

**Chino Basin
Optimum Basin Management Program**

Management Zone 1
Subsidence Management Plan

October 2007



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Acronym and Abbreviations List

CIM	State of California Institution for Men
EDM	Electronic Distance Measurement
OBMP	Optimum Basin Management Program
IMP	MZ-1 Interim Monitoring Program
InSAR	Synthetic Aperture Radar Interferometry
MZ-1	Chino Basin Management Zone 1
MZ-2	Chino Basin Management Zone 2
MZ-1 Plan	MZ-1 Subsidence Management Plan
Watermaster	Chino Basin Watermaster

1. PROBLEM DESCRIPTION AND MANAGEMENT GOALS

One of the earliest indications that land subsidence was occurring in Chino Basin was the appearance of ground fissures in the City of Chino. These fissures appeared as early as 1973, but an accelerated occurrence of ground fissuring ensued after 1991 and resulted in damage to existing infrastructure. The scientific studies that followed attributed the fissuring phenomenon to differential land subsidence caused by pumping of the underlying aquifer system and the consequent drainage and compaction of aquitard sediments.

In 1999, the Phase I Report of the Optimum Basin Management Program (OBMP) identified pumping-induced drawdown and subsequent aquifer-system compaction as the most likely cause of the land subsidence and ground fissuring observed in MZ-1. Program Element 4 of the OBMP – *Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1* called for the development and implementation of an interim management plan for MZ-1 that would:

- Minimize subsidence and fissuring in the short-term
- Collect information necessary to understand the extent, rate, and mechanisms of subsidence and fissuring
- Formulate a management plan to reduce to tolerable levels or abate future subsidence and fissuring

In 2000, the Implementation Plan in the Peace Agreement called for an aquifer-system and land subsidence investigation in the southwestern region of MZ-1 to support the development of a management plan for MZ-1 (second and third bullets above). This investigation was titled the *MZ-1 Interim Monitoring Program (IMP)*. From 2001-2005, Watermaster developed, coordinated and conducted the IMP under the guidance of the MZ-1 Technical Committee, which is composed of representatives from all major MZ-1 producers and their technical consultants. Specifically, the producers represented on the MZ-1 Technical Committee include: the Agricultural Pool, City of Chino, City of Chino Hills, City of Ontario, City of Pomona, City of Upland, Monte Vista Water District, Southern California Water Company, and the State of California (CIM).

As of October 2005, the main conclusions derived from the investigation were:

1. Groundwater production from the deep, confined aquifer system in this area causes the greatest stress to the aquifer system. In other words, pumping of the deep aquifer system causes water level drawdowns that are much greater in magnitude and lateral extent than drawdowns caused by pumping of the shallow aquifer system.
2. Water level drawdowns due to pumping of the deep aquifer system can cause inelastic (permanent) compaction of the aquifer-system sediments, which results in permanent land subsidence. The initiation of inelastic compaction within the aquifer system at the Ayala Park Extensometer was identified during this investigation when water levels fell below a depth of about 250 feet in the PA-7 piezometer at Ayala Park (see stress-strain diagram on Figure 1-1).
3. The current state of aquifer-system deformation in south MZ-1 (in the vicinity of Ayala Park) is essentially elastic. Very little inelastic (permanent) compaction is now occurring in this area, which is in contrast to the recent past when about 2.2 feet of land subsidence occurred, accompanied by ground fissuring, from about 1987-1995.
4. Through this study, a previously undetected barrier to groundwater flow was identified. The barrier is located within the deep aquifer system and is aligned with the historical zone of ground fissuring. Pumping from the deep aquifer system is limited to the area west of the barrier, and the resulting drawdowns do not propagate eastward across the barrier. Thus, compaction occurs within the deep



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PROBLEM DESCRIPTION AND MANAGEMENT GOALS

system on the west side of the barrier, but not on the east side, which causes concentrated differential subsidence across the barrier and creates the potential for ground fissuring.

5. InSAR and ground level survey data indicate that permanent subsidence in the central region of MZ-1 (north of Ayala Park) has occurred in the recent past. The InSAR data also suggest that the groundwater barrier extends northward into central MZ-1. These observations suggest that the conditions that very likely caused ground fissuring near Ayala Park in the 1990s are also present in central MZ-1, and should be studied in more detail.

The investigation methods, results, and conclusions (listed above) are described in detail in the MZ-1 Summary Report (February 2006), which is included as Appendix A. The investigation provided enough information for Watermaster to develop Guidance Criteria for the MZ-1 producers in the investigation area that, if followed, would minimize the potential for subsidence and fissuring during the completion of the MZ-1 Subsidence Management Plan (this document). The Guidance Criteria are the basis for the MZ-1 Subsidence Management Plan (hereafter, the MZ-1 Plan) and are included in Section 4 of the MZ-1 Summary Report (Appendix A).

The goal of the MZ-1 Plan is:

To develop a pumping and recharge plan to reduce to tolerable levels or abate future land subsidence and ground fissuring.

This initial version of the MZ-1 Plan is specific to southwestern MZ-1 where:

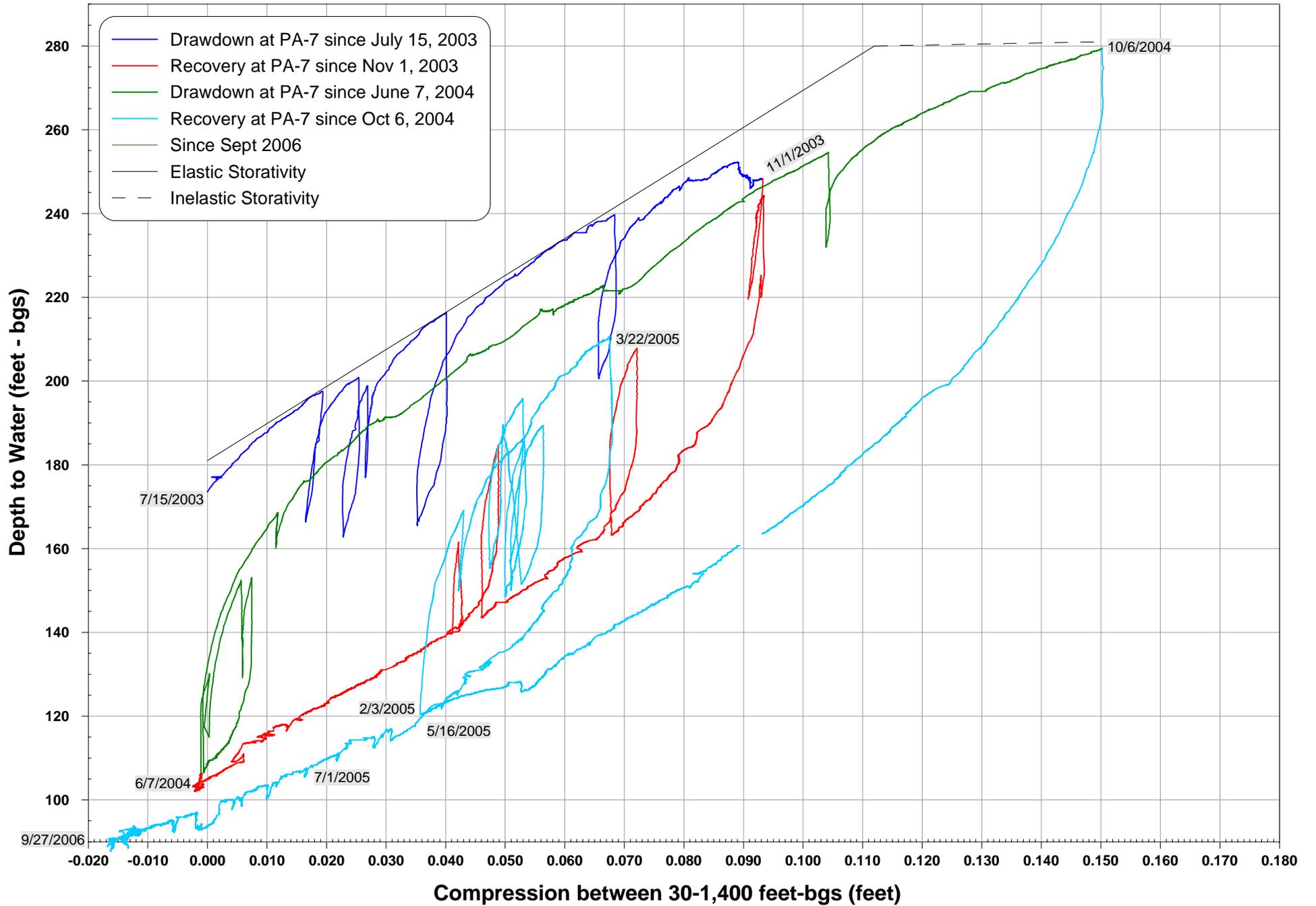
1. Historical subsidence was accompanied by ground fissuring
2. The aquifer-system and land subsidence investigation was focused

However, the investigation also has shown that land subsidence has occurred (or could possibly occur) in other regions of MZ-1, and possibly in other regions of the Chino Basin. In addition, the hydrogeologic conditions that very likely caused ground fissuring in southwestern MZ-1 are also likely present in other regions of MZ-1. For these reasons, the Watermaster conducts aquifer-system and subsidence monitoring efforts in other regions of Chino Basin.

A key element of the MZ-1 Plan is its *adaptive* nature. As new data are collected and periodically analyzed to evaluate the on-going effectiveness of the plan, the plan will be revised accordingly and approved through the Watermaster process.

Section 2 of this plan describes the current version of the MZ-1 Plan. Section 3 addresses the evaluation and periodic update of the MZ-1 Plan.

Figure 1-1
Stress-Strain Diagram (PA-7 vs. Deep Extensometer)



2. MZ-1 SUBSIDENCE MANAGEMENT PLAN

Managed Wells within the Area of Subsidence Management

Table 2-1 lists the existing wells (hereafter the Managed Wells) and their owners (hereafter the Parties) that are currently subject to the MZ-1 Plan. The Parties are the City of Chino, the City of Chino Hills, and the State of California. Figure 2-1 shows the Area of Subsidence Management (hereafter, the Managed Area). Within the boundaries of the Managed Area, other existing wells and/or newly-constructed wells are subject to being classified as Managed Wells.

The Managed Area was delineated based on:

- Measurements of historical land subsidence
- Proximity to historical ground fissuring
- Areal extent of intensive investigation of the MZ-1 Interim Monitoring Program (IMP)

The Managed Well designations were based upon the observed and/or predicted effects of their pumping on groundwater levels and aquifer-system deformation. Managed Well designations for wells that pumped during the IMP were based on effects measured at the Ayala Park Piezometer/Extensometer Facility. Managed Well designations for wells that were not pumped during the IMP were based on analysis of well construction, geology, and their water level responses to nearby pumping.

Definition of Managed Well: Any production well (regardless of current status) located within the Managed Area that has casing perforations deeper than 400 feet below the ground surface.

The Guidance Level

The IMP showed that water-level drawdowns due to pumping from the deep aquifer system within the Managed Area can cause inelastic (non-recoverable) compaction of the aquifer-system sediments, which results in permanent land subsidence. The initiation of inelastic compaction within the aquifer system was identified during the IMP at the Ayala Park Extensometer when water levels fell below a depth of about 250 feet in the PA-7 piezometer at Ayala Park.

Definition of the Guidance Level: The Guidance Level is a specified depth to water measured in Watermaster's PA-7 piezometer at Ayala Park. It is defined as the threshold water level at the onset of inelastic compaction of the aquifer system as recorded by the extensometer, minus 5 feet. The 5-foot reduction is meant to be a safety factor to ensure that inelastic compaction does not occur in the future. The Guidance Level is established by Watermaster and subject to change based on the periodic review of monitoring data collected by Watermaster. The initial Guidance Level is 245 feet below the top of the well casing (ft-btoc) in PA-7.

Watermaster recommends that the Parties manage their groundwater production so that the water level in PA-7 remains above the Guidance Level. If the water level in PA-7 falls below the Guidance Level, Watermaster recommends that the Parties curtail their production from the Managed Wells as required to (1) allow for water-level recovery and (2) maintain the water level in PA-7 above the Guidance Level.

The magnitude of water level drawdown at which aquifer compaction is initiated in areas other than at the Ayala Park Extensometer has not been directly evaluated. Therefore, caution is recommended when pumping from Managed Wells in order to minimize water level drawdown within the Managed Area. Guidance Levels for wells and/or piezometers in addition to PA-7 may be specified in the future as a



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result of ongoing monitoring and evaluation of groundwater production, groundwater levels, and land subsidence.

Data Exchange between Watermaster and the Parties

Watermaster will provide the Parties with current water level data from PA-7 on its website (www.cbwm.org).

The Parties are requested to maintain accurate records of the operation of the Managed Wells, including production rates and on-off dates and times. The Parties are requested to provide these records to Watermaster monthly. The Parties are requested to promptly notify Watermaster of all operational changes made to maintain the water level in PA-7 above the Guidance Level.

Continued Monitoring within the Managed Area

Watermaster will continue the scope and frequency of monitoring that was implemented during the IMP within the Managed Area. These monitoring efforts are necessary to:

- Supply the Parties with the requisite information to comply with the MZ-1 Plan
- Assess the Parties' compliance with the MZ-1 Plan
- Evaluate the effectiveness of the MZ-1 Plan to reduce to tolerable levels or abate future land subsidence and ground fissuring.

Watermaster will continue the monitoring of:

Piezometric Levels. Watermaster recommends that the Parties allow Watermaster to continue monitoring piezometric levels at their wells listed in Table 2-2. Currently, a pressure-transducer/data-logger is installed at each of these wells and records one water level reading every 15 minutes. In addition, Watermaster will continue to record depth-specific water levels at the piezometers located at the Ayala Park Extensometer facility every 15 minutes.

Watermaster will maintain all pressure-transducers/data-loggers in good working order in an effort to collect a continuous and reliable record of piezometric levels within the Managed Area.

Aquifer-System Deformation. Watermaster will continue to record aquifer-system deformation at the Ayala Park Extensometer facility. At this facility, two extensometers, completed at 550 ft-bgs and 1,400 ft-bgs, will continue to record the vertical component of aquifer-system compression and/or expansion once every 15 minutes (synchronized with the piezometric measurements).

Watermaster will maintain the Ayala Park Extensometer facility in good working order in an effort to collect a continuous and reliable record of aquifer-system deformation at Ayala Park.

Vertical Ground-Surface Deformation. Watermaster will continue the monitoring of vertical ground-surface deformation via ground level surveying and remote sensing (Synthetic Aperture Radar Interferometry [InSAR]) techniques that were established during the IMP.

Currently, Watermaster is attempting to collect synchronous ground-level survey and InSAR data on a semi-annual frequency (Spring/Fall) over a two-year period. After Fall 2007, Watermaster will analyze



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and compare the survey and InSAR data sets, and recommend a new scope and frequency of data collection for both ground-level surveys and InSAR. Factors that will be considered during the comparative analysis and recommendation will be accuracy, reliability, areal extent, and cost.

Horizontal Ground-Surface Deformation. Watermaster will continue the monitoring of horizontal ground-surface displacement across the eastern side of the subsidence trough and the adjacent area east of the barrier/fissure zone. These data, obtained by electronic distance measurements (EDMs), are used to characterize the horizontal component of land surface displacement caused by groundwater production on either side of the fissure zone. Currently, Watermaster is collecting EDMs on a semi-annual frequency (Spring/Fall) between east/west-aligned benchmarks on Eucalyptus, Edison, and Schaefer Avenues.

Expanded Monitoring in Areas of Subsidence Concern

The results of the IMP showed that land subsidence and ground fissuring concerns are not spatially limited to the Managed Area. Specifically, the IMP showed that:

- Hydrogeologic conditions conducive to land subsidence are present in other areas of MZ-1 and the Chino Basin
- Land subsidence is occurring (or has occurred in the past) in other regions of MZ-1 and the Chino Basin
- Hydrogeologic conditions that presumably caused ground fissuring in southwestern MZ-1 are also present in other areas of MZ-1
- Groundwater production (and associated drawdowns) is active, planned, and/or proposed within or near these areas that are susceptible to subsidence and fissuring

For these reasons, Watermaster conducts limited monitoring of the aquifer system and land subsidence outside of the Managed Area (hereafter, Areas of Subsidence Concern). Figure 2-2 shows the three Areas of Subsidence Concern: Central MZ-1, Southeast Area, and Northeast Area.

Central MZ-1. All available data collected and analyzed during the IMP (including historical InSAR [1992-2000] and recent ground level surveys [2003-2005]) indicate that permanent subsidence in the central parts of MZ-1 (north of Ayala Park) has occurred in the past. The InSAR data also suggest that the groundwater barrier extends northward into central MZ-1. These observations suggest that the conditions that very likely caused ground fissuring near Ayala Park in the 1990s are also present in Central MZ-1.

Currently in Central MZ-1:

- In fiscal year 2005/06, Watermaster installed pressure-transducers/data-loggers in about 10 existing production wells within Central MZ-1 to record water levels once every 15 minutes. This initial data collection effort is a Watermaster attempt to better understand the relationships between nearby groundwater production, water levels, and the observed subsidence in Central MZ-1.
- Watermaster monitors vertical ground-surface deformation via ground level surveying and InSAR techniques as part of the same program that is conducted for the Managed Area. These data have revealed the extent, rate, and spatial distribution of land subsidence in Central MZ-1, and has revealed a zone of potential future ground fissuring.



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- Watermaster conducts monitoring of horizontal ground-surface displacement across the zone of potential future ground fissuring (near the intersection of Central Avenue and Philadelphia Street). These data, obtained by EDMs on a semi-annual frequency (Spring/Fall) between east/west-aligned benchmarks on Philadelphia Street, are used to characterize the horizontal component of land surface displacement caused by groundwater production in the region. The data collected as part of this effort can be used to design a program for *detailed* monitoring of horizontal strain across this zone of potential ground fissuring, if deemed necessary by Watermaster.

Watermaster will continue the above listed monitoring efforts. If future data from existing monitoring efforts in this area indicate the potential for adverse impacts due to subsidence, Watermaster will revise the MZ-1 Plan pursuant to the process outlined in Section 3.

Southeast Area. All available data collected and analyzed during the IMP (including historical InSAR [1992-2000] and recent ground level surveys [2003-2005]) indicate that very little permanent subsidence has occurred in the Southeast Area (east of Ayala Park) since the early 1990s. However:

- the historical InSAR data is incoherent (absent) across much of this area
- the geologic conditions that are necessary for land subsidence and ground fissuring are present in this region
- Watermaster's historical records indicate that very little groundwater production has occurred within the deep aquifer system in this region, which would suggest that new groundwater production from the deep aquifer system could cause permanent land subsidence and ground fissuring
- some MZ-1 producers have plans to produce groundwater from the deep aquifer system in this region
- very little is known about the site-specific controls on subsidence and fissuring that are unique to this region, such as the drawdown threshold that would initiate inelastic compaction in the aquifer system, or the effects that land subsidence in this region would have on the historic fissure zone within the adjacent Managed Area

Currently in the Southeast Area:

- Watermaster monitors vertical ground-surface deformation via ground level surveying and InSAR techniques as part of the same program that is conducted for the Managed Area. These data reveal the extent, rate, and spatial distribution of land subsidence across a portion of the Southeast Area.
- Watermaster has installed pressure-transducers/data-loggers in about 16 existing production wells and monitoring wells within the Southeast Area to record water levels once every 15 minutes as part of the MZ-1 and HCMP monitoring programs.

Watermaster will continue the above listed monitoring efforts. If future data from existing monitoring efforts in this area indicate the potential for adverse impacts due to subsidence, Watermaster will revise the MZ-1 Plan pursuant to the process outlined in Section 3.

Northeast Area. All available data collected and analyzed during the IMP (including historical InSAR [1992-2000] and recent ground level surveys [2003-2005]) indicate that minor but persistent permanent subsidence has occurred in the Northeast Area since the early 1990s. The available data does not indicate that any areas are experiencing focused differential subsidence that would indicate the threat of ground fissuring.

Currently in the Northeast Area:

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- Watermaster monitors vertical ground-surface deformation via ground level surveying and InSAR techniques as part of the same program that is conducted for the Managed Area. These data reveal the extent, rate, and spatial distribution of land subsidence across a portion of the Northeast Area.

Watermaster will continue the above listed monitoring efforts. If future data from existing monitoring efforts in this area indicate the potential for adverse impacts due to subsidence, Watermaster will revise the MZ-1 Plan pursuant to the process outlined in Section 3.

Contemplated Activities for 2008/09 and Beyond

Currently, Watermaster and the MZ-1 Technical Committee are contemplating additional testing, monitoring, and other activities within MZ-1.

- *Detailed monitoring of horizontal strain across the fissure zone by installing high-resolution instrumentation or by experimental InSAR.* The high-resolution instrumentation will comprise three measurement technologies that function over a range of spanned distances (12 - 400 ft) and strain resolutions (1e-5 to 1e-8). Data from the highest-resolution, short-span strain gages and tiltmeters would be quasi-continuous, and, when plotted against quasi-continuous water level (stress) measurements in wells, would reveal stress-strain relationships at work in and immediately adjacent to the fissure zone. This work is contemplated to occur just south of Schaefer Avenue across the historic zone of fissuring.

As an alternate or supplement to the high-resolution monitoring, InSAR could be used to measure horizontal deformation. The use of InSAR to monitor horizontal deformation is experimental, but holds the promise of monitoring over large areas and at a finer spatial resolution than the EDMs.

Monitoring and evaluation of horizontal ground-surface deformation across the fissure zone will improve the current understanding of the stress conditions in this area; particularly as groundwater production and associated drawdowns increase to the east (*e.g.* in MZ-2). Understanding the stress-strain relationships over a larger area will be important to effectively managing groundwater production to minimize strain and potential future fissuring. Results of the evaluation would be used to update management options in the MZ-1 Plan.

- *An injection feasibility study at a production well within the Managed Area.* This test would help determine if aquifer injection is a viable tool to manage subsidence within the Managed Area while maximizing the use of existing infrastructure (*i.e.* wells). The proposed project would construct improvements to an existing well to allow injection of water from the City of Chino Hills distribution system into the aquifer during off peak demand periods, and recovery of the stored water through the same well for municipal use during peak periods.

During FY 2007/08, Watermaster and the MZ-1 Technical Committee shall implement the following activities:

- *Further evaluation of the potential contribution of pumping in the central and northern portions of MZ-1 on groundwater conditions in the central and southern portions of MZ-1.* Watermaster, in consultation with the MZ-1 Technical Committee, will specifically design an investigation to address whether production in the northern and central areas have a material impact on subsidence. This investigation may include additional testing, monitoring, construction of new monitoring facilities (*e.g.* extensometers and piezometers), and development and use of a three-dimensional, computer-simulation model of groundwater flow and subsidence.
- *Additional testing and monitoring to refine the Guidance Criteria.* Watermaster, in consultation with the MZ-1 Technical Committee, will assist the Parties in designing pumping plans within the Managed

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Area for the purpose of further refining the Guidance Criteria and improving the prudent extraction of groundwater. Computer-simulation models of groundwater flow and subsidence will assist in the development of these pumping plans. Watermaster has recently developed an analytical drawdown model of the deep aquifer system within the Managed Area and a numerical, one-dimensional compaction model at Ayala Park. Watermaster also has recently updated its regional MODFLOW model of Chino Basin. The City of Chino Hills has recently developed a MODFLOW model of MZ-1. All of the above models can be useful tools in the development of the pumping plans.

- *Development of alternative pumping plans.* Watermaster, in consultation with the MZ-1 Technical Committee, will cooperate with the City of Chino Hills to evaluate the best available options for the City to produce a reasonable quantity of groundwater from MZ-1, taking into account any new information derived from the bulleted activities described above, the City's relative share of Operating Safe Yield, its historical investments in water supply development, its water supply requirements, and the physical limitations within MZ-1. The pumping plans will not be designed in such a manner as to purposefully cause drawdown below the Guidance Level.

By the end of March 2008, the MZ-1 Technical Committee will have discussed and evaluated the above activities, and for the activities that the Committee recommends for implementation, will have composed specific scope(s) of work and detailed cost estimates. These recommendations and supporting documentation will be forwarded to Watermaster for inclusion in the budgeting process for FY 2008/09.

**Table 2-1
MZ-1 Managed Wells**

CBWM_ID	Owner	Well Name	Status	Screened Interval ft-bgs	Capacity gpm
600487	Chino Hills	1B	Inactive ¹	440-470, 490-610, 720-900, 940-1180	up to 1200
600687	Chino Hills	7C	Not Equipped ²	550-950	--
600498	Chino Hills	7D	Inactive	320-400, 410-450, 490-810, 850-930	400
600488	Chino Hills	15B	Active ³	360-440, 480-900	1500
600489	Chino Hills	16	Inactive	430-940	800
600499	Chino Hills	17	Active	300-460, 500-980	700
600500	Chino Hills	19	Active	340-420, 460-760, 800-1000	1100-1500
3600461	Chino	7	Not Equipped	180-780	
600670	Chino	15	Not Equipped	270-400, 626-820	
3602461	CIM	11A	Active	135-148, 174-187, 240-283, 405-465, 484-512, 518-540	500-600

¹ Well can pump groundwater with little or no modifications, but no pumping is planned for the current year.

² Unable to pump the well without major modifications, and no pumping is planned for the current year.

³ Well is currently being used for water supply.



**Table 2-2
Wells Used for Water-Level Monitoring
within the Managed Area**

CBWM_ID	Owner	Well Name	Status	Screened Interval ft-bgs	Capacity gpm
	Chino Hills	1A	Active ¹	166-317	700-800
	Chino Hills	1B	Inactive ²	440-470, 490-610, 720-900, 940-1180	up to 1200
	Chino Hills	7C	Not Equipped ³	550-950	--
	Chino Hills	5	Active		
	Chino Hills	15A	Not Equipped	190-310	--
	Chino Hills	15B	Active	360-440, 480-900	1500
	Chino Hills	16	Inactive	430-940	800
	Chino Hills	17	Inactive	300-460, 500-980	700
	Chino Hills	18	Not Equipped	420-460, 480-980	--
	Chino Hills	19	Active	340-420, 460-760, 800-1000	1100-1500
	Chino	4	Active	160-200, 200-275	350-750
	Chino	6	Active	200-375	500-750
	Chino	7	Not Equipped	180-780	
	Chino	15	Not Equipped	270-400, 626-820	
	Chino	Schaefer	Not Equipped		
	Chino	YMCA	Not Equipped		
	Chino	12th&G	Not Equipped		
	CIM	1A	Active	160-213, 484-529	1100-1200
	CIM	11A	Active	135-148, 174-187, 240-283, 405-465, 484-512, 518-540	500-600
	CIM	MW-22DR	Monitoring ⁴	514.5-528.9	
	CIM	MW-24S	Monitoring	94-103.6	
	CIM	MW-24I	Monitoring	157.1-171.7	
	CIM	MW-33S	Monitoring	97.3-107	

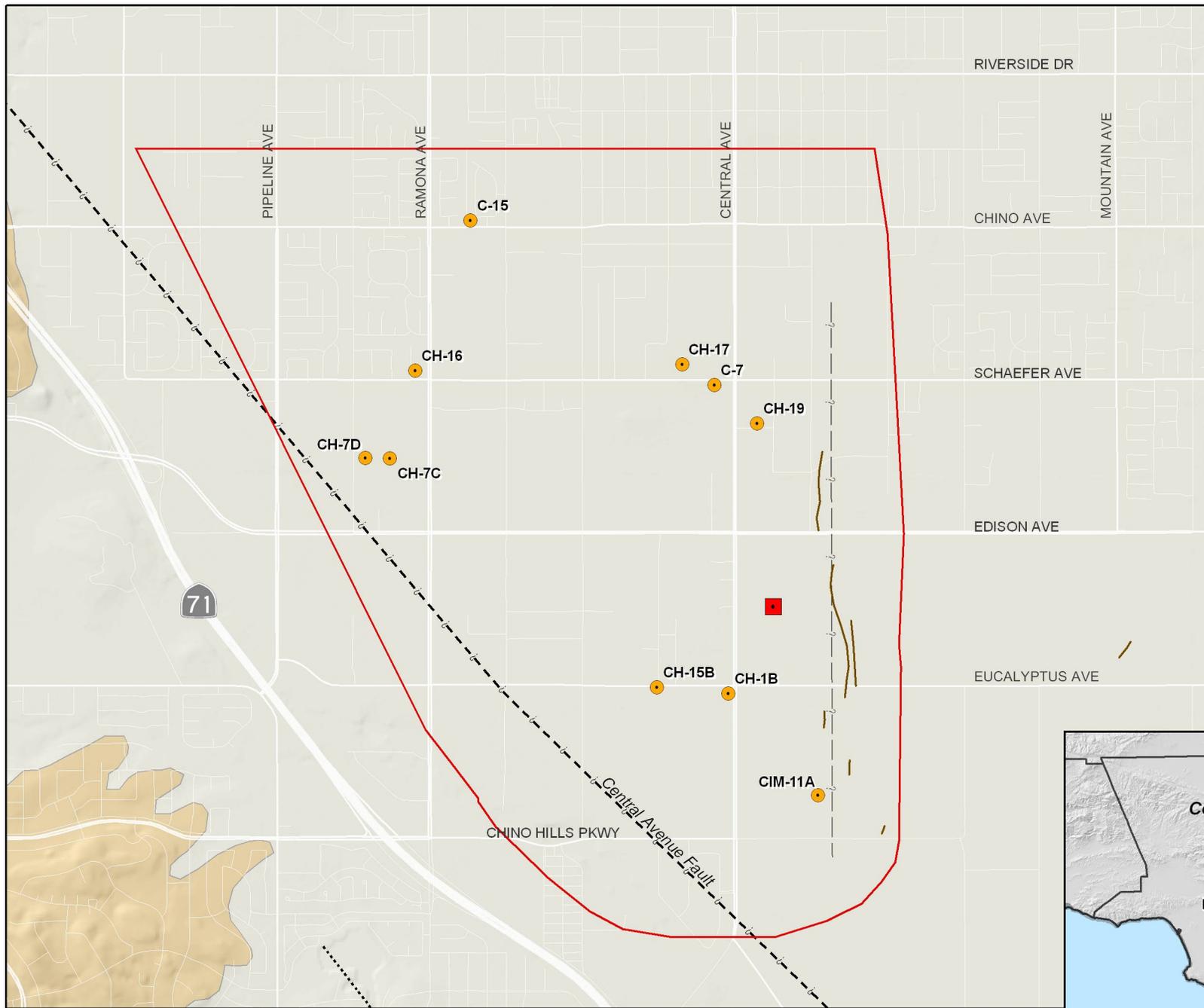
¹ Well is currently being used for water supply.

² Well can pump groundwater with little or no modifications, but no pumping is planned for the current year.

³ Unable to pump the well without major modifications, and no pumping is planned for the current year.

⁴ Well was designed and constructed as a monitoring well, and is not equipped to pump groundwater.





-  MZ-1 Managed Well
-  Ayala Park Extensometer
-  Area of Subsidence Management
-  Ground Fissure (1994)
-  Approximate Location of Groundwater Barrier

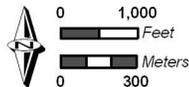


MZ-1 Managed Area and Managed Wells

Figure 2-1

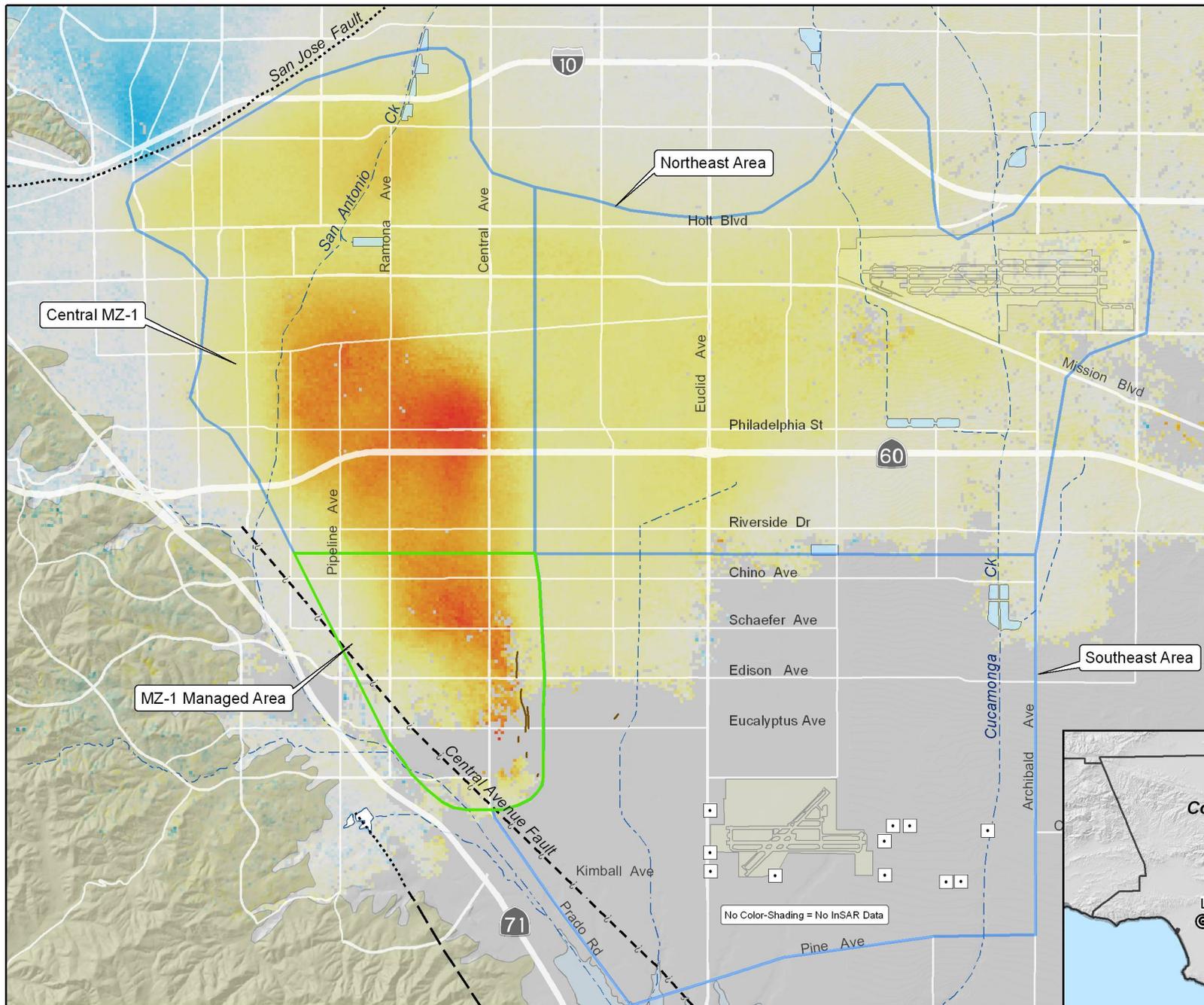


MZ-1 Subsidence Management Plan



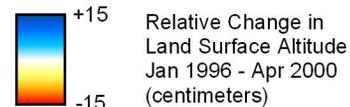
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 WILDERMUTH ENVIRONMENTAL INC.



- Area of Subsidence Management
- Areas of Subsidence Concern

Results of InSAR Analysis



Other Features

- Chino-I Desalter Well
- Ground Fissure (early 1990s)
- Unconsolidated Sediments
- Sedimentary Bedrock

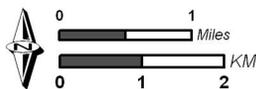


Subsidence Management Areas

Figure 2-2



Chino Basin OBMP
MZ-1 Subsidence Management Plan



Author: AEM
Date: 20060321
File: Figure_2-2.mxd

Produced by:
WILDERMUTH
ENVIRONMENTAL, INC.

3. EVALUATION AND UPDATE OF THE MZ-1 SUBSIDENCE MANAGEMENT PLAN

A key element of the MZ-1 Plan is the verification of the protective nature of the plan as related to permanent land subsidence and ground fissuring. This verification is accomplished through continued monitoring and reporting by Watermaster and revision of the MZ-1 Plan when appropriate. In this sense, the MZ-1 Plan is adaptive.

Within the Managed Area, Watermaster recommends that all¹ deep aquifer-system pumping cease for a continuous 2- to 6-month period between October 1 and March 31 of each year. The recovery period will begin with 6 months the first year of the program, 4 months the second year, 3 months the third year, 2 months the fourth year, and 6 months for the fifth year of the program. The cessation of pumping is intended to allow for sufficient water level recovery at PA-7 to recognize inelastic compaction, if any, at the Ayala Park Extensometer and at other locations where groundwater-level and ground-level data are being collected. Following the fifth year of the program, the effectiveness of the recovery period duration will be assessed and an appropriate annual recovery period will be recommended for the MZ-1 Plan.

At the end of March of each year, the MZ-1 Technical Committee will convene to review all available data collected and analyses performed over the past year, and to formally recommend revisions or additions to the MZ-1 Plan. This will include, but not be limited to, recommendations for all deep aquifer recovery periods as outlined above. These recommendations will be run through the Watermaster process during May and, if approved, will be budgeted for and implemented during the following fiscal year.

At the conclusion of each fiscal year (June 30), Watermaster will produce a MZ-1 Annual Report that will include:

- Tables that describe the pumping history for the year for each well in the Managed Area
- Stress-strain diagrams from the Ayala Park Extensometer facility with interpretation
- Maps of ground surface deformation as measured by the ground level surveys and/or InSAR
- Maps of groundwater elevations to compare with the measurements of ground-surface deformation
- Stress-strain time series charts or diagrams at other locations in MZ-1
- Tables that describe utilization of replacement water supplies (if any)
- The revised MZ-1 Plan, that may include changes to:
 - The delineation of the Managed Area
 - The list of Managed Wells
 - Definition of the Guidance Level, which could include additional Guidance Levels at other locations in MZ-1
 - On-going monitoring of the aquifer system and ground surface

¹ Well 11A will be exempt from this recommendation. This is based on the small amount of water pumped from the deep zone by this well and the impracticability to shut down this well due to permitting requirements. This exemption shall be subject to continuous review by the MZ-1 Technical Committee to ensure that continued pumping from this well does not interfere with water level recovery.



APPENDIX A – MZ-1 SUMMARY REPORT (FEBRUARY 2006)