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TECHNICAL MEMORANDUM

DATE: July 8, 2021

Project No.: 941-80-20-22
SENT VIA: EMAIL

TO: Ground-Level Monitoring Committee

FROM: Michael Blazevic

REVIEWED BY: Andy Malone

SUBJECT: Recommended Scope of Services and Budget of the Ground-Level Monitoring Committee for Fiscal Year 2021/22 (Final)

BACKGROUND AND PURPOSE

Pursuant to the Optimum Basin Management Program Implementation Plan and the Peace Agreement, the Chino Basin Watermaster (Watermaster) implements a Subsidence Management Plan (SMP) for the Chino Basin to minimize or stop the occurrence of land subsidence and ground fissuring. The Court approved the SMP and ordered its implementation in November 2007 (2007 SMP). The 2007 SMP was updated in 2015 (2015 SMP) and can be downloaded from the Watermaster website. The SMP outlines a program of monitoring, data analysis, and annual reporting. A key element of the SMP is its adaptive nature—Watermaster can adjust the SMP as warranted by the data.

The Watermaster Engineer, with the guidance of the Ground-Level Monitoring Committee (GLMC), prepares the annual reports which include the results of the monitoring program, interpretations of the data, recommendations for the Ground-Level Monitoring Program (GLMP) for the following fiscal year (FY), and recommendations for adjustments to the SMP, if any.

This Technical Memorandum (TM) describes the Watermaster Engineer's recommended activities for the GLMP for FY 2021/22 in the form of a proposed scope of services and budget.

Members of the GLMC are asked to:

- Review this TM prior to March 4, 2021
- Attend a meeting of the GLMC at 9:00 am on March 4, 2021 to discuss the proposed scope of services and budget for FY 2021/22
- Submit comments and suggested revisions on the proposed scope of services and budget for FY 2021/22 to the Watermaster by March 19, 2021
- Attend a meeting of the GLMC at 9:00 am on April 1, 2021 to discuss comments and revisions to the proposed scope of services and budget for FY 2021/22

- Submit additional comments and suggested revisions on the proposed scope of services and budget for FY 2021/22 to the Watermaster by May 21, 2020.

The final scope of services and budget that is recommended by the GLMC will be included in the Watermaster's FY 2021/22 budget. The final scope of services, budget, and schedule for FY 2021/22 will be included in Section 4 of the *2020/21 Annual Report of the GLMC*.

RECOMMENDED SCOPE OF SERVICES AND BUDGET – FY 2021/22

A proposed scope of services for the GLMP for FY 2021/22 is shown in Table 1 as a line-item cost estimate. The proposed scope of services is summarized below.

Task 1. Setup and Maintenance of the Monitoring Network

The Chino Basin extensometer facilities are key monitoring facilities for the GLMP. They require regular and as-needed maintenance and calibration to remain in good working order and to ensure the recording of accurate measurements.

Task 1.1. Maintain Extensometer Facilities

This subtask includes performing monthly visits to the Ayala Park, Chino Creek, and Pomona extensometer facilities to ensure functionality and calibration of the monitoring equipment and data loggers.

Task 1.2. Annual Lease Fees for the Chino Creek Extensometer Site

The County of San Bernardino (County) owns the land the Chino Creek extensometer facility is located on. As such, the Watermaster entered into a lease agreement with the County in 2012 and pays the County and annual rental payment of $1,596.

Task 2. Aquifer-System Monitoring and Testing

This task involves the collection and compilation of hydraulic head and aquifer-system deformation data from the Ayala Park, Chino Creek, and Pomona extensometer facilities.

Task 2.1. Conduct Quarterly Data Collection from Extensometers; Data Checking and Management

This subtask involves the routine quarterly collection and checking of data from the extensometer facilities. Quarterly data collection is necessary to ensure that the monitoring equipment is in good working order and to minimize the risk of losing data because of equipment malfunction. For this subtask, the complete extensometer records from the Ayala Park, Chino Creek, and Pomona extensometer facilities will be loaded to HydroDaVE^{SM} (Hydrologic Database and Visual Explanations) and checked. Both hydraulic head and aquifer-system data from the extensometer facilities will be loaded and checked to HydroDaVE on a quarterly basis.

Table 1. Work Breakdown Structure and Cost Estimates Ground-Level Monitoring Program: FY 2021/22

Task Description			Notes	Labor (days)		Other Direct Costs						Totals					
				Person Days	Total	Travel	New Equip.	Equip. Rental	Outside Pro	Misc.	Total	Totals by Task	Recommended Budget *FY 2021/22* *a*	Approved Budget *FY 2020/21* *b*	Net Change *FY 2020/21 to 2021/22* *a - b*	Potential Carry-Over *FY 2021/22* *c*	Budget with Carry-Over *FY 2021/22* *a - c*
Task 1. Setup and Maintenance of the Monitoring Network					**$26,208**						**$7,388**	**$33,596**	**$33,596**	**$32,988**	**$608**	**$0**	**$33,596**
1.1	Maintain Extensometer Facilities																
	1.1.1	Routine maintenance of Ayala Park, Chino Creek, and Pomona extensometer facilities		14	$19,824	$1,056	$250	$152			$1,458	$21,282	$21,282	$20,818	$464	$0	$21,282
	1.1.2	Replacement/repair of equipment at extensometer facilities		4	$6,384	$264	$2,000	$70	$2,000		$4,334	$10,718	$10,718	$10,574	$144	$0	$10,718
1.2	Annual Lease Fees for the Chino Creek extensometer site			0	$0					$1,596	$1,596	$1,596	$1,596	$1,596	$0	$0	$1,596
Task 2. MZ-1: Aquifer-System Monitoring and Testing					**$30,736**						**$680**	**$31,416**	**$31,416**	**$27,392**	**$4,024**	**$0**	**$31,416**
2.1	Conduct Quarterly Data Collection from Extensometers; Data Checking and Management																
	2.1.1	Download data from the Ayala Park extensometer facility		2	$2,687	$230		$76			$306	$2,993	$2,993	$2,930	$63	$0	$2,993
	2.1.2	Download data from the Chino Creek extensometer facility		2	$2,687	$26					$26	$2,713	$2,713	$2,650	$63	$0	$2,713
	2.1.3	Download data from Pomona extensometer facility		4	$5,374	$272		$76			$348	$5,722	$5,722	$5,596	$126	$0	$5,722
	2.1.4	Process, check, and upload data to database		13	$19,988						$0	$19,988	$19,988	$16,216	$3,772	$0	$19,988
Task 3. Basin Wide Ground-Level Monitoring Program (InSAR)					**$5,116**						**$85,000**	**$90,116**	**$90,116**	**$90,002**	**$114**	**$0**	**$90,116**
3.1	Acquire TerraSAR-X Data and Prepare Interferograms for 2021/22			1	$1,845				$85,000		$85,000	$86,845	$86,845	$86,808	$37	$0	$86,845
3.2	Check and Review InSAR Results			2	$3,271						$0	$3,271	$3,271	$3,194	$77	$0	$3,271
Task 4. Perform Ground-Level Surveys					**$7,728**						**$192,203**	**$199,931**	**$93,982**	**$51,828**	**$42,154**	**$0**	**$93,982**
4.1	Conduct Spring-2022 Elevation surveys in Northwest MZ-1			0.5	$926				$25,157		$25,157	$26,083	$26,083	$34,784	-$8,701	$0	$26,083
4.2	Conduct Spring-2022 Elevation Survey in the Northeast Area			0	$0				$47,069		$47,069	$47,069	$0	$0	$0	$0	$0
4.3	Conduct Spring-2022 Elevation Survey in the Southeast Area			0.5	$926				$49,797		$49,797	$50,723	$50,723	$0	$50,723	$0	$50,723
4.4	Conduct Spring-2022 Elevation and EDM Surveys in the Managed Area/Fissure Zone Area			0	$0				$52,270		$52,270	$52,270	$0	$0	$0	$0	$0
4.5	Replace Destroyed Benchmarks (if needed)			0	$0				$17,910		$17,910	$17,910	$11,300	$11,300	$0	$0	$11,300
4.6	Process, Check, and Update Database			4	$5,877						$0	$5,877	$5,877	$5,744	$133	$0	$5,877
Task 5. Data Analysis and Reporting					**$85,586**						**$0**	**$85,586**	**$85,586**	**$74,932**	**$10,654**	**$0**	**$85,586**
5.1	Prepare Draft 2020/21 Annual Report of the Ground-Level Monitoring Committee			20.5	$33,286						$0	$33,286	$33,286	$35,196	-$1,910	$0	$33,286
5.2	Prepare Final 2020/21 Annual Report of the Ground-Level Monitoring Committee			10.5	$19,546						$0	$19,546	$19,546	$19,088	$458	$0	$19,546
5.3	Compile and Analyze Data from the 2021/22 Ground-Level Monitoring Program			14	$21,144						$0	$21,144	$21,144	$20,648	$496	$0	$21,144
5.4	Conduct Reconnaissance-Level Subsidence Investigation of the Northeast Area (southeast part)																
	5.4.1	Collect and compile available InSAR, ground-level survey, lithologic, piezometric level, and pumping and recharge data		2.75	$4,442						$0	$4,442	$4,442	$0	$4,442	$0	$4,442
	5.4.2	Prepare lithologic cross-sections and data graphics of pumping, piezometric levels, and InSAR time-histories; share with the GLMC		4.25	$7,168						$0	$7,168	$7,168	$0	$7,168	$0	$7,168
Task 6. Develop a Subsidence-Management Plan for Northwest MZ-1					**$238,164**						**$480**	**$238,644**	**$238,644**	**$99,189**	**$139,455**	**$91,691**	**$146,953**
6.1	Aquifer-System Monitoring																
	6.1.1	Collect pumping and piezometric level data from agencies every two months; check and upload data to HDX		9.75	$12,669						$0	$12,669	$12,669	$10,599	$2,070	$0	$12,669
	6.1.2	Prepare and analyze charts and data graphics of pumping and recharge (Northwest MZ-1), piezometric levels, and aquifer-system deformation from PX		8.25	$11,913						$0	$11,913	$11,913	$11,634	$279	$0	$11,913
6.2	Update the One-Dimensional (1D) Compaction Models at the MVWD-28 and PX Locations																
	6.2.1	Construct a 1D compaction model at the PX location		0	$0						$0	$0	$0				
	6.2.2	Calibrate 1D compaction model to derive hydraulic and mechanical properties of aquifers/aquitards and estimate the pre-consolidation stress(es)		0	$0						$0	$0	$0	$0	$0	$0	$0
	6.2.3	Update the 1D compaction model at the MVWD-28 location from a three to a five layer model and re-calibrate		0	$0						$0	$0	$0				
6.3	Document the One-Dimensional (1D) Compaction Models at the MVWD-28 and PX Locations																
	6.3.1	Prepare for and conduct a meeting to review the results of the 1D compaction models	a	4.25	$8,722	$120					$120	$8,842	$8,842	$0	$8,842	$0	$8,842
	6.3.2	Review and respond to the GLMC comments on the 1D compaction models		3	$6,140						$0	$6,140	$6,140	$0	$6,140	$0	$6,140
	6.3.3	Prepare a draft TM summarizing the construction and calibration of the PX 1D compaction model and updates to the MVWD-28 1D compaction model and distribute to the GLMC		25.5	$46,664						$0	$46,664	$46,664				
	6.3.4	Prepare for and conduct a GLMC meeting to receive feedback and comments on the draft TM	a	4.75	$9,299						$0	$9,299	$9,299	$0	$61,813	$14,735	$47,078
	6.3.5	Incorporate the GLMC comments and prepare a final technical memorandum		3.0	$5,730	$120					$120	$5,850	$5,850				
6.4	Refine and Evaluate Subsidence-Management Alternatives																
	6.4.1	Run the Baseline Management Alternative (BMA)		19	$33,176						$0	$33,176	$33,176				
	6.4.2	Prepare a TM that summarizes the evaluation of the BMA and a recommended ISMA		10.75	$19,425						$0	$19,425	$19,425				
	6.4.4	Meet with the GLMC to receive feedback on the TM		4.5	$8,757	$120					$120	$8,877	$8,877				
	6.4.5	Run the Initial Subsidence Management Alternative (ISMA)		25.75	$46,945						$0	$46,945	$46,945	$76,956	$60,311	$76,956	$60,311
	6.4.6	Prepare a technical memorandum that summarizes the evaluation of the ISMA and a recommended Subsidence Management Alternative (SMA-2)		10.75	$19,425						$0	$19,425	$19,425				
	6.4.7	Prepare for and conduct a meeting to receive feedback and comments on the draft technical memorandum		4.75	$9,299	$120					$120	$9,419	$9,419				
Task 7. Meetings and Administration					**$53,813**						**$407**	**$54,220**	**$54,220**	**$51,250**	**$2,971**	**$0**	**$54,220**
7.1	Prepare for and Conduct Four Meetings of the Ground-Level Monitoring Committee		a	14	$27,877	$240					$240	$28,117	$28,117	$25,838	$2,279	$0	$28,117
7.2	Prepare for and Conduct One As-Requested Ad-Hoc Meeting		a	3	$5,857	$167					$167	$6,024	$6,024	$5,804	$221	$0	$6,024
7.3	Perform Monthly Project Management			6	$11,108						$0	$11,108	$11,108	$10,848	$260	$0	$11,108
7.4	Prepare a Recommended Scope and Budget for the GLMC for FY 2022/23			4.75	$8,970						$0	$8,970	$8,970	$8,760	$210	$0	$8,970
Totals													**$627,560**	**$427,581**	**$199,979**	**$91,691**	**$535,869**

Task 3. Basin-Wide Ground-Level Monitoring Program (InSAR)

This task involves the annual collection and analysis of Synthetic Aperture Radar (SAR) scenes to estimate the vertical ground motion across the western portion of Chino Basin from March 2021 to March 2022.

As part of the approved scope of services and budget of the GLMC for FY 2020/21, the GLMC directed the Watermaster Engineer to perform a pilot study of the Sentinel-1A InSAR data. The TM documenting the objectives, methods, results, and conclusions and recommendations of the pilot study is included in Attachment A. The conclusions from the pilot study were relied upon in recommending Tasks 3.1 and 3.2 for FY 2021/22.

Task 3.1. Acquire TerraSAR-X SAR Data and Prepare Interferograms for 2021/22

In this subtask, five SAR scenes that will be acquired by the TerraSAR-X satellite from March 2021 to March 2022 are purchased from the German Aerospace Center. General Atomics (formerly Neva Ridge Technologies) will use the SAR scenes to prepare 12 interferograms that describe the incremental and cumulative vertical ground motion that occurred from March 2021 to March 2022 and since 2011. The associated costs for General Atomics to task, acquire, purchase, and process the InSAR data is as follows:

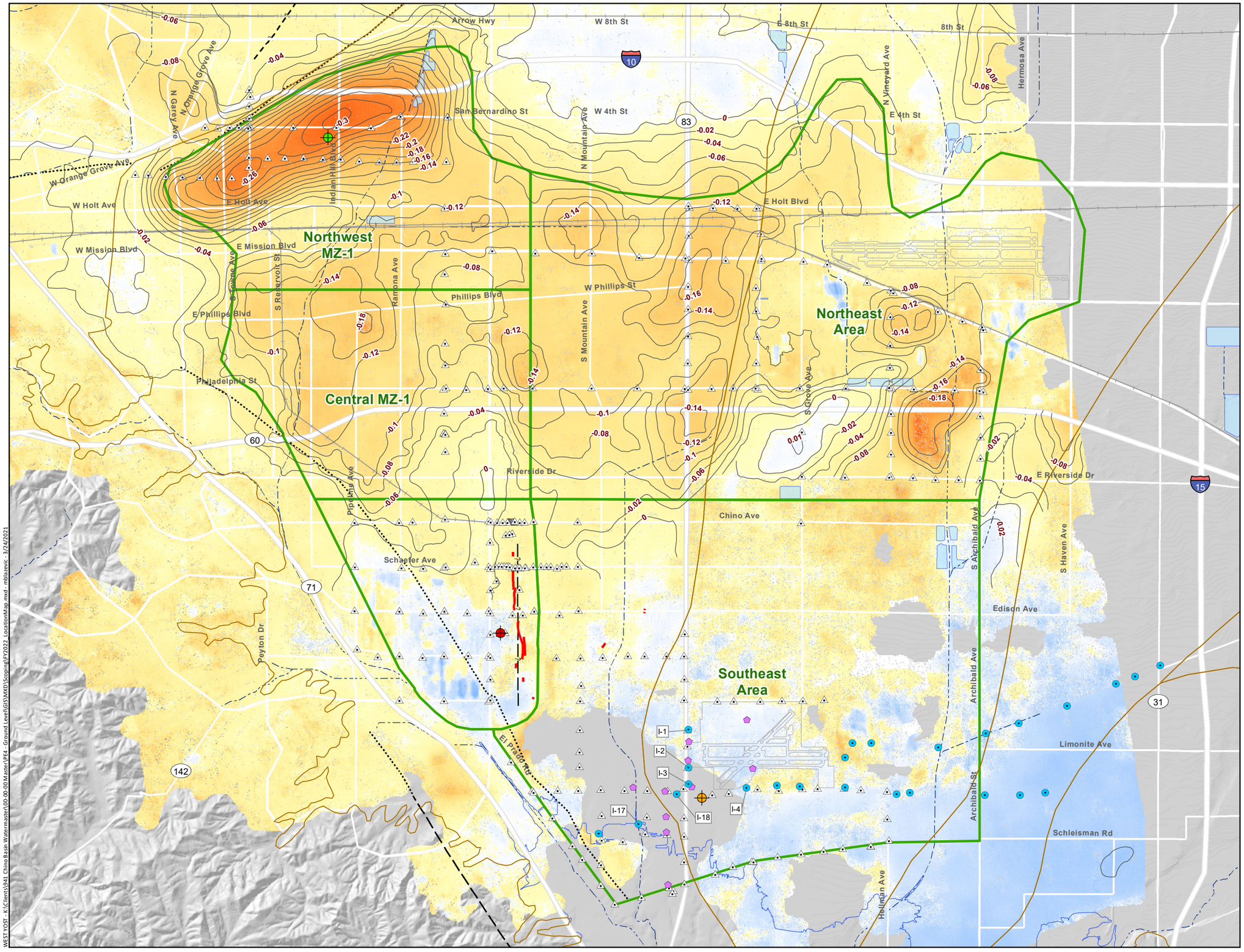
- Task TerraSAR-X for five acquisitions for the western Chino Basin ($12,000)
- Purchase all TerraSAR-X data ($17,000)
- Process the purchased TerraSAR-X data ($56,000)

Task 3.2. Check and Review InSAR Results

In this subtask, the Watermaster Engineer reviews the InSAR results with General Atomics and performs checks for reasonableness and accuracy of the InSAR estimates of vertical ground motion across the western Chino Basin.

Task 4. Perform Ground-Level Surveys

This task involves conducting elevation surveys at benchmark monuments across defined areas of western Chino Basin to estimate the vertical ground motion that occurred since the prior survey. Figure 1 shows the location of the benchmark monuments surveyed across the western Chino Basin. Electronic distance measurements (EDM surveys) are also performed between benchmark monuments to estimate horizontal ground motion in areas where ground fissuring due to differential land subsidence is a concern.



N

0 1 2

Miles

Relative Change in Land Surface Altitude as Estimated by InSAR (March 2011 to March 2020)

+ 0.35 ft

0 ft

-0.20

- 0.35 ft

InSAR absent or incoherent

- Areas of Subsidence Concern
- Pomona Extensometer Facility
- Ayala Park Extensometer Facility
- Chino Creek Extensometer Facility
- Chino Desalter Authority Well
- SB County Proposed Extraction Well
- Ground-Level Survey Benchmark
- Ground Fissures
- Approximate Location of the Riley Barrier

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Figure 1

Ground-Level Monitoring Program
Fiscal Year 2021/22

Chino Basin Watermaster
Ground-Level Monitoring Committee

Table 2 documents the areas surveyed over the last five years as part of the GLMP.

Table 2. Ground Level Monitoring Program Ground-Level Survey History Over the Last Six Years

Ground-Level Survey Area	Ground-Level Survey Completed (Y/N)?					
	2016	2017	2018	2019	2020	2021[b]
Managed Area	Y	N	Y	N	N	N
Fissure Zone Area[a]	Y	N	Y	N	N	N
Central Area	N	N	N	N	N	N
Northwest Area	Y	Y	Y	Y	Y	Y
San Jose Fault Zone Area[a]	Y	Y	Y	Y	Y	Y
Southeast Area	Y	Y	Y	N	N	N
Northeast Area	N	N	Y	Y	Y	N

(a) Denotes EDM survey area.
(b) The 2021 ground-level surveys are scheduled to begin in early March 2021.

The ground-level survey efforts recommended for FY 2021/22 include the following Tasks.

Task 4.1. Conduct Spring-2022 Elevation surveys in Northwest MZ-1

In this subtask, the surveyor conducts elevation and EDM surveys at the established benchmarks in Northwest MZ-1 in Spring 2022. The elevation survey will begin at the Pomona Extensometer Facility and includes benchmarks across Northwest MZ-1. The elevation survey will be referenced to a newly established elevation datum at the Pomona Extensometer.

The vertical elevation survey is recommended in FY 2021/22 because of the recent subsidence that has occurred in Northwest MZ-1 and will support the development of a subsidence management plan in Northwest MZ-1. The EDM survey is ***not*** *recommended to be performed across the San Jose fault zone because the surveys have demonstrated since 2013 that the horizontal strain measured between benchmark pairs appears to behave elastically.*

Task 4.3. Conduct Spring-2022 Elevation in the Southeast Area

In this subtask, the surveyor conducts elevation surveys at the established benchmarks in the Southeast Area in Spring 2022. The elevation survey will begin at the Ayala Park Extensometer Facility and will include benchmarks throughout the Southeast Area.

The elevation survey in the Southeast Area is recommended because six Chino Creek Desalter wells (I-1 to I-4, I-17, and I-18) are expected to begin pumping in Summer/Fall 2023 and the InSAR data is largely incoherent across this area (see Figure 1).

Task 4.5. Replace Destroyed Benchmarks (if needed)

In this subtask, the surveyor replaces benchmark monuments that have been destroyed since the last survey, if any.

Task 4.6. Process, Check, and Update Database

In this subtask, the Watermaster Engineer receives and catalogs the survey results provided by the surveyor, prepares the data for display as a GIS layer, and performs checks against InSAR and extensometer data for reasonableness and accuracy.

The ground-level surveys efforts **not** recommended for FY 2021/22 include the following Tasks.

Task 4.2. Conduct Spring-2021 Elevation Survey in the Northeast Area

This survey is not recommended for FY 2021/22 because heads have been relatively stable or increasing across most of this area and recent ground motion as measured by InSAR and ground-level surveys has been minor in this area.

Task 4.4. Conduct Spring-2021 Elevation and EDM Surveys in the Managed Area/Fissure Zone Area

This survey is not recommended for FY 2021/22 because over the past several years hydraulic heads at PA-10 and PA-7 have increased to their highest levels since implementation of the GLMP in 2003; and, recent ground motion as measured by InSAR, ground-level surveys, and the Ayala Park Extensometer has been minor in this area.

Task 5. Data Analysis and Reporting

Task 5.1. Prepare Draft 2020/21 Annual Report of the Ground-Level Monitoring Committee

Prepare the text, tables, and figures for a draft 2020/21 Annual Report of the GLMC and submit the report to the GLMC by September 24, 2021 for review and comment.

Task 5.2. Prepare Final 2020/21 Annual Report of the Ground-Level Monitoring Committee

Update the text, tables, and figures based on the comments received from the GLMC and prepare a final *2020/21* Annual Report of the GLMC by October 29, 2021. Responses to comments will be included as an appendix to the final report. The report will be included in the agenda packet for the November 2021 Watermaster meetings for approval.

Also, as part of Task 5, Watermaster's Engineer will work with the GLMC to develop concepts for streamlining the Annual Report of the Ground-Level Monitoring Committee and the reporting process for future years. Watermaster's Engineer will present a recommended approach to streamline the report and reporting process to the GLMC, Watermaster's staff, and Watermaster's legal counsel during the scheduled meetings of the GLMC in FY 2021/22.

Task 5.3. Compile and Analyze Data from the 2021/22 Ground-Level Monitoring Program

In this subtask, monitoring data generated from the GLMP during 2021/22 is checked, mapped, charted, and analyzed as the first step in the preparation of the subsequent annual report. Some of the maps, charts, and tables are shared with the GLMC at its meetings in early 2022 during the development of a recommended scope of services and budget for FY 2022/23.

Task 5.4. Conduct Reconnaissance-Level Subsidence Investigation of the Northeast Area

In the Northeast Area, the long- and short-term InSAR estimates indicate that persistent downward ground motion has occurred in a concentrated area south of the Ontario International Airport between Vineyard Avenue and Archibald Avenue. The western edge of this subsiding area exhibits a steep subsidence gradient or "differential subsidence." Subsidence may have occurred in this area in response to declining hydraulic heads, but there is not enough historical hydraulic head data in this area to confirm this relationship. This task will include data collection, review, and analysis of available borehole and lithologic data, pumping and recharge data, high-frequency hydraulic head measurements, and InSAR estimates of vertical ground motion at up to four locations in the southeast part of the Northeast Area. Figures and charts will be prepared to support the data analysis, interpretations, and any recommendations for future investigations and monitoring.

Task 6. Develop a Subsidence-Management Plan for Northwest MZ-1

The 2007 SMP called for ongoing monitoring and data analysis of the Managed Area; including annual reporting and adjustments to the SMP, as warranted by the data. The 2007 SMP also called for expanded monitoring of the aquifer-system and land subsidence in other areas of subsidence and ground fissuring concern. Figure 1 shows the location of these so-called Areas of Subsidence Concern: Central MZ-1, Northwest MZ-1, Northeast Area, and Southeast Area. The expanded monitoring efforts outside of the Managed Area are consistent with the requirements of OBMP Program Element 1 and its implementation plan contained in the Peace Agreement.[1]

The 2007 SMP stated that if data from existing monitoring efforts in the Areas of Subsidence Concern indicate the potential for adverse impacts due to subsidence, the Watermaster would revise the SMP to avoid those adverse impacts. The 2014 Annual Report of the GLMC recommended that the 2007 SMP be updated to better describe the Watermaster's land subsidence efforts and obligations, including areas outside of MZ-1. As such, the update included a name change to the 2015 Chino Basin Subsidence Management Plan (2015 SMP) and a recommendation to develop a subsidence management plan for Northwest MZ 1.

The Watermaster had been monitoring vertical ground motion in Northwest MZ-1 via InSAR during the development of the 2007 SMP. Land subsidence in Northwest MZ-1 was first identified as a concern in 2006 in the MZ-1 Summary Report and again in 2007 in the 2007 SMP. Of particular concern was the occurrence of concentrated differential subsidence across the San Jose Fault in Northwest MZ-1—the same pattern of differential subsidence that occurred in the Managed Area during the time of ground fissuring. Ground fissuring is the main subsidence-related threat to infrastructure. The issue of differential subsidence, and the potential for ground fissuring in Northwest MZ-1, has been discussed at prior GLMC meetings, and the subsidence has been documented and described as a concern in the Watermaster's State of the Basin Reports, the annual reports of the GLMC, and in the *Initial Hydrologic Conceptual Model and Monitoring and Testing Program for the Northwest MZ-1 Area* (WEI, 2017). The Watermaster increased monitoring efforts in Northwest MZ-1 beginning in FY 2012/13 to include ground elevation surveys and electronic distance measurements (EDM) to monitor ground motion and the potential for fissuring.

[1] http://www.cbwm.org/rep_legal.htm.

In 2015, the Watermaster's Engineer developed the *Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area* (Work Plan; WEI 2015b).[2] The Work Plan is characterized as an ongoing Watermaster effort and includes a description of a multi-year scope-of-work, a cost estimate, and an implementation schedule. The Work Plan was included in the 2015 SMP as Appendix B. Implementation of the Work Plan began in July 2015. On an annual basis, the GLMC analyzes the data and information generated by the implementation of the Work Plan. The results and interpretations generated from the analysis are documented in the annual report of the GLMC and used to prepare recommendations for future activities.

The following tasks are recommended for in FY 2021/22 to implement the Work Plan:

Task 6.1. Aquifer-System Monitoring

The established monitoring program of piezometric levels and pumping at wells in Northwest MZ-1 will continue through various techniques, including: 1) SCADA-based monitoring by the Monte Vista Water District; 2) monitoring of piezometric levels via sonar[3]; 3) monitoring of piezometric levels via pressure transducers at City of Pomona production wells; and 4) manual measurements of piezometric levels. These data, along with data collected from the PX in Task 2.1, will improve the understanding of the hydrogeology in Northwest MZ-1, will be used to develop the Subsidence Management Plan for Northwest MZ-1, and in the future, will be used to adapt the Subsidence Management Plan, as appropriate.

In this subtask, all data is collected, compiled, checked, and analyzed every three months. Charts and data graphics of pumping, piezometric levels, and aquifer-system deformation will be updated to support the data collection and analysis.

Task 6.3. Document the One-Dimensional (1D) Compaction Models at the MVWD-28 and PX Locations

This task will help answer the question: What are the *pre-consolidation stresses* within the compacting intervals of the aquifer-system?

The *pre-consolidation stress* is a piezometric "threshold." When piezometric levels are above the threshold, subsidence is abated. When piezometric levels are below the threshold, subsidence is caused. The determination of *pre-consolidation stress* by aquifer-system layer can provide "guidance" for the Chino Basin parties to manage pumping and recharge to avoid the future occurrence of land subsidence in Northwest MZ-1.

The model calibration results for two 1D compaction models located within the area of maximum subsidence in Northwest MZ-1 (at the MVWD-28 and PX sites) will be used, in combination with other monitoring data, to estimate the current (2018) pre-consolidation stresses by aquifer-system layer for Northwest MZ-1. The 1D compaction models, the calibration results, and the preliminary estimates of the pre-consolidation stress by aquifer-system layer will be presented by the Watermaster Engineer at a GLMC meeting. The Watermaster Engineer will accept verbal feedback and written comments from the GLMC, and then prepare a draft technical memorandum (TM) to document 1D compaction models, the calibration results, and the preliminary estimates of the pre-consolidation stress. Another GLMC meeting will be held to review the draft TM. The GLMC will submit written comments and suggested revisions to the

[2] Work Plan to Develop a Subsidence-Management Plan for Northwest MZ-1

[3] The use of sonar technology to measure piezometric levels in wells in currently being used in Monte Vista Water District wells 28 and 31.

Watermaster Engineer. A final TM will be prepared that incorporates the feedback and comments from the GLMC.

Task 6.4. Refine and Evaluate the Subsidence-Management Alternatives

This task will help answer the question: What are potential methods to manage the land subsidence in Northwest MZ-1?

The 1D compaction models at MVWD-28 and PX will be used to characterize the mechanical response of the aquifer-system to a Baseline Management Alternative (BMA). A draft TM will be prepared that summarizes the evaluation of the BMA, particularly, the ability of the BMA to raise and hold piezometric levels above the estimated pre-consolidation stresses. The draft TM may also include a recommendation for the Initial Subsidence Management Alternative (ISMA) if the BMA is not successful at raising and holding hydraulic heads above the estimated pre-consolidation stresses. The assumptions of the ISMA, including the groundwater production and replenishment plans of the Chino Basin parties, will be described and must be agreed upon by the GLMC. A GLMC meeting will be held to review the model results and evaluation of the BMA, review the recommended ISMA, and to receive feedback on the draft TM.

After the recommended ISMA is agreed upon by the GLMC, the Watermaster's MODFLOW model will be updated to run the ISMA and will be used to estimate the hydraulic head response to the ISMA at the MVWD-28 and PX locations. The projected hydraulic heads generated from the MODFLOW model using the ISMA will be extracted from the MODFLOW model results at the MVWD-28 and PX locations and will be used as input files for both 1D compaction models. The 1D compaction models will then be run to characterize the mechanical response of the aquifer-system to the ISMA at both the MVWD-28 and PX locations.

A draft TM will be prepared that summarizes the evaluation of the ISMA, particularly, the ability of the ISMA to raise and hold piezometric levels above the estimated pre-consolidation stresses. The draft TM may also include a recommendation for a second Subsidence-Management Alternative (SMA-2), if the ISMA is not successful at raising and holding hydraulic heads above the estimated pre-consolidation stresses. The assumptions of the SMA-2, including the groundwater production and replenishment plans of the Chino Basin parties, will be described, and must be agreed upon by the GLMC. A GLMC meeting will be held to review the model results and evaluation of the ISMA, review the recommended SMA-2, and to receive feedback on the TM.

If necessary and recommended by the GLMC, additional subsidence management alternative scenarios may be run in FY 2022/23. It is currently envisioned by the GLMC that, based on the results of the 1D compaction model results, the GLMC may recommend an update to the Watermaster's Subsidence Management Plan in FY 2022/23 to minimize or abate the future occurrence of land subsidence in Northwest MZ-1.

Task 7. Meetings and Administration

Task 7.1. Prepare for and Conduct Four Meetings of the Ground-Level Monitoring Committee

This subtask includes preparing for and conducting four meetings of the GLMC:

- July 2021 – Implementation of the GLMP for FY 2021/22
- September 2021 – Review the draft 2020/21 Annual Report of the Ground-Level Monitoring Committee

- February 2022 – Review the draft recommended scope and budget for FY 2022/23
- March 2022 – Review the final recommended scope and budget for FY 2022/23 (if needed)

Task 7.2. Prepare for and Conduct One As-Requested Ad-Hoc Meeting

This subtask includes preparing for and conducting one ad-hoc meeting of the GLMC, as requested by the GLMC or Watermaster staff.

Task 7.3. Perform Monthly Project Management

This subtask includes monthly project administration and management, including staffing, financial and schedule reporting to Watermaster and subcontractor coordination.

Task 7.4. Prepare a Recommended Scope and Budget for the GLMC for FY 2022/23

This subtask includes preparing a draft and final recommended scope of services and budget for FY 2022/23 for the GLMC to support the Watermaster's budgeting process.

Response to GLMC Comments

The comments received from the GLMC as of April 19, 2021 on the, "Recommended Scope of Services and Budget of the Ground-Level Monitoring Committee for Fiscal Year 2021/22" and the Watermaster Engineer's response to comments is documented below.

City of Ontario by Christopher T. Quach

Comment 1 – Scope and Services and Budget (Task 5, Sub-task 5.4)

Ontario is in support of Task 5.4 to begin the subsidence investigation. We agree this seems like the correct initial approach to get ahead of it in relation to the proposed cost and nature of the investigatory work.

Response:

No change has been made to the scope of services or budget.

Comment 2 – Overall Scope and Services and Budget

We currently don't have any other comments on the rest of the proposed budget.

Response:

No change has been made to the scope of services or budget.

City of Chino by Dave Crosley

Comment 1 – Scope and Services and Budget (Tasks 1 through 5 and Task 7)

Chino concurs with recommendations in the GLMP scope and budget for items identified as Tasks 1 through 5 and Task 7. For Task 3, Chino supports acquiring and processing the TerraSAR-X data to continue with the higher level of accuracy these data provide. As Watermaster continues to prove the value of InSAR data for evaluating ground movements, we recommend further evaluation of potential cost savings as certain ground level surveys can be reliably replaced in the future by InSAR. The accuracy of InSAR compared to ground level surveys and the offset in costs should be documented to further support the use of InSAR.

Response:

No change has been made to the scope of services or budget.

Comment 2 –Scope and Services and Budget (Task 6, Sub-task 6.3)

For Task 6, Subtask 6.3, Chino recommends proceeding with use of 1D compaction models at the PX facility and MVWD-28 along with the Chino Basin MODFLOW model for use in developing the subsidence management plan for Northwest MZ-1. It is our opinion that the higher vertical resolution that can be simulated by the 1D compaction models will provide added benefit in the hydrogeologic understanding between aquifer and aquitard responses to changes in groundwater levels within the various aquifers compared to a 3D model where these zones would be averaged over greater aquifer thicknesses. The 1D model simulating the PX facility location will be the most reliable for subsidence management based on the detailed hydrogeologic data that has been collected at this location along with the facility's ongoing ground level monitoring. Establishing a guidance level at this location, where greatest subsidence has been measured by InSAR, should be representative for Northwest MZ-1 just as the guidance level that was developed for the Ayala Park extensometer facility has proven successful for the Managed Area. The extrapolation of hydrogeologic data and associated uncertainties that would be associated with the construction and use of a 3D model has the potential to lose the accuracy needed to successfully simulate aquitard compaction across the entire soil column for groundwater level management planning. It is our opinion that the added cost to develop a 3D subsidence model for Northwest MZ-1 is not warranted at this time.

Response:

The recommended scope of services and budget for sub-task 6.3 has been updated based on the City of Chino's comments and feedback received from the April 1, 2021 meeting GLMC.

Comment 3 – Overall Scope and Services and Budget (Task 6, Sub-task 6.4)

We understand that the scope of Subtask 6.4 is to refine and evaluate possible subsidence management alternatives. There are 20 identified tasks for this scope. While it is not clear how many of these 20 identified tasks can be completed or will be necessary in the next fiscal year, Chino recommends only budgeting through Subtask 6.4.10 at this time. This will bring the evaluation through the development of Subsidence Management Alternative 2 (SMA-2). Evaluation of additional alternatives may be pre-mature at this time as the PX continues to operate and our knowledge of the ground response to groundwater levels continues to improve. Following completion of SMA-2 activities and evaluation by the GLMC, future possible alternatives could be devised for modeling and implementation for future fiscal years.

Response:

The recommended scope of services and budget for sub-task 6.4 has been updated based on the City of Chino's comments.

City of Pomona and Monte Vista Water District by Christopher Coppinger

Comment 1 – Task 1.1. Maintain Extensometer Facilities

Geoscience agrees that site visits for downloads and maintenance should be performed monthly. However, future reports should include fieldnotes or "run sheets" as an appendix to the annual report. It is not clear what maintenance is expected or has been performed in the past. Maintenance requirements may provide data on inherent error in the method and instruments.

Response:

Section 2.1.1 in the Annual Reports of the GLMC list specific maintenance activities performed at the Ayala Park, Chino Creek, and Pomona Extensometer facilities for the reporting year.

Inclusion of field notes as an appendix to the Annual Report should be discussed and recommended by the GLMC.

Comment 2 – Task 2.1. Conduct Quarterly Data Collection from Extensometers; Data Checking and Management

The data download task should overlap with monthly maintenance. Downloads should be occurring with planned site visits.

The cost for task 2.1.4 has increased from the previous year. During the GLMC meetings, WY indicated these increases represented the effort to import extensometer data into the WM database. Access to raw data would allow full review of cost and allow determination of inherent error. Stakeholders should be provided access to the database if they are funding collection of the data and construction of the database.

Response:

Site visits for data download and routine maintenance are performed together. Every effort is made to make field work efficient.

Consistent with the long-standing policy of the Watermaster and the GLMC, all data collected for the GLMP are available to any Party via a Request for Information to the Watermaster.[4]

Comment 3 – Task 3. Basin-Wide Ground-Level Monitoring Program (InSAR)

During the GLMC meetings, Geoscience indicated the review of TerraSAR-X and Sentinel-1A datasets did not support the additional cost of TerraSAR-X data collection. The free TRE Altamira data set showed similar trends as the TerraSAR-X, had better spatial coverage of the Chino Basin than TerraSAR-X, and includes monthly data collection. Additionally, DWR processing and review of the Tre Altamira data set provides additional quality control for the InSAR data.

Since the March GLMC meetings, DWR has modified the SGMA data portal. These modifications have made the Sentinel-1A dataset less accessible. If the Sentinel-1A dataset cannot be reliably obtained, Geoscience recommends continuing InSAR collection as proposed by WY. General Atomic's deliverables should be included in the annual reports as appendices.

Data accessibility should be reviewed next fiscal year and the Sentinel-1A/Tre Altamira dataset adopted once DWR has finalized the data distribution platform.

Response:

Comments noted. The recommendation in this memorandum for the GLMP in FY 2021/22 is to acquire and utilize the TerraSAR-X InSAR estimates of vertical ground motion as provided by General Atomics. The

[4] http://www.cbwm.org/docs/forms/20120229%20Request%20For%20Information%20Form--PDF%20Form%20Version.pdf

acquisition and use of alternative InSAR datasets in the future can be discussed and recommended by the GLMC in FY 2021/22.

Inclusion of General Atomic's InSAR deliverables as an appendix to the Annual Report should be discussed and recommended by the GLMC. Consistent with the long-standing policy of the Watermaster and the GLMC, all data collected for the GLMP are available to any Party via a Request for Information to the Watermaster.

Comment 4 – Task 4. Perform Ground-Level Surveys

Geoscience recommends that all survey deliverables are included as attachments to provide measurement errors and access to data that stakeholders are paying for.

Geoscience agrees with the recommendations in Tasks 4.1 through 4.5. Task 4.6 includes data processing of the survey deliverables.

Response:

Inclusion of survey deliverables as an appendix to the Annual Report should be discussed and recommended by the GLMC. Consistent with the long-standing policy of the Watermaster and the GLMC, all data collected for the GLMP are available to any Party via a Request for Information to the Watermaster.

Comment 5 – Task 4.6. Process, Check, and Update Database

The person days and subsequent cost seem high for this task. Are surveyors able to provide deliverables in a format that would reduce the level of effort? What data processing is required once the survey deliverables are received?

Response:

The level of effort to conduct the GLMP and the associated cost estimates for time and materials are based on several years of experience in conducting the GLMP. The cost estimates represent conservative, best estimates for time and materials to complete each task.

The surveyors provide the survey deliverables in industry-standard electronic formats.

Once the survey deliverables are received, the following activities are executed to process, check, and update the database:

- Reviewing the surveyor's summary report and results.
- Updating and reviewing the time-series of ground-level elevations by benchmark.
- Corresponding with the surveyor to discuss the results, questions, and other information related to the ground-level survey results.
- Preparing GIS shapefiles showing the benchmark location and ground-level elevation change for various time-periods.
- Comparing the benchmark ground-level elevation change for various time-periods against the InSAR results for the same time-periods to check for reasonableness.

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Comment 6 – Task 5.3. Compile and Analyze Data from the 2021/22 Ground-Level Monitoring Program

Data compilation is included in each of the data collection tasks. What additional effort is included with this task?

Response:

In this task, the data is exported from the databases and is mapped, charted, reviewed, and analyzed. The information is used to prepare the figures and tables included in the Annual Report. The level of effort and the associated costs are based on several years of experience. The cost estimates represent conservative, best estimates for time and materials to complete the task.

Comment 7 – Task 5.4. Conduct Reconnaissance-Level Subsidence Investigation of the Northeast Area

The data presented does not yet rise to the level of requiring an additional investigation. In prior years, InSAR was incoherent in large parts of the eastern half of the basin. We recommend an additional year of monitoring InSAR data to confirm the trend before committing to further investigation.

Response:

Comment noted. Please see the comments received from the City of Ontario and City of Chino and the responses regarding Task 5.4.

This task has been approved by the Watermaster Board for completion in FY 2021/22.

Comment 8 – Task 6.1. Aquifer System Monitoring

Task 6.1 appears to overlap with data collection efforts in Task 5. The prior year budget should cover data collection and analysis in FY 2020/21, the current proposal should cover FY 2021/22. What additional scope would be included in Task 6.1? Data collection from PX has been included in new maintenance and download tasks.

Response:

There are no "data collection" efforts in Task 5. The data collection efforts proposed in Task 6.1 are specific to wells in the Northwest MZ-1 area. In addition, the data collection efforts proposed in Task 6.1 do not include data collection at the PX, which is included in Task 2.1.

We have revised the text for Task 6.1 for clarity.

Comment 9 – Task 6.3. Document the One-Dimensional (1D) Compaction Models at the MVWD-28 and PX Locations

Geoscience has previously expressed concern with use of 1D models to simulate delayed subsidence (See November 2017 TM entitled *Review of "Task 3 and Task 4 of the Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area: Development and Evaluation of Baseline and Initial Subsidence – Management Alternatives" Draft Technical Memorandum by Wildermuth Environmental,*

Inc., Dated October 19, 2017). The 1D model of PX utilizes groundwater elevations exported from the five-layer Chino Basin model and subsidence estimated from InSAR data.

Based on the data provided in the March and April meetings, Geoscience recommends limiting the scope of Task 6.3 to documenting the 1D models that have been already prepared. The 1D models should not be utilized for further efforts until documentation has been provided to stakeholders.

Response:

The intent of Task 6.3 is to document the construction and calibration of the 1D compaction models in a technical memorandum. The model calibration results also include estimates of the *pre-consolidation stress* for each model cell. It is appropriate and efficient to describe these model calibration results, in their entirety, to facilitate understanding and discussion within the GLMC on the pre-consolidation stresses in Northwest MZ-1. The technical memorandum for Task 6.3 will go through the standard review and comment process of the GLMC before starting Task 6.4.

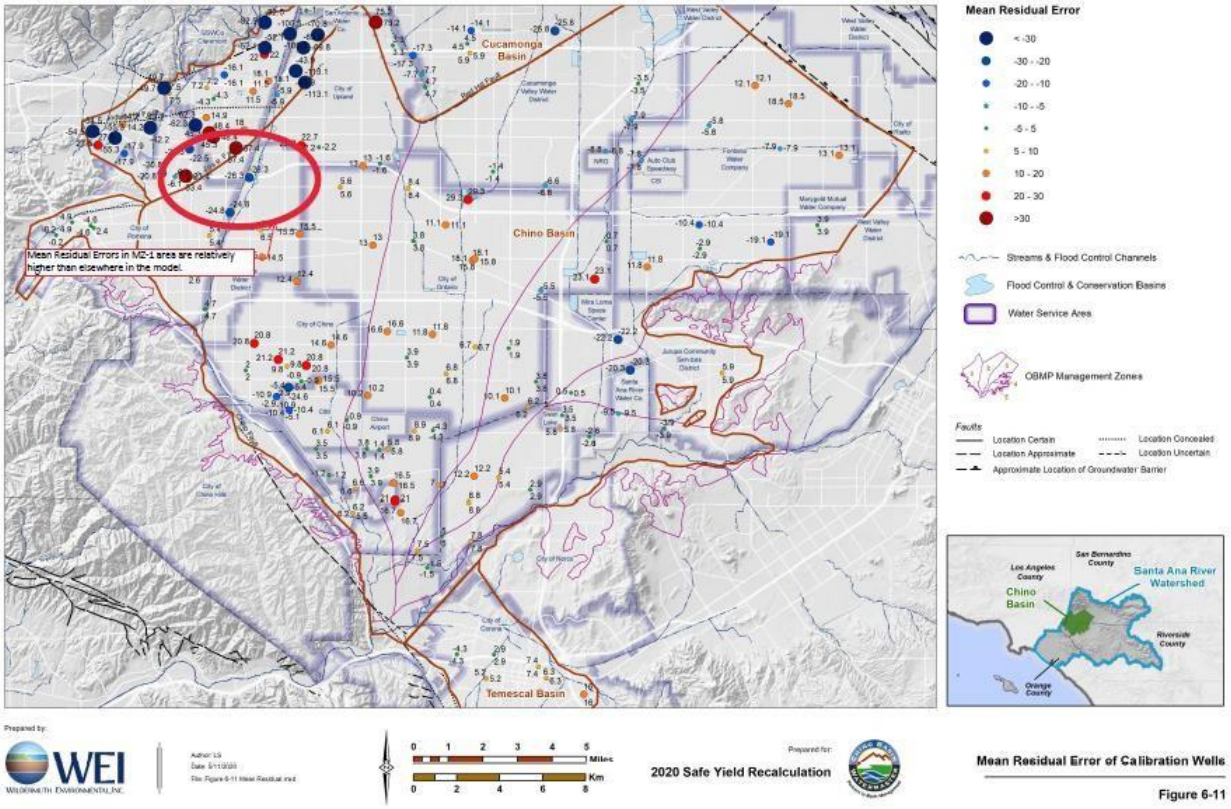
Comment 10 – Groundwater Elevation

Comments to the 2020 Safe Yield update identified a spatial bias in calibration at the Six Basins/Chino Basin Boundary. At the time, WEI indicated that wells in the area are perforated across multiple layers and that estimated water level would be influenced by head in all layers.

Figure 6-11 “Mean Residual Error of Calibration Wells” from the 2020 Safe Yield Recalculation is reproduced below. The Northwest MZ-1 area shows a high mean residual error relative to other parts of the basin.

The PX facility and the planned extended pumping test will provide layer specific groundwater elevation data. Additional calibration efforts or updates to the conceptual model may be required if predicted water levels in the deep PX completions are not consistent with MODFLOW model predicted water level and model predicted changes in water level.

The TM should provide data on the sensitivity of estimated pre-consolidation stress and other model based subsidence estimates to variation in layer specific model-simulated heads.



Response:

In our professional opinion, the Chino Valley Model (CVM) is sufficiently calibrated to be used as input data for the calibration of the 1D models. The CVM exhibits "very good" calibration across the Chino Basin and reproduces the behavior of historical groundwater levels. In Northwest MZ-1, the mean residual errors at wells are higher compared to some other areas of the basin, but are the same as in other areas, and have been deemed acceptable in model calibration and for the use of the model in the Safe Yield Reset. We recently performed an exercise of model validation in Northwest MZ-1 by comparing recently measured heads at the depth-specific PX piezometers (2019-2020) versus model-generated heads by model layer at the PX site at the end of the calibration period (2018).

The head data that is being collected at the PX piezometers will be valuable data for the future recalibrations of the CVM and the 1D model. However, we advise that those recalibration efforts and expenses are best planned for 5-10 years from now, when the data set is long enough to justify the recalibrations.

Sensitivity analyses for the 1D compaction models should be discussed by the GLMC and added to the scope of work if agreed upon by the GLMC.

Comment 11 – InSAR-Estimated subsidence and Model-Simulated Aquifer System Deformation

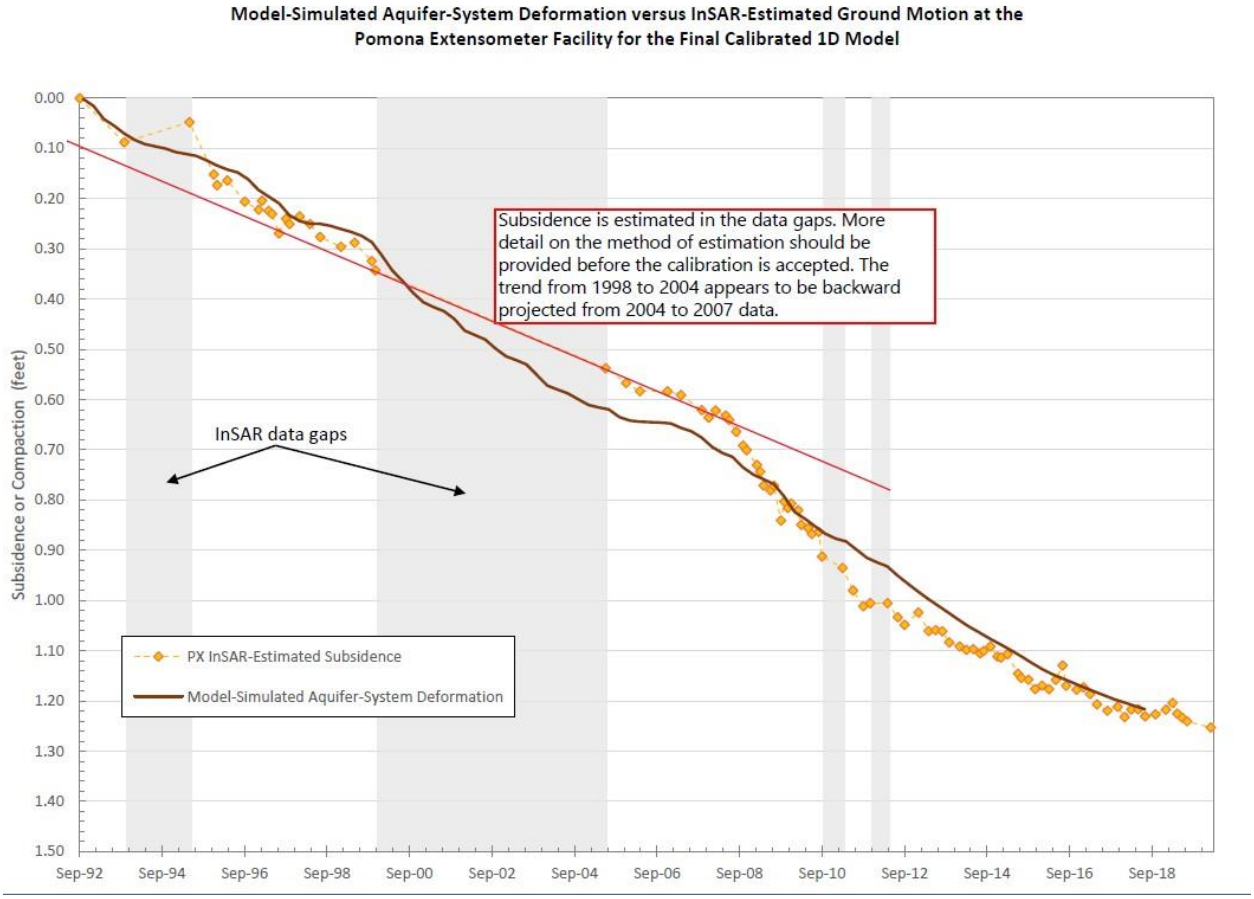
During the March 4 meeting, WY presented InSAR-Estimated subsidence and Model-Simulated Aquifer System Deformation for the PX 1D model. InSAR data gaps were shown, with the InSAR-Estimated Subsidence projected through the data gaps. WY did not provide the method used to estimate subsidence

in the data gap. Additional detail on the method should be provided before the calibration is accepted. The prediction trend appears to be backward projected from September 2004 to late 2007 levels.

If possible, the InSAR data should be compared to land level survey data. GLMC was not conducting ground level surveys in Northwest MZ-1 throughout the 1992 through 2018 period. However, there are Los Angeles County Department of Public Works Survey Division (LADPW) leveling circuits near the PX facility, with the closest benchmark approximately 700 ft away. The LADPW surveys are not conducted to the same accuracy as the GLMC leveling surveys, but the historical data may provide an additional check to InSAR estimated subsidence.

The Model-Simulated deformation vs InSAR-Estimated ground motion figure is reproduced below.

The Model-Simulated deformation vs InSAR-Estimated ground motion figure is reproduced



Response:

The GSSI comments and questions are not related to the recommended scope of work, but are intended for consideration in constructing, calibrating, and documenting the 1D compaction models at the MVWD-28 and PX locations. The comments are noted.

A description of the methods used to account for gaps in the InSAR record will be included in the technical memorandum for Task 6.3.

The *Task 3 and Task 4 of the Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area: Development and Evaluation of Baseline and Initial Subsidence – Management Alternatives,* describes the effort by WSP USA (former surveyor for the GLMP) to validate the InSAR-derived estimates of vertical ground motion in Northwest MZ-1 using historical ground-elevation data from repeated leveling surveys performed by the National Geodetic Survey (NGS) and the Metropolitan Water District of Southern California (MWD). At the time of the investigation, the NGS and MWD survey data were the most accurate and best available historical estimates of vertical ground motion in Northwest MZ-1. These estimates were also used to check the reasonableness of the 1D compaction model at MVWD-28, which utilized the InSAR-derived estimates of vertical ground motion at one specific location as calibration targets.

The use of the LADPW survey data referenced by Geoscience should be discussed by the GLMC and added to the scope of work if agreed upon by the GLMC.

Comment 12 – Task 6.4. Refine and Evaluate the Subsidence-Management Alternatives

WY proposes using the 1D compaction models to update the Baseline Management Alternative (BMA) and Initial Subsidence Management Alternatives developed in Task 3 and Task 4 of the 2015 work plan.

The 2015 workplan anticipated construction of the PX-1 Facility in FY 2016-17, updates to the conceptual model, and updates to the groundwater model before BMA is revaluated.

Construction of PX-1 was significantly delayed. Development of the deep completions took place in February and March of 2019 according to the Draft Well Completion report (WEI 2020). At the time of this memo, details of the installation of instruments and final completion of the extensometer facility are not available on Watermaster's website. Data presented during the March 4 meeting suggests transducer data has been loaded into Watermaster's database since at least December 2020.

Geoscience recommends that the committee consider the planned data collection and long-term pumping test before the conceptual model is revisited. Significant effort was expended to install a monitoring system in Northwest MZ-1. Data should be collected from the monitoring system to inform the modeling effort.

The 2015 schedule is reproduced below.

Table 4-1
Schedule
Work Plan to Develop a Subsidence-Management Plan for the North MZ-1 Area

Task Descriptions	FY2015-16				FY2016-17				FY2017-18				FY2018-19				FY2019-20			
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Task 1 – Describe Initial Hydrogeologic Conceptual Model & the Monitoring and Testing Program																				
1.1 Describe the information and knowledge needed to manage subsidence																				
1.3 Describe current state of knowledge with tables and figures																				
1.4 Describe the gaps in data and knowledge																				
1.5 Describe the potential locations and general design of the Pomona Extensometer facility (PX)																				
1.6 Describe the proposed monitoring and testing program																				
1.7 Prepare Task 1 memorandum – *Initial Hydrogeologic Conceptual Model and ...*																				
Task 2 – Implement the Initial Monitoring Program																				
2.1 Canvass all wells in the North MZ-1 Area																				
2.2 Establish monitoring and reporting strategies with producers																				
2.3 Install transducers in all wells not currently equipped with transducers																				
2.4 Perform one quarter of passive monitoring																				
2.5 Conduct short-term controlled pumping tests; analyze data																				
2.6 Prepare Task 2 memorandum – *Results of Initial Monitoring and Testing Program*																				
Task 3 – Develop and Evaluate the Baseline Management Alternative																				
3.1 Obtain concurrence on the Baseline Management Alternative (BMA)																				
3.2 Characterize and evaluate the basin response to the BMA (no subsidence management)																				
3.3 Estimate future subsidence in the North MZ-1 Area																				
3.4 Catalog property and infrastructure potentially impacted by subsidence and fissuring																				
3.5 Determine if damages due to subsidence are insurable and estimate cost for insurance policy																				
3.6 Prepare Task 3 memorandum – *Evaluation of the Baseline Management Alternative*																				
Task 4 – Develop and Evaluate the Initial Subsidence-Management Alternative																				
4.1 Estimate pre-consolidation stress in the North MZ-1 Area																				
4.2 Describe the Initial Subsidence-Management Alternative (ISMA)																				
4.3 Characterize and evaluate the basin response to the ISMA																				
4.4 Prepare Task 4 memorandum – *Evaluation of the Initial Subsidence-Management Alternative*																				
Task 5 – Design and Install the Pomona Extensometer Facility																				
5.1 Identify alternative sites for the Pomona Extensometer facility (PX)																				
5.2 Acquire construction and permanent easements																				
5.3 Prepare plans and technical specifications for bid package																				
5.4 Provide support for bidding process																				
5.5 Provide construction oversight to install the PX																				
5.6 Install transducers, data loggers, and telemetry; perform testing																				
5.7 Prepare Task 5 memorandum – *Completion Report for the Pomona Extensometer Facility*																				
Task 6 –Design and Conduct One-Year Aquifer-System Stress Tests																				
6.1 Describe the implementation plan for a one-year test of the ISMA																				
6.2 Collect and analyze data (monthly)																				
6.3 Prepare quarterly summaries of the data collection and analytical results																				
Task 7 – Update Hydrogeologic Conceptual Model																				
7.1 Construct and calibrate one-dimensional compaction model at the PX																				
7.2 Update hydrogeologic conceptual model based on testing and modeling results																				
7.3 Prepare Task 7 memorandum – *Updated Hydrogeologic Conceptual Model of the North MZ-1 Area*																				
Task 8 – Update Chino Basin Groundwater Model																				
8.1 Update groundwater model based on the Task 7 Memorandum																				
8.2 Add SUB package to groundwater model																				
8.3 Prepare Task 8 memorandum – *Updated Chino Basin Groundwater Model with SUB Package*																				
Task 9 – Refine and Evaluate Subsidence-Management Alternatives																				
9.1 Re-evaluate the BMA and ISMA																				
9.2 Develop a new subsidence-management alternative (SMA-2)																				
9.3 Characterize and evaluate the basin response to the SMA-2																				
9.4 Characterize and evaluate the basin response to the SMA-3 and SMA-4																				
9.5 Select preferred subsidence-management alternative for the North MZ-1 Area																				
9.6 Prepare Task 9 memorandum – *Subsidence Management Plan for the North MZ-1 Area*																				
Task 10 – Update the Chino Basin Subsidence Management Plan																				
10.1 Describe implementation plan for the Subsidence-Management Plan (SMP) for the North MZ-1 Area																				
10.2 Prepare Task 10 memorandum – *Updated Chino Basin Subsidence Management Plan*																				
10.3 LSC recommends the updated Chino Basin Subsidence Management Plan (CBSMP)																				
10.4 Review the updated CBSMP with Watermaster in the monthly process meetings																				
Task 11 – Meetings and Administration (Annual)																				
11.1 Ad Hoc Meetings																				
11.2 Project Administration and Financial Reporting																				
11.3 Scope and Budget for Subsequent Fiscal Year																				

Schedule.xlsx –NorthMZ-1WorkPlan_Schedule
5/5/2015

Land Subsidence Committee

Response:

The 2015 workplan is a planning document that described a step-wise plan to develop subsidence management criteria for Northwest MZ-1. However, the workplan and the Subsidence Management Plan also envisioned that the GLMC would analyze the data generated by the monitoring program each year and recommend the logical next steps for the subsequent year(s). For example, the GLMC is now recommending the use of 1D compaction models instead of the SUB package in MODFLOW to develop and test subsidence management strategies.

In our opinion, the CVM and the 1D compaction models are calibrated and ready to be used to estimate the pre-consolidation stress and provide guidance to the Stakeholders on pumping and recharge strategies to avoid the future occurrence of land subsidence in Northwest MZ-1. Continued data collection is also recommended to support future updates and improvements to the CVM and 1D compaction models.

The most prudent path forward is to:

1. Utilize the 1D models to develop estimates of the pre-consolidation stress in Northwest MZ-1.
2. Utilize the 1D models to test the future pumping and recharge plans of the Parties and estimate the potential for the future occurrence of land subsidence.
3. Develop Guidance Criteria to assist all Stakeholders in their groundwater management and water-supply planning efforts, basin-wide.
4. Update the Chino Basin Subsidence Management Plan based on the above.
5. Continue the monitoring program, including the collection of head and extensometer data at the PX.

6. Utilize the monitoring data in 5-10 years to update the CVM and the 1D models and, potentially, adapt the Guidance Criteria and the Subsidence Management Plan if appropriate.

Comment 13 – Task 7. Meetings and Administration

Geoscience recommends documentation in Task 6.3 be released to allow one of the scheduled meetings to include discussion of the 1D model.

Response:

A draft of the TM for Task 6.3 will be released for review and comment by the GLMC. A GLMC meeting will be held to review the draft TM. A final TM will be prepared that addresses the comments received by the GLMC members. Please see Task 6.3.2 in Table 1 – Work Breakdown Structure and Cost Estimates Ground-Level Monitoring Program: FY 2021/22 (Draft 3).

Comment 14 – Comparison of the Sentinel-1A and TerraSAR-X InSAR datasets across the Chino Basin

WY's review of the Sentinel-1A and TerraSAR-X datasets was provided as an attachment to the FY2021/22 budget. Geoscience has the following comments:

1) In prior versions of the SGMA Data Viewer, it appeared that monthly ground motion displacement was provided by DWR. Was WY able to download these data? Are they consistent with WY calculations?
2) It appears Sentinel-1A data is collected at twice the frequency as TerraSAR-X data. Is this the case? If so, is there benefit to the more frequent data collection? In 2017 communication regarding other basins, NevaRidge staff indicated more frequent data collection reduced error caused by crop growth and other seasonal activity. Is this still the case?
3) The Sentinel-1A data undergoes QC and calibration review by DWR. These efforts are documented and available to stakeholders through the DWR web portal. Is the TerraSAR data subject to the same reviews? Are the reviews available to stakeholders?
4) Sentinel-1A data has significantly higher coherence. Is there benefit to InSAR data at the Chino Creek facility?
5) Direct subtraction of the displacement rasters would allow a more precise comparison than the side-by-side graphic comparisons.
6) Without specifying the accuracies of other sources of data used in this analysis, it is unclear that increased accuracy is necessary. More information is needed to define what accuracy is acceptable and determine if the higher resolution/accuracy of the TerraSAR-X dataset is imperative to identifying risk to infrastructure and calculating better calibration targets for a model.

Geoscience's initial recommendation was to utilize the DWR provided Sentinel-1A data. However, recent changes to the SGMA Data Viewer made the data inaccessible. DWR indicates that the functionality will return shortly. Due to these changes, Geoscience now recommends proceeding with TerraSAR-X data as proposed by WY and reviewing the SGMA data viewer platform in fiscal year 2022/23.

Response:

These comments are noted and can be re-evaluated during the preparation of the *Recommended Scope of Services and Budget of the Ground-Level Monitoring Committee for Fiscal Year 2022/23,* at future GLMC meetings, or at requested ad-hoc meetings with the technical members of the GLMC.

No change has been made to the scope of services or budget (Task 3).

Attachment A

Comparison of the Sentinel-1A and TerraSAR-X InSAR Datasets Across the Chino Basin

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TECHNICAL MEMORANDUM

DATE: February 26, 2021

Project No.: 941-80-20-21
SENT VIA: EMAIL

TO: Ground-Level Monitoring Committee

FROM: Michael Blazevic, PG, CHG

REVIEWED BY: Andy Malone, PG

SUBJECT: Comparison of the Sentinel-1A and TerraSAR-X InSAR Datasets Across the Chino Basin

BACKGROUND AND OBJECTIVES

Since the inception of the Ground Level Monitoring Program (GLMP), the Chino Basin Watermaster (Watermaster) has employed various methods to monitor vertical ground motion via extensometers, traditional ground-level surveys, and the remote-sensing technique of Interferometric Synthetic Aperture Radar (InSAR). Analysis of these data over time has shown that InSAR is increasingly a reliable and accurate method for monitoring vertical ground motion across most of the areas of subsidence concern in the Chino Basin for the following reasons:

- Improvements in satellite technology over time have increased the spatial resolution, temporal resolution, and accuracy of InSAR; and
- Land-use changes from agricultural to urban have added hard, consistent radar wave reflectors to the ground surface over time. As such, InSAR results are now coherent and useful across most of the areas of subsidence concern.

For the GLMP, the InSAR-derived estimates of vertical ground motion across the areas of subsidence concern are used by the GLMC to:

- Provide an aerially continuous estimation of the occurrence and magnitude of vertical ground motion across the western Chino Basin over time. Monitoring of vertical ground motion via InSAR since 2006 across the Chino Basin helped identify land subsidence and the pattern of concentrated differential subsidence across the San Jose Fault in Northwest MZ-1.
- Identify areas of differential subsidence. Differential subsidence is sometimes indicative of the existence of groundwater barriers (i.e., the Riley Barrier in the Managed Area and the San Jose Fault in Northwest MZ-1); hence, the information derived from InSAR has improved the hydrogeologic understanding of the groundwater basin.
- Provide calibration data for the computer-simulation modeling of aquifer-system deformation and land subsidence across the Chino Basin. Specifically, Watermaster's Engineer is updating the Chino Valley Model (CVM) by adding a subsidence package (SUB) to

the MODFLOW model so that it can be used to simulate historical and potential future land subsidence across Northwest MZ-1. The SUB package will be calibrated across Northwest MZ-1 using the InSAR estimates of historical vertical ground motion.

Since 2011, the GLMC has chosen to acquire and use a single Synthetic Aperture Radar (SAR) scene from the TerraSAR-X satellite that covers only the western portion of the Chino Basin. This decision was based on:

- Observations that InSAR-derived estimates of ground motion from 1992-2005 indicated that little if any subsidence had occurred within the eastern portion of the basin; and
- The desire to manage costs for the GLMP. However, it has been shown in the Watermaster's State of the Basin Reports (WEI, 2019)[1] that hydraulic heads have decreased across the central and eastern portions of the Chino Basin since about 2005. Subsidence may have occurred in these areas in response to the declining heads, yet these areas have not been monitored for vertical ground motion since 2009.

There is a new satellite that was launched in 2014 by the European Space Agency, Sentinel-1A, that provides InSAR estimates of vertical ground motion across the state of California, including the entire Chino Basin. InSAR estimates of vertical ground motion from Sentinel-1A are freely available from the California's Department of Water Resources (DWR).[2] As part of the approved scope and budget of the GLMC for FY 2020/21, the GLMC directed the Watermaster Engineer to perform a study comparing the Sentinel-1A and TerraSAR-X InSAR datasets across the Chino Basin. The questions to be answered by the study are:

- Has land subsidence occurred in the eastern portion of Chino Basin during the period 2015 to 2018 as hydraulic heads have declined over this period? If so, what is its magnitude and spatial distribution? Does the GLMC see a concern for land subsidence that would warrant ongoing monitoring of eastern Chino Basin via InSAR?
- Across the western portion of the Chino Basin, how do the estimates of vertical ground motion derived from Sentinel-1A compare with those derived from TerraSAR-X in terms of spatial distribution, magnitude, coherence, and accuracy?
- If the GLMC were to switch to using Sentinel-1A, would the monitoring program be compromised? If so, how?

The purpose of this technical memorandum is to answer these questions and develop recommendations for the GLMC on the potential future uses of the Sentinel-1A and TerraSAR-X InSAR datasets for the GLMP.

METHODS

To answer the questions above, the following methods were used:

[1] West Yost, formerly Wildermuth Environmental, Inc. (2019). Chino Basin Optimum Basin Management Program, 2018 State of the Basin Report.

[2] SGMA Data Viewer (ca.gov)

- Identify, download, and compile the Sentinel-1A moving annual cumulative displacement InSAR rasters for the entire Chino Basin from the DWR over a three-year period between 2015 and 2018.
- Utilize ArcMap's Spatial Analyst extension to extract monthly vertical ground motion displacements from the moving annual cumulative displacement InSAR rasters.
- Compare various aspects of the Sentinel-1A and TerraSAR-X[3] estimates of vertical ground motion – namely the magnitude of vertical ground motion, coherence, and the spatial resolution of ground motion across the Chino Basin.

RESULTS

Sentinel-1A and TerraSAR-X InSAR Processing Procedures

A brief summary of the InSAR processing procedures used by TRE ALTAMIRA and General Atomics (GA) for the Sentinel-1A and TerraSAR-X InSAR data, respectively, was provided by GA (S. Yarborough, personal communication, January 19, 2021):

Sentinel-1A

- SAR data is processed in large polygons across California. One processing polygon covers the entire Chino Basin.
- Ascending and descending satellite track data are combined to estimate differential vertical ground motion from radar line-of-sight (RLoS) measurements for a given time period.
- Differential vertical ground motion estimates are compared with observations from GPS stations located across California using 100 m radius of motion estimates around each station to derive absolute vertical measurements. For reference, one station is located in the Chino Basin near Rancho Cucamonga.
- Absolute vertical ground motion measurements are projected to 100 m x 100 m grids across each processing polygon and interpolated to regular time intervals (1st day of each month). Any voids are filled by spatial interpolation in each processing polygon. Each grid is an average of all measurements within a single 100 m x 100 m grid, located at the grid center.

For a more detailed description of these processes, see TRE ALTAMIRA (2020).[4]

TerraSAR-X

- The approximate InSAR processing footprint extends from Falling Springs (north) to Villa Park (south) and from La Puente (west) to the Ontario International Airport (east).
- Differential vertical ground motion is measured along the RLoS between each radar collection.
- Vertical ground motion offsets resulting from RLoS errors are removed with a combination of interferometric processing, and a reference patch in an observed stable location in the Chino Basin. The current reference patch is a 750 m x 750 m area, centered approximately

[3] The TerraSAR-X InSAR rasters between the time-period 2015 and 2018 were readily available for this study as part of the long-term ground motion monitoring conducted for the GLMP.
[4] TRE ALTAMIRA (2020). *InSAR land surveying and mapping services in support of the DWR SGMA program.*

at the intersection of W. Phillips Blvd and S. White Avenue in Pomona, CA. Any vertical motion in the reference patch is assumed to show the constant offset resulting from RLoS errors, and the average value measured across the patch in each differential vertical motion height map is then removed from the vertical motion height map. The normalized differential height maps are then summed to provide a total displacement over the desired time-period.

- Small voids are filled by spatial interpolation in each InSAR frame, providing continuous high-resolution measurements over areas with intermittent signal loss.
- Sequential measurements are summed, providing a normalized total vertical ground motion estimate for a given time period.
- Normalized RLoS measurements are projected to 15 m x 15 m grids. Each grid is an average of all measurements within a single 15 m x 15 m grid, located at the grid center.

Sentinel-1A and TerraSAR-X InSAR Dataset Information

Table 1 lists the basic dataset description and information for the Sentinel-1A and TerraSAR-X InSAR datasets.

Table 1. Sentinel-1A and TerraSAR-X InSAR Dataset Information

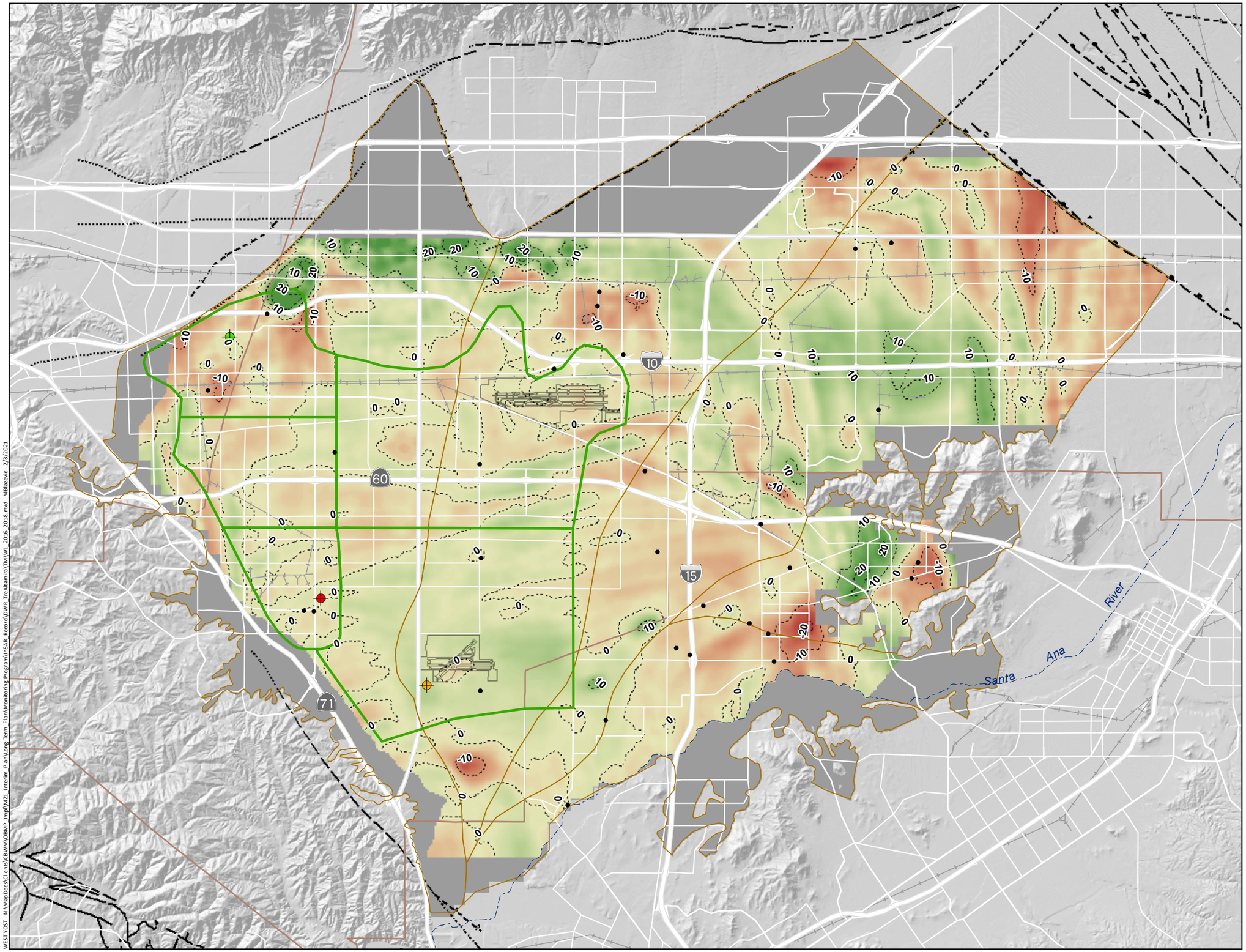
Dataset Description	Sentinel-1A	TerraSAR-X
Processor	TRE ALTAMIRA	General Atomics
Current Availability	June 2015 – September 2019	March 2011 – March 2020
Current Coverage	Entire Chino Basin	Western Chino Basin
Current Acquisition Frequency	Monthly	Every Two Months
Spatial Resolution	100 m	15 m
Accuracy	+/- 1.6 cm	+/- 0.8 cm
Cost	Free	$87,000

Sentinel-1A and TerraSAR-X InSAR Observations

It has been shown in the Watermaster's State of the Basin Reports (WEI, 2019) that hydraulic heads have decreased across the central and eastern portions of the Chino Basin since about 2005. Subsidence may have occurred in these areas in response to the declining heads, yet these areas have not been monitored for vertical ground motion since 2009. For reference, Figure 1 shows the change in groundwater levels for the two-year period between spring 2016 and spring 2018 across the Chino Basin. Groundwater levels have generally remained stable across most of the areas of subsidence concern but have declined up to 10 ft across parts of Northwest MZ-1. East of the areas of subsidence concern, groundwater levels have decreased in the central and northern portions of the basin by about 10 ft.

Figure 2 shows the total vertical ground motion estimated by the Sentinel-1A between June 2015 and May 2018 across the entire Chino Basin. The main observations from Figure 2 are:

- The InSAR coherence is good across the entire Chino Basin.



N

0 1 2

Miles

Groundwater Level Change (ft)
Spring 2016 to Spring 2018

20 ft Increase

0 ft

-20 ft Decrease

Area not Included in the Change Calculation Due to Lack a of Groundwater Level Data

Contour of Groundwater-Level Change (ft)

Well with Groundwater Level Time History

OBMP Management Zones

Areas of Subsidence Concern

Pomona Extensometer Facility

Ayala Park Extensometer Facility

Chino Creek Extensometer Facility

CHINO BASIN WATERMASTER
Partners in Basin Management

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Figure 1

Groundwater Level Change
Spring 2016 to Spring 2018

Chino Basin Watermaster
Ground-Level Monitoring Committee

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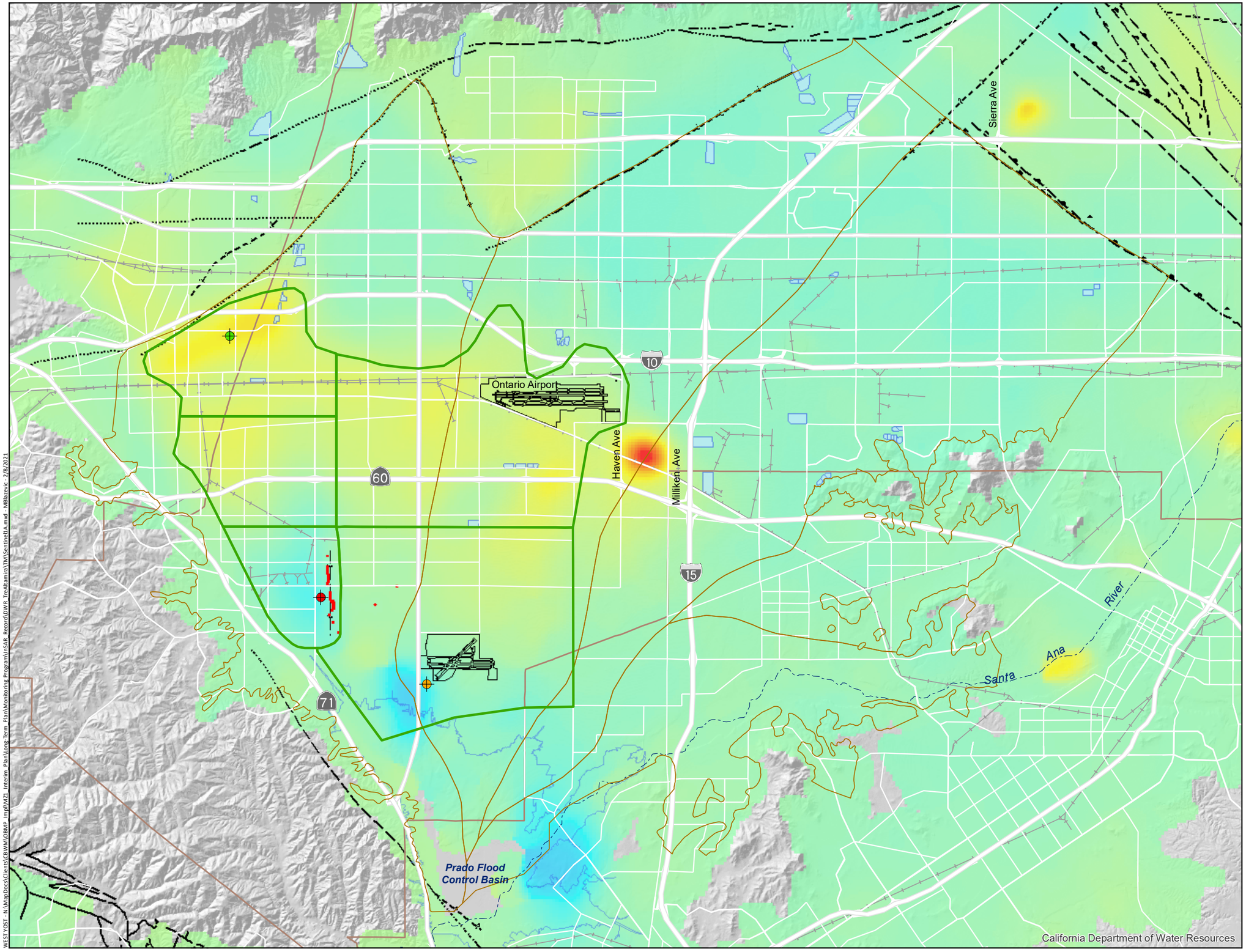

N

0 1 2

Miles

Relative Change in Land Surface Altitude
as Estimated by InSAR
(June 2015 to May 2018)

0.16 ft

0 ft

-0.16 ft

InSAR absent or incoherent

OBMP Management Zones

Areas of Subsidence Concern

Pomona Extensometer Facility

Ayala Park Extensometer Facility

Chino Creek Extensometer Facility

Ground Fissures

Approximate Location of the Riley Barrier

Flood Control and Conservation Basins

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Figure 2

**Vertical Ground Motion
Estimated by Sentinel-1A
June 2015 to May 2018**

Chino Basin Watermaster
Ground-Level Monitoring Committee

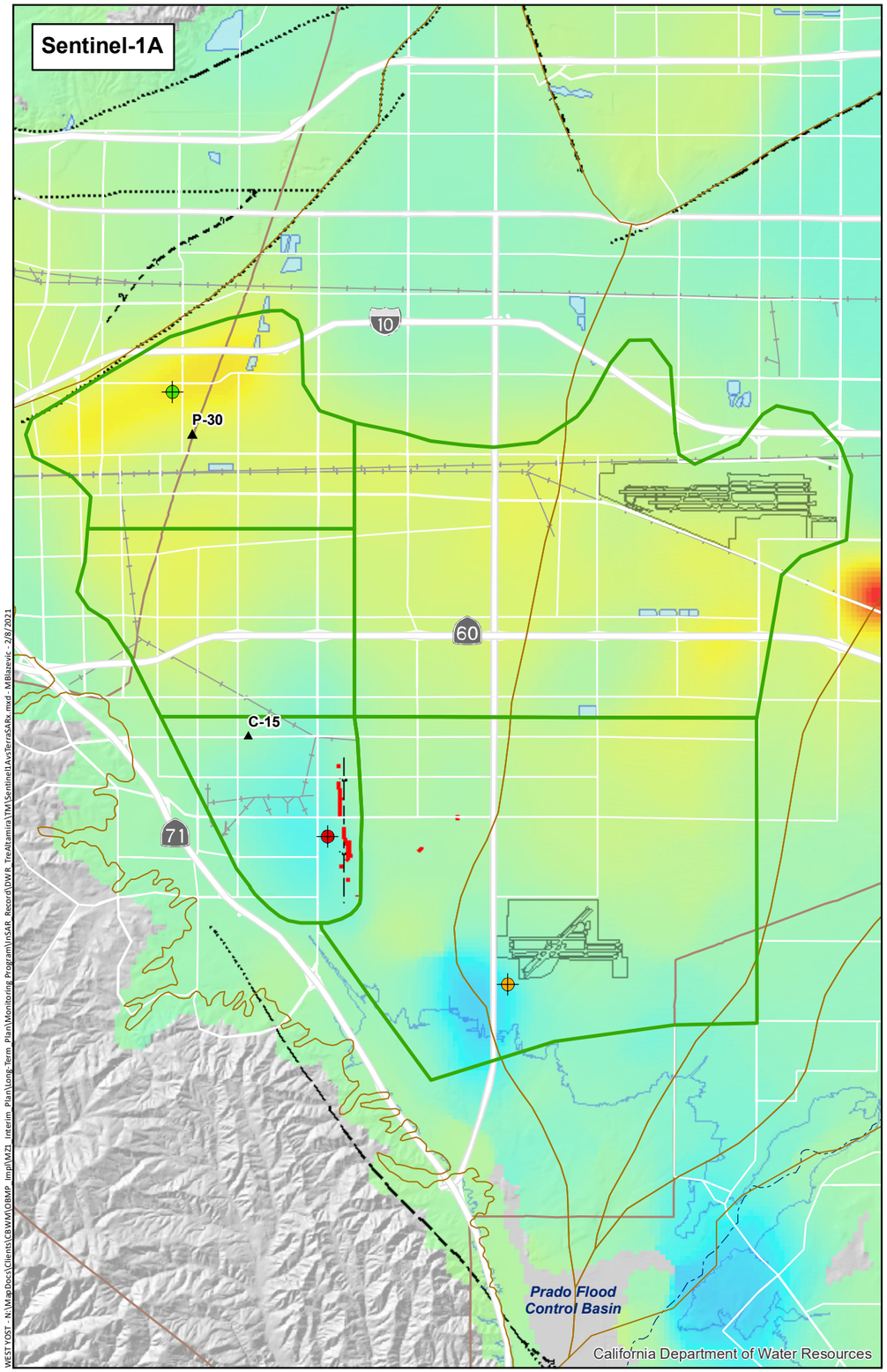
- Estimates of vertical ground motion are mostly downward across the areas of subsidence concern. The spatial pattern of vertical ground motion estimated by the Sentinel-1A is consistent with the long-term ground motion trends measured by the TerraSAR-X and is consistent with the spatial pattern and groundwater level change shown in Figure 1 between 2016 and 2018.
- Estimates of vertical ground motion are mostly upward across the eastern portion of the basin. The spatial pattern of vertical ground motion estimated by Sentinel-1A is not consistent with the spatial pattern and groundwater level change shown in Figure 1 between 2016 and 2018.
- There are focused patterns of vertical ground motion that are not explained by changes in groundwater levels shown in Figure 1. These areas are located just southeast of the Ontario Airport between Haven Avenue and Milliken Avenue, along the Santa Ana River, and just northeast of the intersection of the 210 Fwy and Sierra Avenue. Examination of these areas in Google Earth shows they correspond to recent earthwork construction activities and/or excavation activities.

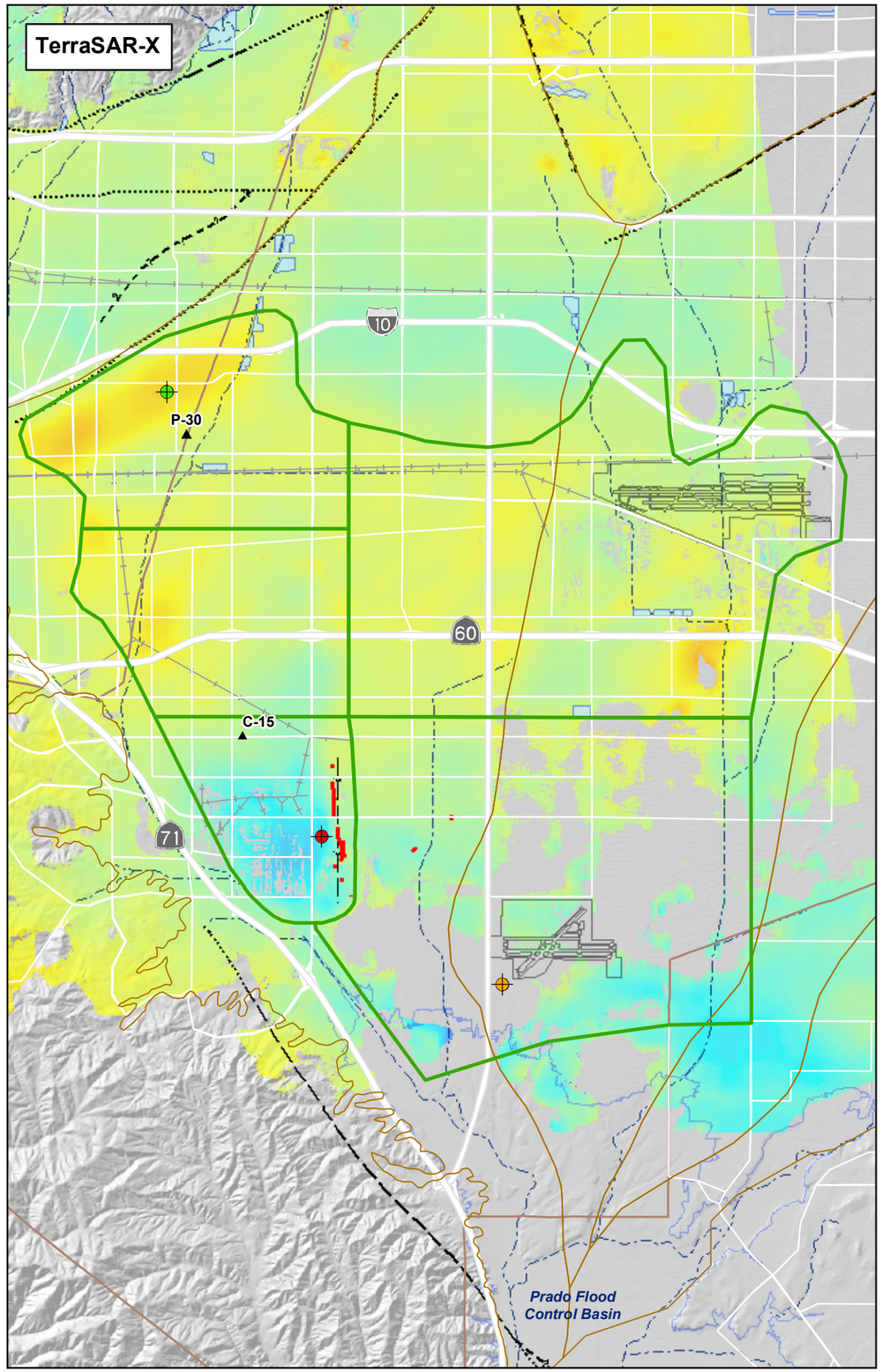
Figures 3 and 4 show total vertical ground motion estimated across the western Chino Basin between June 2015 and May 2018 from Sentinel-1A and TerraSAR-X. Across the areas of subsidence concern, the main observations are:

- The spatial pattern of vertical ground motion is generally consistent between the two InSAR datasets.
- Between the two InSAR data sets, the spatial resolution of TerraSAR-X is noticeably better and the spatial details of subsidence are better delineated with TerraSAR-X.
- The magnitudes and directions of ground motion are not always consistent between the Sentinel-1A and TerraSAR-X InSAR datasets. InSAR data from TerraSAR-X across the western portion of Central MZ-1, Northwest MZ-1, and Northeast Area show greater magnitudes of downward vertical ground motion compared to the Sentinel-1A InSAR data. Where TerraSAR-X InSAR data is coherent across the southern part of the Managed Area (near Ayala Park), it shows slightly greater upward ground motion compared to the Sentinel-1A InSAR data. Across other parts of the western Chino Basin, the vertical ground motion magnitude and direction estimated by the two satellites is variable and not consistent.

Figures 5 and 6 are time-series charts that compare the hydraulic heads at C-15 and P-30 to vertical ground motion as measured by Sentinel-1A and TerraSAR-X between 2015 and 2018. For reference, the point locations are shown on Figure 3. The main observations and interpretations from Figures 5 and 6 are:

- The Sentinel-1A InSAR data are plotted on a monthly time-step, whereas the TerraSAR-X InSAR data are plotted on a two-month time-step. Because of this, Sentinel-1A InSAR data shows slightly more variability month to month compared to TerraSAR-X InSAR data. Both Sentinel-1A and TerraSAR-X InSAR data generally show a similar pattern of vertical ground motion annually.
- Both Sentinel-1A and TerraSAR-X InSAR data show a persistent downward vertical ground motion trend between 2015 and 2018.
- Sentinel-1A InSAR data shows a consistent pattern of upward ground motion in the fall of each year. This pattern of upward ground motion in the fall of each year is not observed in the TerraSAR-X InSAR data.





N

0 1 2

Miles

Relative Change in Land Surface Altitude
as Estimated by InSAR
(June 2015 to May 2018)

0.16 ft

0 ft

-0.16 ft

InSAR absent or incoherent

Areas of Subsidence Concern

Pomona Extensometer Facility

Ayala Park Extensometer Facility

Chino Creek Extensometer Facility

Ground Fissures

Approximate Location of the Riley Barrier

Flood Control and Conservation Basins

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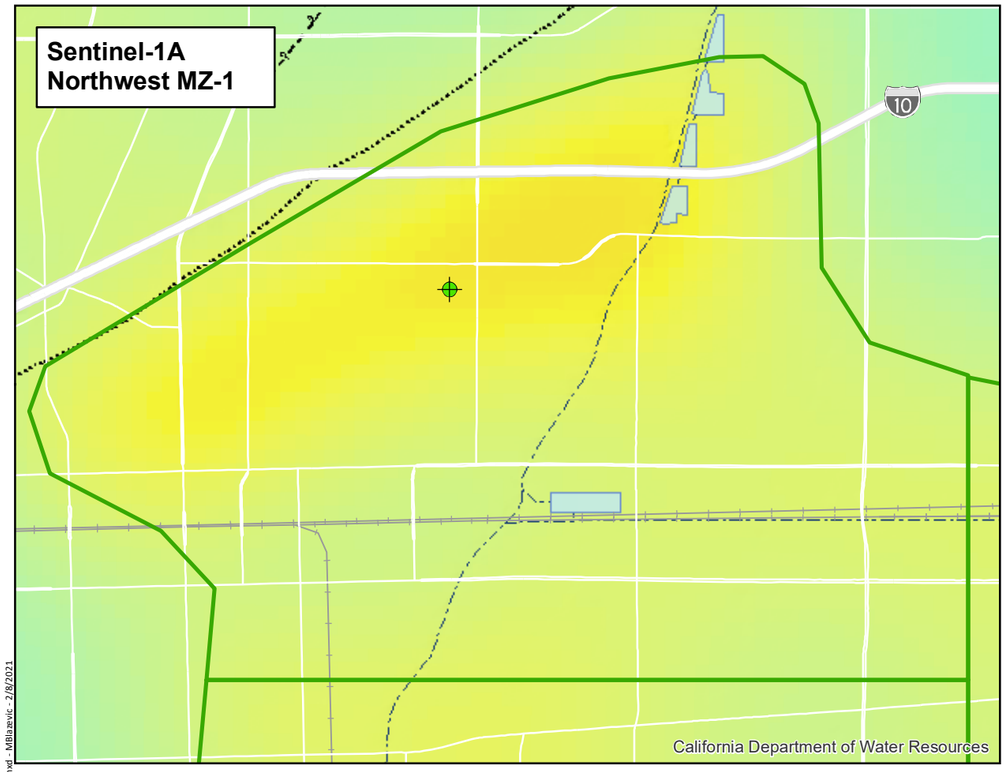
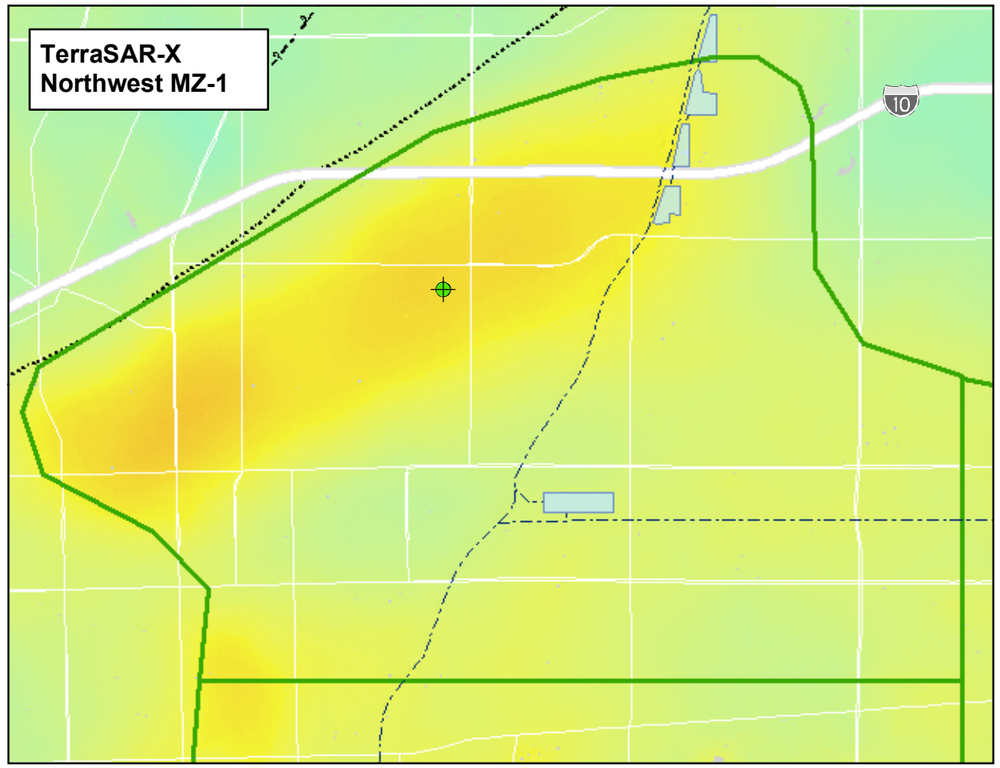
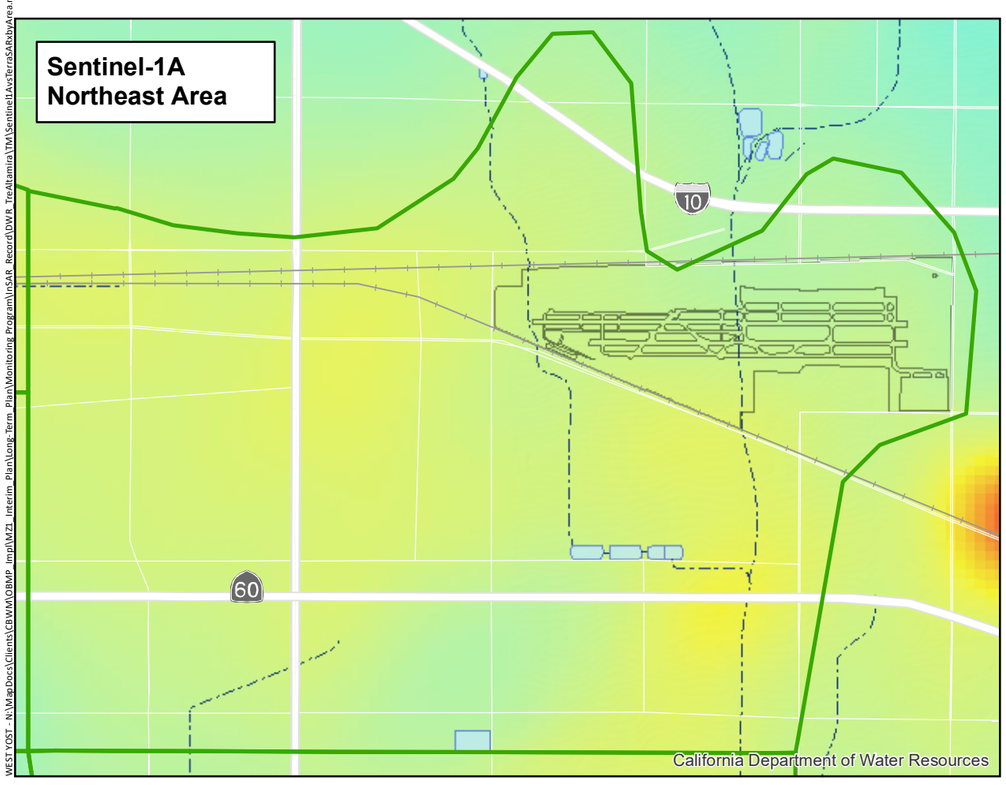
Figure 3

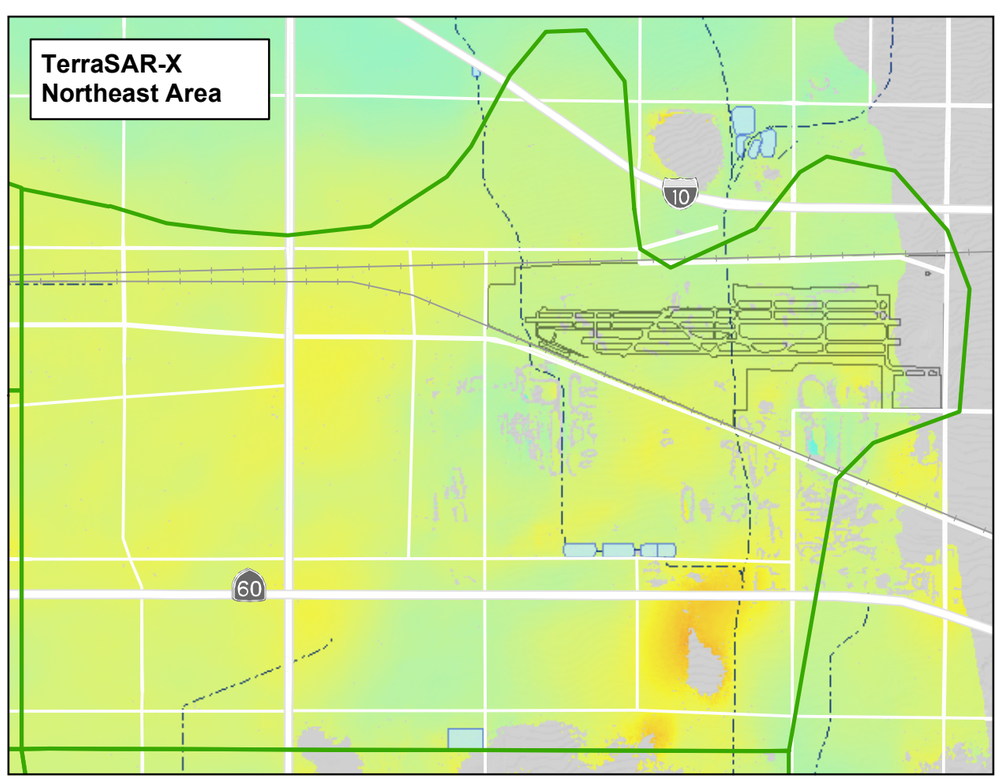
Sentinel-1A
Total Vertical Ground Motion
Estimated across the Chino Basin
June 2015 to May 2018

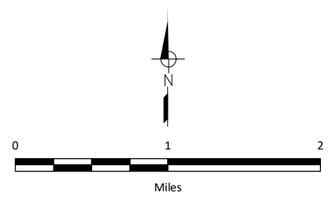
Chino Basin Watermaster
Ground-Level Monitoring Committee











Relative Change in Land Surface Altitude
as Estimated by InSAR
(June 2015 to May 2018)

InSAR absent or incoherent

Areas of Subsidence Concern

Pomona Extensometer Facility

Flood Control and Conservation Basins

Figure 4

Sentinel-1A Versus TerraSAR-X Total Vertical Ground Motion Estimated across Northwest MZ-1 and Northeast Area June 2015 to May 2018

Chino Basin Watermaster
Ground-Level Monitoring Committee

Figure 5. Cumulative Vertical Ground Motion Displacement Measured by the Sentinel-1A and TerraSAR-X Satellites at City of Chino 15
August 2015 to May 2018

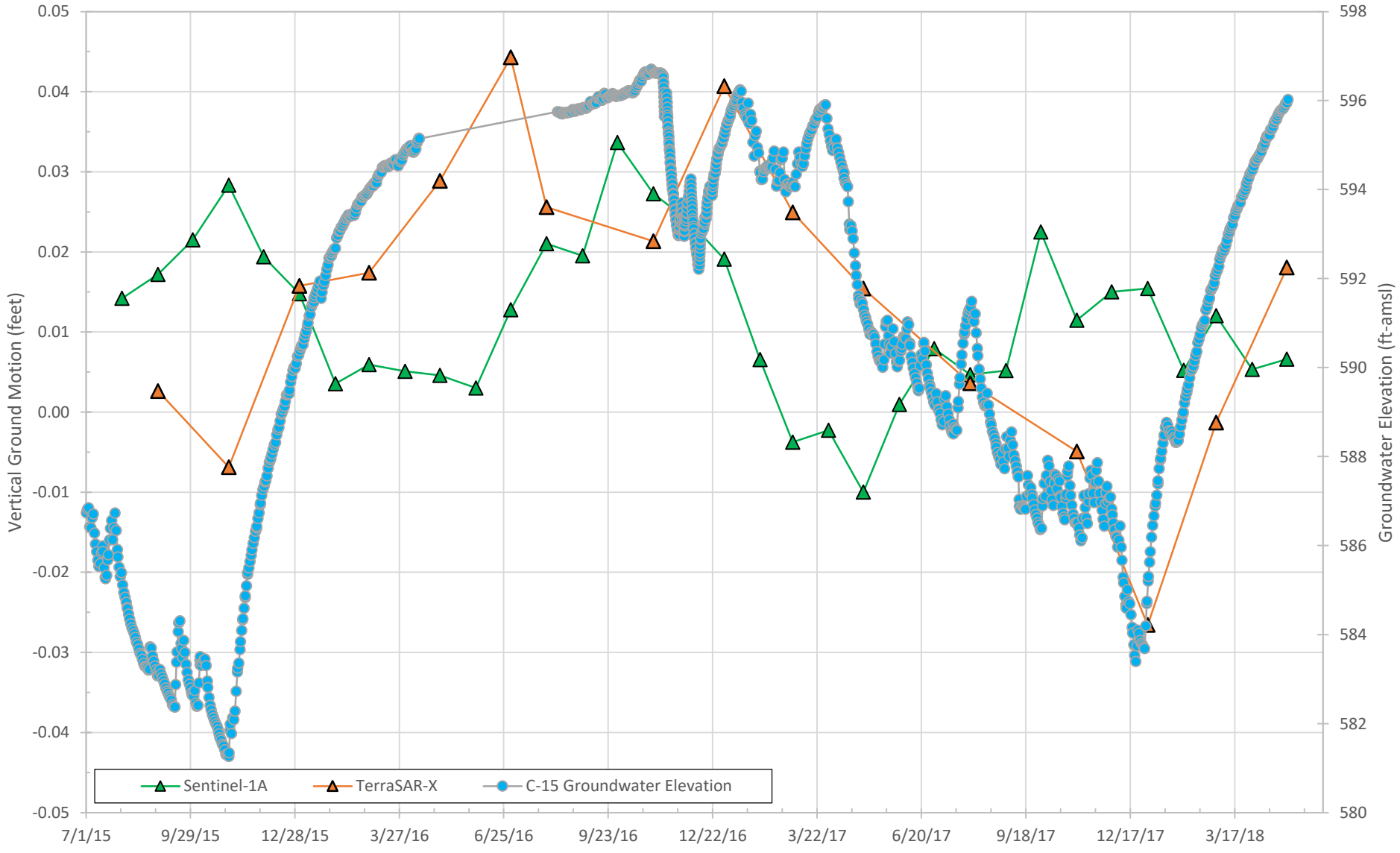
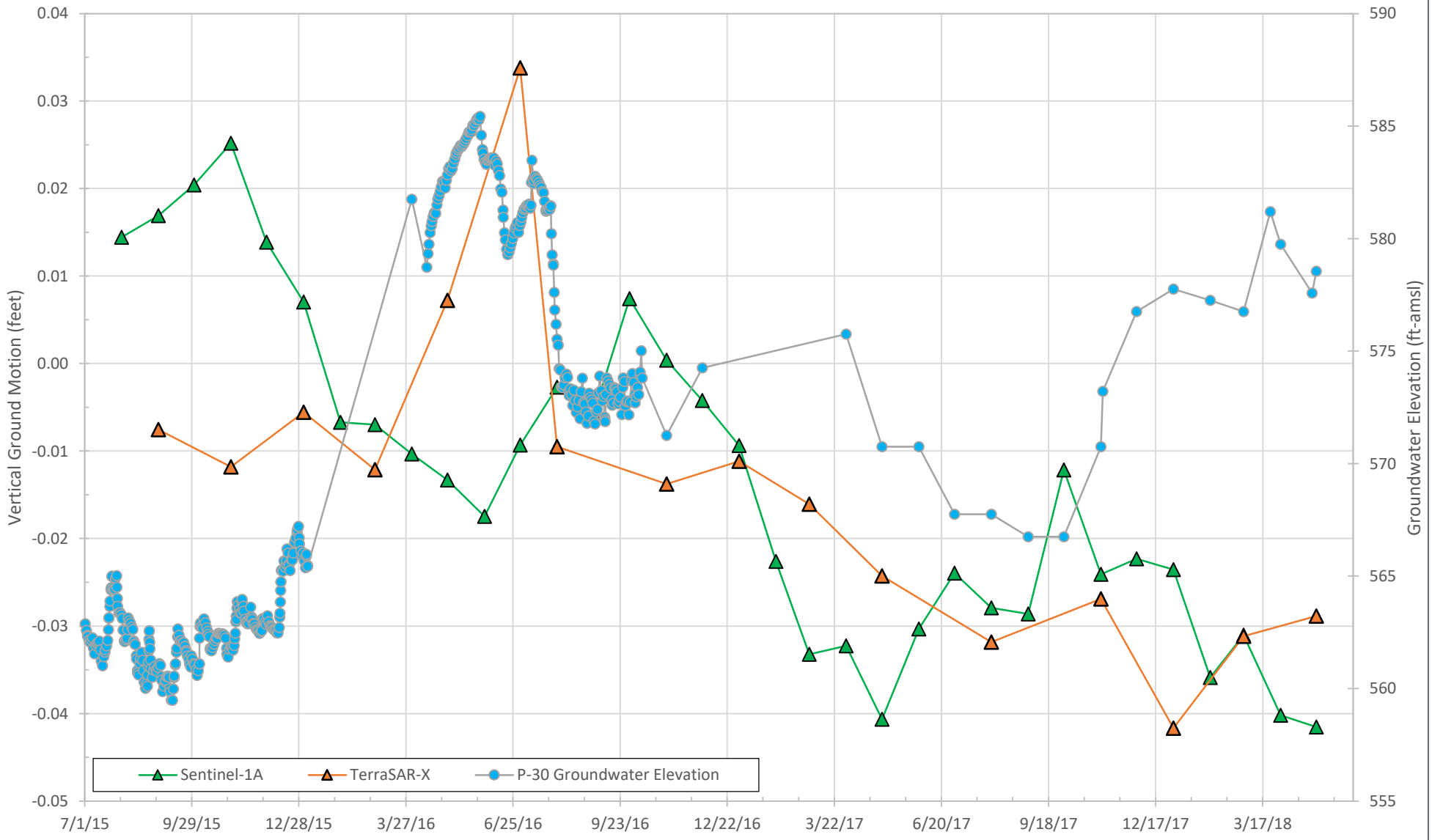


Figure 6. Cumulative Vertical Ground Motion Displacement Measured by the Sentinel-1A and TerraSAR-X Satellites at City of Pomona 30
August 2015 to May 2018



- The vertical ground motion magnitudes measured by the two InSAR data sets at each point location is inconsistent.
- The seasonal fluctuations of hydraulic head at C-15 and P-30 are coincident with the seasonal fluctuations of vertical ground motion measured by the TerraSAR-X InSAR data.
- The seasonal fluctuations of hydraulic head at C-15 and P-30 are not coincident with the seasonal fluctuations of vertical ground motion measured by the Sentinel-1A InSAR data. For example, in Figure 5, there are instances where Sentinel-1A estimates upward vertical ground motion but hydraulic head at C-15 is declining or stable.

One explanation for the limited relationship between the hydraulic head at C-15 and P-30 and the vertical ground motion observed with the Sentinel-1A InSAR data is that the Sentinel-1A grid size (100 m) is much larger compared to the TerraSAR-X grid size (15 m). Likewise, the TerraSAR-X accuracy (+/- 8 mm) is twice that of the Sentinel-1A accuracy (+/- 16 mm). A larger grid size and decreased accuracy will smooth-out the ground displacement magnitude over a larger area and produce less accurate ground motion results at specific point locations.

CONCLUSIONS AND RECOMMENDATIONS

Based on the figures, information, and observations discussed above, we summarize the advantages and limitations of both the Sentinel-1A and TerraSAR-X InSAR data sets in Table 2.

The recommendations from this study are:

- The GLMC should continue using TerraSAR-X for the following reasons:
  - TerraSAR-X InSAR data is available at a higher spatial resolution compared to the freely available Sentinel-1A InSAR data. Higher spatial resolution InSAR can better delineate areas of subsidence and better identify areas of differential subsidence. High-resolution InSAR is more appropriate over urban areas, such as the Chino Basin, where the finer detail can identify risk to infrastructure, characterize rapidly developing small features which may lead to ground fissures, and more accurately depict the depth and spatial extent of broad subsidence features.
  - TerraSAR-X InSAR data is purchased at higher vertical accuracy compared to the feely available Sentinel-1A InSAR data. For subsidence model calibration purposes, the TerraSAR-X InSAR data will provide more accurate calibration targets for vertical ground motion compared to the Sentinel-1A InSAR data. The vertical ground motion estimated by TerraSAR-X has shown to be coincidental with changes to hydraulic heads (see Figures 5 and 6). For the areas of subsidence concern, this relationship indicates hydraulic heads, which are controlled by the pumping and recharge stresses in the area, have at least some control on the pattern and rate of subsidence and that the information could be used as management criteria to protect against the future occurrence of land subsidence.
  - TerraSAR-X InSAR data has been collected for the GLMP since 2011. The GLMC is also in the process of developing a Subsidence Management Plan for Northwest MZ-1. To maintain continuity of the InSAR record during development and completion of the Northwest MZ-1 Subsidence Management Plan, it is recommended the GLMC continue

to use TerraSAR-X InSAR data, at least until the Northwest MZ-1 Subsidence Management Plan is completed.

- Based on the spatial pattern of vertical ground motion estimated by Sentinel-1A between 2015 and 2018 across the eastern Chino Basin, there is no immediate need to monitor vertical ground motion across the eastern Chino Basin. The GLMC could evaluate using the freely available Sentinel-1A InSAR data about once every five years to check for vertical ground motion trends across the eastern Chino Basin.

Table 2. Sentinel-1A and TerraSAR-X Advantages and Limitations

Criteria	Sentinel-1A	TerraSAR-X
Spatial Coverage	Coverage for the entire Chino Basin.	The GLMP only purchases InSAR for the western Chino Basin.
Spatial Resolution	Published to the DWR SGMA Data Viewer at a spatial resolution of 100 m.	Processed by GA at a spatial resolution of 15 m.
Vertical Accuracy	Published to the DWR SGMA Data Viewer at an accuracy of +/- 16 mm.	Processed by GA at an accuracy of +/- 8 mm.
Acquisition Frequency	Monthly.	Bimonthly (every two months).
Period of Record	As of December 2020, the InSAR is available for the time-period between June 2015 and September 2020.	The InSAR has been used by the GLMP since 2011 and is currently available through March 2020.
Continuity	The frequency at which new InSAR scenes will be available through the DWR SGMA Data Viewer is unknown.	The GLMP collects InSAR on a year-round basis in order to maintain continuity in the InSAR record from year-to-year.
Cost	The InSAR is freely available through the DWR SGMA Data Viewer website. There would be associated costs to download, re-project, and load the rasters to ArcMap for viewing and analysis.	The InSAR is ordered, purchased, and processed by GA each fiscal year. The cost is $87,000 and includes time by the Watermaster Engineer to review the InSAR deliverables with GA and load the InSAR rasters to ArcMap for viewing and analysis.