage. Canal seepage in JID is estimated to be about 12,300 AF in a typical year.

Pipeline Seepage. Seepage from City of San Joaquin pipelines, and JID's Lateral G pipeline, help to recharge the groundwater. No estimates of the seepage are currently available.

Flood flow seepage. Natural seepage occurs in the District from flood flow waters in the Fresno Slough and the James Bypass channel. However, this seepage volume has not been measured or estimated.

Deep percolation from precipitation. In JID, deep percolation from normal rainfall events is probably negligible. Some deep percolation occurs during exceptionally long and heavy storms. However, such storms are infrequent.

Deep percolation from irrigation. Deep percolation occurs when some of the water applied for irrigation percolates beyond the crop root zone and accumulates in the aquifer. The extent of deep percolation varies with the irrigation method, irrigation efficiency, and antecedent moisture condition. During 2002 and 2003, deep percolation from local irrigation was estimated to be from 8,000 to 10,000 AF/year, but was only estimated to be about 2,000 AF in 2009.

Existing Activities

- Groundwater recharge in the 220-acre K-Basin recharge project.
- Groundwater recharge in the Fresno Slough and Fresno Slough Bypass
- Measure the volume of water delivered to groundwater recharge basins.
- Periodically remove sediment and rip the soils in recharge basins to maintain recharge rates.

Planned Actions

- Work cooperatively to minimize development on lands that are favorable for artificial recharge.
- Design and construct the Water Augmentation Project, which will increase recharge capabilities in the District
- Estimate seepage from City of San Joaquin pipelines either from water balance calculations or through field tests.
- Install facilities to measure deliveries to the City of San Joaquin stormwater basins so incidental recharge can be estimated.

7.4 - Conjunctive Use of Water Resources

Conjunctive use of water is defined as the coordinated use of both subsurface and surface water sources so that the combination will result in optimum benefits. Conjunctive operation of a ground water basin is defined in DWR Bulletin 118-80 as:

> *"Operation of a ground water basin in coordination with a surface water reservoir system. The basin is intentionally recharged in years of above average precipitation so ground water can be extracted in years of below average precipitation when surface water supplies are below normal."*

Such management results in the groundwater storage being reduced in dry periods and increased in wetter periods. To avoid a condition of overdraft, replenishment must balance extraction over the long-term.

A conjunctive use program requires:

- A source of surface water in years of high surface water supply.
- Recharge facilities.
- Conveyance facilities to import and export water to and from the ground water storage area.
- Available storage capacity in the aquifer.
- Extraction facilities.
- Distribution facilities for surface and ground water.

Existing conjunctive use operations can be expanded by adding interconnections and promoting water supply exchanges between districts that allow for more flexibility in the region's water supply. The region's assets of federal, state, and local water supplies, dewatered groundwater storage, numerous interconnected conveyance facilities, and significant irrigation demand make it an ideal location to regulate surface and groundwater supplies conjunctively.

The region must absorb wet year water supplies in order to maintain a reliable and economical water supply. Wet year water is available on short notice and not always at times when the water can be delivered for an irrigation demand. Therefore, it is important that the region work cooperatively to increase its ability to absorb surface water when available. Regional Water Management Plans, including the 'Westside Integrated Water Resources Plan', can help identify viable regional projects.

<u>Regional Conjunctive Use Projects</u>
In 2004, JID completed construction of the 220-acre K-Basin Recharge Project. The project includes several wells to recover some of the recharged water.

The JID Water Augmentation Project will include new facilities for storing and recharging water, with the goal of reducing JID's dependence on surface water. The project will include improvements to basins and construction of new recovery wells and conveyance facilities. The project will provide facilities for regulation storage, floodwater storage, groundwater recharge, and groundwater banking. It is estimated that the project will allow JID to capture and recharge an average of 2,100 AF/year of Kings River floodwater. Five recovery wells will have the capacity to extract 30 AF/day. The project is currently being designed and construction is expected to be completed by the end of 2011 or 2012.

JID has also prepared a Water Banking Prospectus for the Water Augmentation Project. JID is actively seeking an agency that wants to bank water in JID using the proposed facilities. As a condition of any banking agreement at least 10% of the banked water must be left behind. This will contribute to local recharge and higher groundwater levels while the water is banked. The volume of water that will be banked still has to be negotiated with a potential banking partner.

One example of a 'regional' groundwater recharge project is the proposed McMullin Group recharge project. This project would use flood flows to recharge the groundwater system. The project, which includes a series of ponds and canals, was investigated and a draft feasibility study was completed in April 2000. At that time, two sites in the McMullin Recharge Project area were considered covering 138 acres. With support from DWR grant funding, additional hydrogeologic evaluations have been made of the sites since the completion of the draft feasibility study. In response to interpretation of the hydrogeologic evaluations, several recharge ponds have been proposed for development. These ponds can be operated using available floodwater. This project was identified as a regional goal in the Lower Kings Basin GMP with estimated costs of $2.2 million and a completion date of 2010.

The City of San Joaquin does not have a surface water supply, but does divert stormwater to basins where some is percolated, thereby recharging the groundwater.

Existing Activities

- Continue groundwater recharge and banking in the K-Basin Recharge Project.

Planned Actions

- Support the development of new surface storage and water supply projects that would permit the participants to better utilize surface water supplies.
- Investigate additional groundwater banking projects and facilities.
- When transferring surface water, attempt to transfer it to neighboring agencies so it benefits local groundwater levels.
- Design and construct the JID Water Augmentation Project.
- Construct four production wells in JID as part of a Federal Drought Relief grant.
- Actively recruit regional water agencies to store water in JID's groundwater banking facilities.
- Discuss options with the Fresno Irrigation District to purchase surplus surface water to reduce demand on local groundwater resources.

7.5 - Water Conservation and Education

City of San Joaquin

The City of San Joaquin prepared a Water Conservation Plan in 2009. The plan identified several measures that can help reduce water consumption. The Plan outlined two general conservation strategies:

1) **Twenty Percent Reduction in Water Use.** A citywide reduction in water use of 20% by the year 2011 (to mirror the reduction goals of the current California Green Building Standards Code). These savings will be accomplished through equipment upgrades and a targeted education and community outreach program. Showerhead and faucet replacements are planned to be part of the upgrades installed as part of the city's low income housing rehabilitation program. Beginning in the 2010-2011 academic year, students at San Joaquin Elementary school will receive water conservation training.

2) **Water Meters.** Install water meters on all service accounts by the year 2020. California state law requires meters on all service accounts by the year 2025. Installing meters can also lead to reduced water use, and will enable to city to charge residents based on actual water usage. Studies show that cities with metered water use up to 15% less water than cities without meters. When meters are used to institute a tiered pricing structure, another 10% savings occurs. In addition to providing customers with feedback on their consumption levels, service meters in conjunction with supply meters, enable a system to better account for leaks in the system, The guidance from the EPA estimates that by installing meters water use can be reduced by 20%. Currently, only some commercial and industrial accounts are metered. Residential meters are planned for the future as required by the State. In the Water Conservation Plan, meters were not found to be the most economical alternative for conserving water, so the City will seek funding to assist with their purchase and installation.

The City's current ordinance that allows landscape watering only on certain days is also a fairly effective method in preventing over watering. The City will include inserts in water bills reminding residents of these landscape watering rules.

James Irrigation District

The District considers water conservation and education important aspects of their overall groundwater management efforts. All water deliveries are metered and billed based on the volume used. Therefore, all customers have an incentive to minimize water usage. Water conservation education is achieved through the annual grower's meeting and district newsletter. JID has also constructed several regulation reservoirs, that help to reduce operational spills and thus conserve water.

Existing Activities

- JID's monthly water statements include water use information for each customer. In addition, the District maintains historic water use by turnout. This data is available to water users on request as it could be beneficial in making on-farm water management decisions.
- The District holds an annual grower's meeting and publishes a semi-annual newsletter to help educate local growers on important issues such as water conservation and water quality protection.

Planned Actions

- Evaluate the feasibility of a grey water system in the City of San Joaquin.
- Seek funding to install water meters in the City of San Joaquin
- Implement the City of San Joaquin's water conservation education program.

7.6 - Water Recycling

The City does not currently recycle any of their water. Wastewater effluent is currently discharged to aerated lagoons at the western end of JID for evaporation and percolation. The annual volume of water treated is about 121 million gallons. The City plans to improve their wastewater treatment system to include advanced secondary treatment with activated sludge, nitrogen removal, and sludge handling. Construction of the new facilities is expected in 2010 or 2011. The effluent will have better quality that is suitable for non-edible crops. The City has held discussions with farmers to use the effluent, and also plans to meet with JID to discuss delivery of the water into the JID distribution system. No other urban agencies are located in the area that could feasibly deliver recycled water to the Plan Area.

The City has noticed some high salt contents in their wastewater. They are investigating whether a commercial or industrial entity is dumping wastewater with high salt loads.

Existing Activities

None

Planned Actions

- Remain cognizant of opportunities to purchase recycled water from other municipalities.
- Hold a joint meeting with the City and JID to discuss beneficial use of recycled water on JID crops. Discuss the merits of performing a feasibility study on importing recycled water to JID.
- Investigate the source of saline water in the San Joaquin wastewater.

8 - GROUNDWATER OPERATIONS

8.1 - Well Construction Policies

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. Department of Water Resources Bulletin 74-81 provides useful guidelines for the construction of groundwater wells. In addition, Fresno County has enacted and is responsible for enforcing a County Well Ordinance that regulates well construction. Proper wellhead protection is essential to ensure that contaminants do not inadvertently enter a well. Well construction policies that are intended to ensure proper wellhead protection are discussed in Section 6.2 – Wellhead Protection.

In addition, the following quality assurance procedures will be followed when constructing District or City owned wells. Landowners are also encouraged to follow these procedures when constructing private wells:

1. Well construction will be performed under contract by a licensed and experienced well driller, in accordance with specifications prepared by a licensed engineer or geologist, and reviewed by legal counsel.
2. A licensed engineer or geologist will oversee construction of the wells.
3. A licensed land surveyor will oversee survey of any newly constructed wells.
4. Wells will be constructed according to guidelines in DWR Bulletin 74-81.

Existing Activities

- Construct wells according to DWR Bulletin 74-81.
- Construct wells using qualified and licensed contractors, engineers, geologists and land surveyors.
- Use plastic well casings in areas where the groundwater and soils are highly corrosive.

Planned Actions

None

8.2 - Operation of Facilities

The City currently has three productions wells but has an immediate need for one more wells due to the age and condition of their current wells (the three wells are 10, 30 and 40 years old). The City is concerned about how they will pay for a new well and are seeking funding opportunities.

The City will be installing three monitoring wells at the water treatment plant expansion in 2010 or 2011. The wells are expected to have depths ranging from 50 to 80 feet deep.

Groundwater facilities in JID include the K-Basin Recharge Project, about 65 extraction wells and about 20 monitoring wells. Proper construction, operation, and maintenance of these groundwater facilities is an important part of groundwater management.

The District normally constructs two new irrigation supply wells each year and subsequently retires two older wells that have a combination of the lowest efficiencies and poorest water quality. This helps to ensure the District's water reliability (by retiring older wells), and ensuring higher water quality. This also expands the grid of available testing points.

JID will also strive to provide the best facilities for delivery of surface water supplies, since they are used conjunctively with groundwater. JID realizes that the success of conjunctive use programs is often contingent on the quality of surface water conveyance systems.

Existing Activities

- Development of a groundwater bank as part of the JID Water Augmentation Project
- Maintenance and upgrading of conveyance facilities for capacity and stability.
- Maintenance of recharge facilities including de-vegetation, disking, deep ripping, and de-silting, as necessary to improve recharge potential.
- Replace at least two wells each year to help ensure the wells are efficient and have suitable water quality.

Planned Actions

None

9 - GROUNDWATER PLANNING AND MANAGEMENT

9.1 – Land-Use Planning

An important component of developing a Groundwater Management Plan is the review of land-use plans for the surrounding area or basin, and coordinating efforts with regional and local land-use planning agencies. Land-use planning activities in unincorporated areas of Fresno County are performed by the County of Fresno's Department of Public Works planning department, and overseen by the Fresno County Planning Commission. Responsibility for land-use planning in incorporated areas lies with each city's planning staff. The City of San Joaquin is the only urban development within the Plan Area, and its staff is responsible for land-use planning within its Sphere of Influence.

The intent of this Plan is not to dictate land-use planning policies, but rather to establish some land-use planning goals that can aid in protecting and preserving groundwater resources. The Plan Participants will comment on environmental documents for land-use related activities that may impact groundwater. They will also work cooperatively with other agencies to minimize adverse impacts to groundwater supplies and quality as a result of proposed land-use changes. Some specific land-use planning goals include: (1) preserving areas with high groundwater recharge potential for recharge activities; (2) protecting areas sensitive to groundwater contamination; (3) requiring hydrogeologic investigations, water master plans, and proven and sustainable water supplies for all new developments; and (4) requiring appropriate mitigation for any adverse impacts that land-use changes have on groundwater resources.

Existing Activities

- Notify residents and agencies of projects that have the potential to impact groundwater within their sphere of influence.
- When appropriate, comment on environmental documents and land-use plans that have the potential to impact groundwater.

Planned Actions

None

9.2 - Groundwater Reports

The City of San Joaquin has not historically prepared Annual Groundwater Reports, primarily due to their small size, limited water use, limited water supply data, and lack of available staff. However the City plans to improve groundwater monitoring and data collection, and develop an outline for a brief groundwater report or groundwater memorandum consistent with their needs. This groundwater memorandum will be completed prior to the Annual Groundwater Advisory Committee meeting and used during discussions with JID. The City will consider preparing a comprehensive Groundwater Report as they expand.

JID has a goal to prepare groundwater reports every year to document groundwater levels, available groundwater storage, historical trends, and other important groundwater related topics. This information will be used to forecast future problems, plan future groundwater projects, and develop new groundwater policies. The annual report will cover the prior calendar year and will be completed each year by April 30th. See **Attachment 5** for a report outline.

Existing Activities

- JID prepares a Water Management Plan every five years for the United States Bureau of Reclamation as a requirement to maintain their Central Valley Project water supply. The Water Management Plan includes sections on groundwater usage and groundwater projects.

Planned Actions

- Prepare an annual Groundwater Memorandum documenting the City's groundwater efforts and statistics
- Prepare an annual JID Groundwater Report that will include the following:

  1. Groundwater level data;
  2. Groundwater contour maps and groundwater flow directions;
  3. Groundwater storage calculations;
  4. Evaluation of one-year and five-year historical trends in groundwater levels, contours, and storage, and perceived reasons for any changes;
  5. Evaluate the adequacy of monitoring efforts and monitoring protocols.
  6. Estimates of deliveries to recharge basins;
  7. Summary of important groundwater management actions;
  8. Discussion on whether management actions are meeting the management objectives;
  9. Summary of proposed management actions for the future;
  10. Summary of groundwater related actions taken by other regional groups;
  11. Recommendations for changes in the content or format of the annual report;
  12. Recommendations for updates to the GMP.

9.3 - Plan Implementation

Implementation of this updated GMP is expected to result in significant amounts of new knowledge and an achievable improvement in groundwater management in JID and the City of San Joaquin. **Attachment 6** includes an implementation schedule for this GMP from 2010-2015. The schedule does not include existing activities that will be continued, but rather documents new projects.

The goals listed in this GMP are considered reasonable and within the capabilities of the District and City. However, most of the goals will require some funding or staff time to achieve. Since staff time and funding are only available in finite quantities, and can often fluctuate, the Plan Participants must by necessity prioritize efforts and cannot guarantee that all of the goals will be accomplished. The Plan Participants recognizes the importance of groundwater management, and will make their best efforts to meet the goals outlined in this plan. If staff or funds are limited, then the projects in the implementation schedule will be prioritized.

9.4 - Plan Re-evaluation

The Groundwater Advisory Committee will be responsible for monitoring the progress in implementing the GMP objectives. Refer to Section 4.1 for more information on the membership, policies, and procedures of the Committee. The Committee will attempt to meet at least once a year to review and evaluate groundwater conditions as well as evaluate the effectiveness of the GMP. As new policies, practices, and ordinances become necessary or desirable to enhance the management of the local groundwater supply, this Plan will be amended as necessary.

Existing Activities

None

Planned Actions

- Update the GMP at least every five years, or more frequently if deemed appropriate.
- Evaluate the effectiveness of the GMP and need for an update at the annual Groundwater Advisory Committee meetings.
- Document recommendations for improving or updating the GMP in each annual Groundwater Report.

9.5 - Dispute Resolution

Dispute resolution is addressed in JID through the District's *Rules and Regulations Governing Water Distribution and Canal Maintenance* as follows:

> "*When Landowners/Water Users cannot resolve differences or controversies with the Ditchtender, the Superintendent or Assistant Superintendent, they are expected to discuss the problem with the Manager prior to asking the Board of Directors for final determination. Unresolved disputes must be presented in writing to the Board of Directors. The Board of Directors will take no action until a written complaint is received. The Board of Directors reserves the authority to act as the final level of appeal on differences and controversies between Water Users and District employees.*" (pg 9-10)

If necessary, the District Manager may also use legal counsel or technical consultants to assist in addressing disputes. In addition, the Districts participation in numerous multi-agency organizations (see Section 4.2 - Relationships with Other Agencies) provides several forums and dispute resolution mechanisms when issues arise between different agencies. No groundwater disputes have occurred in JID in recent years.

The City of San Joaquin does not have special procedures for groundwater disputes, but rather they would be handled through standard dispute resolution processes. These would involve contacting the Department of Public Works, and if necessary meeting with the City Manager or the City Council.

Several mechanisms are also available for resolving regional groundwater disputes through agencies such as KRCD, KRWA, and SLDMWA. The Lower Kings Basin Groundwater Management Plan Update also includes a discussion on the resolution of regional groundwater disputes.

Existing Activities

- Resolve groundwater disputes through general dispute resolution procedures.

Planned Actions

- Discuss issues of concern at the annual GAC meetings in an effort to prevent future disputes.

9.6 - Program Funding and Fees

Several alternatives are available to the City and JID for funding groundwater projects, and are described below:

Water Replenishment Fees

Under AB3030, local agencies have the authority to limit groundwater extractions and implement water replenishment fees based upon the amount of water extracted (extraction based fees must first be approved by majority vote of impacted landowners). Inherent in these powers is the authority to implement metering of private wells. These are considered measures of last resort and the Plan Participants will make any and all efforts to ensure the private, non-metered use of groundwater by the local growers.

Capital Improvement Fees

The District has the authority to finance capital improvement projects and collect repayment charges from the benefited parties. This process would require a favorable vote from the constituency, and is considered a realistic alternative for large capital projects, such as groundwater recharge or banking projects. The City also has several mechanisms to finance long-term capital projects, and collect revenue through water user fees.

Grants and Loans

The Plan Participants will pursue available grants and low-interest loans from the Department of Water Resources as well as other State and Federal agencies. The District and City will also seek opportunities to jointly submit grant and loan applications. The District and City realizes that funding from State and Federal agencies for groundwater projects will be partially based on their progress in implementing this GMP.

Groundwater Banking Fees

JID is currently developing a groundwater bank that will be partially used to store water for other agencies. The revenue generated from operating the bank could be reinvested into other groundwater projects.

Other Revenue Sources
Groundwater projects can also be financed through water user fees and assessments that are collected regularly from all landowners.

Exiting Activities

- Regularly research grant and loan opportunities from the State and Federal government.

Planned Actions

- Identify beneficial groundwater projects that become economically feasible when costs are shared among two or more participants.
- Seek funding for projects that could benefit both the City and District.

10 - REFERENCES

1. Belitz, K. and Phillips, S. P., *Alternatives to Agricultural Drains in California's San Joaquin Valley: Results of a Regional-scale Hydrogeologic Approach*, August 1995.

2. Burt, Charles M., Irrigation Training and Research Center, *Rapid Appraisal Site Visit to JID*, October 24, 2000.

3. *California Department of Water Resources, Bulletin No. 74-81 – Water Well Standards: State of California,* 1981.

4. *California Department of Water Resources, California's Ground Water, Bulletin 118 (Update 2003),* 2003.

5. California Department of Water Resources, *Groundwater Basins in California, Bulletin 118-80*, January 1980.

6. California Department of Water Resources, *San Joaquin Valley Drainage Monitoring Program 2000, District Report*, September 2003.

7. California State Senate, *Senate Bill No. 1938: Groundwater Management*, 2002.

8. ConSol, *City of San Joaquin Water Conservation Strategy*, October 2009.

9. Croft, M. G., United States Geological Survey, *Water Supply Paper 1999-H Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California*, 1972.

10. Davis, G. H., Lofgren, B. E. and Mack, S., *Use of Ground-water Reservoirs for Storage of Surface Water in the San Joaquin Valley, California, US Geological Survey Water-Supply Paper 1618*, 1964.

11. Division of Water Resources, *Oil Field Waste Water Disposal, Raisin City Oil Field, Fresno County*, March 1955.

12. Ireland, R. L., *Land Subsidence in the San Joaquin Valley, California, as of 1983,* USGS Water-Resources investigations Report 85-4196, 1986.

13. James Irrigation District, *Rules and Regulations Governing Water Distribution and Canal Maintenance*, July 13, 2004.

14. Page, R. W., *Base of Fresh Water (Approximately 3,000 Micromhos) in the San Joaquin Valley, California*. Hydrologic Investiagtions, Atlas HA-489, 1973.

15. Page, R. W., *Geology of the Fresh Ground-Water Basin of the Central Valley, California, with Texture Maps and Sections.* U.S. Geological Survey, Professional Paper 1401-C, 1986.

16. Page and LeBlanc, *U.S.G.S, Open File Report: Geology, Hydrology and Water Quality in the Fresno Area*, 1969.

17. Poland, J. F., Lofgren, R. L., Ireland, R. L., and Pugh, R. G., *Land Subsidence in the San Joaquin Valley, California, USGS Professional Paper 437-H, Studies of Land Subsidence prepared in cooperation with the California Department of Water Resources*, 1975.

18. Provost and Pritchard Engineering Group, Inc., *Amended Groundwater Management Plan for James Irrigation District*, February 14, 2001.

19. Provost and Pritchard Engineering Group, Inc., *Application for a Construction Loan for Dedicated Groundwater Recharge Basin for James Irrigation District*, February 2001.

20. Provost and Pritchard Engineering Group, Inc., *Application for a Construction Loan for Agricultural Water Conservation Projects for James Irrigation District*, February 16, 2001.

21. Provost & Pritchard Engineering Group, Inc., *Application for a Local Groundwater Assistance Fund Grant (AB303) for Groundwater Management Program*, December 2007.

22. Provost and Pritchard Engineering Group, Inc., *James Irrigation District 5-Year Water Conservation Plan, 1993-2004*, December 2005.

23. Provost and Pritchard Engineering Group, Inc., *Report of Findings for Potential Banking Facilities in James Irrigation District*, November 2005.

24. Provost and Pritchard Engineering Group, Inc., *McMullin Recharge Feasibility Study*, January 2006.

25. San Joaquin Valley Drainage Program*, Assessment of Groundwater Pumping as a Management Strategy in Drainage Problem Areas of the Western San Joaquin Valley,* 1990.

26. San Luis Delta and Mendota Water Authority, *2005 Westside Integrated Water Resources Plan*, 2005.

27. State of California Resources Agency, Department of Water Resources - San Joaquin District, *Water Quality Investigation, Groundwater Quality Investigation, Raisin City Oil Field, Fresno County*, February 20, 1967.

28. Swanson, A. A., *Land Subsidence in the San Joaquin Valley, Updated to 1995,* in: J. W. Borcers, ed: *Land Subsidence Case Studies and Current Research: Proceedings of the Dr. Joseph F. Poland Symposium on Land Subsidence,* Assoc. of Engineering Geologists, Sp. Pub. 8, 1995.

29. Thomson and West, *California Water Code, 2003 Desktop Edition*, 2003.

30. U.S. Department of Agriculture - Soil Conservation Service, *Soil Survey, Eastern Fresno Area*, October 1971.

31. United Stated Geologic Survey, *Distribution of Wells in the Central Part of the Western San Joaquin Valley*, *California, Water-Resources Investigations Report 89-4158*, 1990.

32. United States Bureau of Reclamation, *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside of the San Joaquin Valley*, September 1990.

33. United States Bureau of Reclamation, *Tranquillity Irrigation District, Geology, Chapter III*, prepared by Dan Sokol, 1955.

34. URS Corporation, *San Luis Drainage Feature Re-evaluation*, January 2004.

35. Villarejo, Don, *93640 at Risk: Farmers, Workers and Townspeople in an Era of Water Uncertainty*, March 1996.

36. Water Resources and Information Management Engineering, Inc., *Lower Kings Basin Groundwater Management Plan Update*, April 2005.