23692 Birtcher Drive
Lake Forest CA 92630

949.420.3030 phone
530.756.5991 fax
westyost.com

TECHNICAL MEMORANDUM

DATE: February 23, 2024 Project No.: 941-80-23-25 B.2

TO: Ground-Level Monitoring Committee

CC: Edgar Tellez-Foster, *Interim General Manager of the Chino Basin Watermaster*

FROM: West Yost Associates, *Watermaster Engineer*

REVIEWED BY: Andy Malone, PG

SUBJECT: *1D Model Simulation of Subsidence in Northwest MZ-1—Subsidence Management Alternative #1 (FINAL)*

TABLE OF CONTENTS

BACKGROUND AND OBJECTIVES 2

TECHNICAL APPROACH AND METHODS 4

SUBSIDENCE MANAGEMENT ALTERNATIVE #1 5

Pumping Projections 5

Managed Recharge Projections 5

Hydrologic Response of the Aquifer System to SMA-1 6

PROJECTED AQUIFER-SYSTEM COMPACTION AND LAND SUBSIDENCE UNDER SMA-1 7

CONCLUSIONS AND RECOMMENDATIONS 8

APPENDIX A – RESPONSES TO GLMC COMMENTS 24

BACKGROUND AND OBJECTIVES

The Chino Basin Watermaster's Subsidence Management Plan (SMP)[1] identified several "Areas of Subsidence Concern" across the western portion of Chino Basin where the future occurrence of land subsidence and ground fissuring is a concern. The SMP states that if data from existing monitoring efforts in the "Areas of Subsidence Concern" indicate the potential for adverse impacts due to subsidence, Watermaster will revise the SMP to avoid those adverse impacts.

Figure 1 is a map of the so-called Northwest MZ-1 Area of Subsidence Concern (Northwest MZ-1). Watermaster has monitored vertical ground motion in Northwest MZ-1 via InSAR[2] dating back to 1992. Land subsidence in Northwest MZ-1 was first identified as a concern in 2006 in the MZ-1 Summary Report.[3] Of particular concern is that the subsidence across the San Jose Fault in Northwest MZ-1 has occurred in a pattern of concentrated differential subsidence—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 meetings of the Ground Level Monitoring Committee (GLMC), and the subsidence has been documented and described as a concern in Watermaster's State of the Basin Reports, the annual reports of the GLMC, and in the Initial Hydrologic Conceptual Model for Northwest MZ-1.[4] Watermaster increased monitoring efforts in Northwest MZ-1 beginning in 2012 to include ground-elevation surveys and electronic distance measurements (EDM) to monitor ground motion and the potential for fissuring.

In 2015, the Watermaster's Engineer developed the *Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area* (Work Plan).[5] 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 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 reports of the GLMC and used to prepare recommendations for future activities.

[1] Wildermuth Environmental, Inc. 2015. Chino Basin Subsidence Management Plan. Prepared for the Chino Basin Watermaster. July 23, 2015.

[2] Interferometric Synthetic Aperture Radar (InSAR) is a remote sensing technique that is used to monitor vertical ground motion over time.

[3] Wildermuth Environmental, Inc. 2006. MZ-1 Summary Report. Prepared for the MZ-1 Technical Committee. February 2006.

[4] Wildermuth Environmental, Inc. 2017. Initial Hydrologic Conceptual Model and Monitoring and Testing Program for the Northwest MZ-1 Area. Prepared for the Chino Basin Watermaster. December 2017.

[5] Wildermuth Environmental, Inc. 2015. Work Plan to Develop a Subsidence-Management Plan for Northwest MZ-1. Prepared for the Chino Basin Watermaster. July 23, 2015.

The objective of the *Subsidence Management Plan for Northwest MZ-1* is to provide guidance for the Watermaster and the Parties for how to manage hydraulic heads in Northwest MZ-1 (potentially through the management of pumping, recharge, the use of managed storage, and/or the design and implementation of Storage and Recovery Programs) so that the future occurrence of subsidence is minimized or abated in this area. The development of the *Subsidence Management Plan for Northwest MZ-1* will also include the evaluation of the minimum recharge quantity of supplemental water in MZ-1 as called for in Section 8.4 of the Peace II Agreement.[6]

The Work Plan included tasks to construct, calibrate, and use one-dimensional aquifer-system compaction models in Northwest MZ-1 (1D Models) to:

- Assist in understanding the mechanisms behind the ongoing subsidence in Northwest MZ-1
- Assist in the development of the *Subsidence Management Plan for Northwest MZ-1*.

The Work Plan envisioned the use of the 1D Models to update the Watermaster's three-dimensional groundwater-flow model so it could simulate aquifer-system compaction and then be used to develop the *Subsidence Management Plan for Northwest MZ-1*. However, with input from the GLMC, the Watermaster Engineer subsequently recommended to use the 1D Models directly to develop the *Subsidence Management Plan for Northwest MZ-1*.

In 2021 and 2022, the Watermaster Engineer constructed and calibrated the 1D Models and published a technical memorandum to document the results.[7] Figure 1 shows the locations of the two 1D Models at the PX and MVWD-28 sites in Northwest MZ-1. Figures 2 and 3 are diagrams that depict a profile view of each 1D Model including: the data used to construct the 1D Models (borehole lithology and geophysics) and the vertical discretization of the 1D Model grid cells into "sand" and "clay" layers.

The next step is to use the 1D Models to project the future rates and magnitudes of land subsidence in Northwest MZ-1 under various "Subsidence Management Alternatives." The first Subsidence Management Alternative (SMA-1) represents the recent plans of the Chino Basin Parties for groundwater management (*e.g.,* pumping, recharge, use of managed storage, etc.) over a defined planning horizon. SMA-1 was reviewed by the GLMC before it was simulated with the 1D Models.

This memorandum describes the results, conclusions, and recommendations from the 1D Model simulations of SMA-1.

The need to develop additional Subsidence Management Alternatives and run 1D Model simulations will be based on the 1D Model results and interpretations described herein. Each new Subsidence Management Alternative will be reviewed by the GLMC before model simulations are conducted.

---

[6] See Section 8.4 of the *Final_Peace_II_Documents.pdf (cbwm.org)*

[7] West Yost Associates. 2022. *Construction and Calibration of One-Dimensional Compaction Models in the Northwest MZ-1 Area of the Chino Basin*. Prepared for the Chino Basin Watermaster. December 2022.

TECHNICAL APPROACH AND METHODS

This section describes the technical approach and methods that were employed to develop and run SMA-1 with the 1D Models to support the ongoing effort to develop a *Subsidence Management Plan for Northwest MZ-1*:

1. **Develop SMA-1 with review and input from the GLMC**. SMA-1 represents the most recently reported plans of the Chino Basin parties for pumping, recharge, and the use of managed storage over the defined planning horizon (2018-2050). The GLMC reviewed and provided input on SMA-1 before it was used in this effort.
2. **Simulate the hydrologic response of the Chino Basin to SMA-1 by aquifer layer**. The existing numerical groundwater-flow model of the Chino Basin (referred to as the Chino Valley Model [CVM]) is used to simulate the hydrologic response of the Chino Basin to SMA-1. The CVM is a five-layer model, so it predicts the hydraulic heads in each model layer under the projected pumping and recharge stresses over the planning horizon.
3. **Simulate the aquifer-system compaction that is predicted to occur in Northwest MZ-1 under SMA-1**. The hydraulic heads of SMA-1, as simulated by the CVM in each model layer, are used as input data for the 1D Models. The output of the 1D Models represents the vertical aquifer-system compaction (and hence, the resulting land subsidence) that is predicted to occur in Northwest MZ-1 under SMA-1. The output is described in terms of the rates, duration, and magnitude of vertical deformation of the aquifer sediments that is predicted to occur at the 1D Model locations over the planning horizon, by CVM layer.
4. **Evaluate model results and develop recommendations***.* The Watermaster Engineer and the GLMC evaluate the projected hydraulic heads versus the projected compaction as simulated by the 1D Models, and then can make one or more of the following recommendations:
    a. Recommend "acceptable thresholds" for projected land subsidence that will avoid or mitigate Material Physical Injury (MPI).
    b. Recommend "subsidence management strategies" for Northwest MZ-1. These recommended strategies may come in the form of:
        i. Recommended operating ranges for hydraulic heads by aquifer layer.
        ii. Recommended groundwater management practices, such as pumping, recharge, the use of local storage, and/or the design and implementation of Storage and Recovery programs. Such recommendations can include guidance for the locations and depth intervals for pumping and recharge.
    c. Recommend the minimum recharge quantity of supplemental water in MZ-1.
    d. Recommend additional work, such as: filling data gaps and/or collecting additional hydrogeologic information; developing additional SMAs; performing CVM and 1D Model simulations of the additional SMAs; and making revised recommendations based on the model results (*i.e.,* 4.a. through 4.c. above). Any additional SMAs will be reviewed by the GLMC before taking the next step to simulate the SMA with the CVM and the 1D Models.

5. **Repeat methods to develop the *Subsidence Management Plan for Northwest MZ-1*.** The methods above are repeated until enough information has been generated to develop the *Subsidence Management Plan for Northwest MZ-1*.

Subsidence Management Alternative #1

SMA-1 is equivalent to the planning scenario that was simulated to support the 2020 Safe Yield Recalculation (2020 SYR)[8] using the 2020 CVM. The 2020 SYR was intended to represent and simulate the Parties' projected pumping, recharge, and use of storage through 2050. This scenario spanned from fiscal year (FY) 2018 through 2050 and included the cultural conditions (e.g., land use, water supply plans) that were assumed based on the best-available planning data at the time of the 2020 SYR.[9] An advantage of using 2020 SYR as the planning scenario for SMA-1 is that the CVM modeling is complete and the simulated hydraulic heads by model layer are readily available for use as input data for the 1D Models.

The remainder of this section describes the pumping and recharge assumptions of 2020 SYR (*i.e.,* SMA-1) and the CVM output, which is the simulated hydrologic response of the aquifer system to SMA-1.

Pumping Projections

The projected pumping and use of managed storage was based on planning data collected from the Parties. The Parties provided projections of monthly groundwater pumping and other water supplies, the use of current and projected wells including a prioritization of use, and the future use of their local storage accounts. These projections were used to develop monthly pumping projections by well in the Chino Basin for 2018-2050.

Table 1 shows the projected pumping by well for the three Appropriative Pool parties with wells near Northwest MZ-1 for 2018-2050: Monte Vista Water District (MVWD), City of Pomona (Pomona), and Golden State Water Company (GSWC). Projected pumping of the three parties reaches 18,650 afy in FY 2040 and stays constant through FY 2050.

Managed Recharge Projections

Recharge components in the Chino Basin primarily include (i) subsurface inflow from adjacent groundwater basins and bedrock, (ii) deep infiltration of precipitation and applied water, (iii) streambed infiltration, and (iv) managed aquifer recharge. Managed aquifer recharge includes the recharge of stormwater, recycled water, and imported water in the Chino Basin via spreading basins or Aquifer Storage and Recovery (ASR) wells.

Table 2 shows the projected managed aquifer recharge at the recharge basins located within or directly upgradient of Northwest MZ-1. Projected stormwater recharge was based on the CVM's surface-water model simulations, which included planned improvements developed during and after the 2013 Recharge Master Plan Update that were assumed to be operational in FY 2023. Projected recycled water recharge at spreading basins were estimates provided by the Inland Empire Utilities Agency (IEUA). Projected imported

[8] West Yost Associates. 2020. *2020 Safe Yield Recalculation*. Prepared for the Chino Basin Watermaster. May 2020.

[9] Refer to Section 7.3 of the 2020 SYR report for more detail on the pumping and recharge projections.

water recharge were estimates based on the requirement to satisfy a portion of the Parties' replenishment obligations when aggregate production exceeds aggregate production rights. Projected managed aquifer recharge in Northwest MZ-1 reaches about 7,000 afy in FY 2040 and stays constant through FY 2050.

Hydrologic Response of the Aquifer System to SMA-1

SMA-1 was simulated for the 2020 SYR from FY 2018 through 2050. Figures 4, 5, and 6 are maps of the Chino Basin that illustrate the changes in hydraulic heads from FY 2018 to FY 2050 in CVM Layers 1, 3, and 5, respectively:

- Figure 4 shows that heads in Layer 1 are projected to decline by up to 25 feet across Northwest MZ-1. Layer 1 represents the shallow, unconfined aquifer in the western portion Chino Basin. At the 1D Model locations, heads in Layer 1 are projected to decline by about 13 to 15 feet.

- Figure 5 shows that heads in Layer 3 are projected to increase by up to 5 feet in the western portion of Northwest MZ-1 and decrease by up to 30 feet in the eastern portion of Northwest MZ-1. Layer 3 represents the intermediate, semi-confined aquifer in the western portion Chino Basin. At the 1D Model locations, heads in Layer 3 are projected to decline by about 5 feet near PX and decline by about 10 feet near MVWD 28.

- Figure 6 shows that heads in Layer 5 are projected to increase across most of Northwest MZ-1. Layer 5 represents the deep, confined aquifer in the western portion Chino Basin. At the 1D Model locations, heads are projected to increase by about 25 feet near PX and increase by about 40 feet near MVWD 28.

Figures 7 and 8 are time-series charts of projected hydraulic heads in CVM model layers 1, 3, and 5 under SMA-1 at the PX and MVWD 28 locations, respectively. The charts span the projection period for SMA-1 (2018-2050), but also show the historical simulation period (1930-2017) to illustrate the lead up to projection period.[10] Note the following changes in hydraulic heads over the historical and projection periods from 1930 to 2050:

- From 1930-1977, heads declined gradually and persistently in Northwest MZ 1 by about 190 feet. Head declines in Layer 5 lagged the head declines in Layers 1 and 3 because there were very few pumping wells with screens across Layer 5 during these times.

- From 1978-2018, heads in Layers 1 and 3 stabilized or increased slightly in response to: implementation of the Judgment which restricted pumping; the wet periods in the late 1970s, early 1980s, and 1990s which enhanced recharge; and the availability of imported water from the State Water Project. However, heads continued to decline in Layer 5 due to the construction of additional deep wells in Northwest MZ-1 with screens across Layer 5 and the associated increases in groundwater extraction from Layer 5.

[10] For the historical period, heads were estimated for the construction and calibration of the 1D Models. For 1930-1977, heads were estimated based on the measured groundwater elevations at wells in the vicinity of the 1D Models. For 1977-2018, heads were estimated from CVM output data at the 1D Model locations by model layer.

- From 2018-2050 in SMA-1, heads in Layers 1 and 3 at the PX and MVWD-28 locations are projected to decline at a gradual rate starting in 2019 with total declines of up to 17 ft by 2050. These projected declines in heads are generally due to a projected increase in pumping from 2018 through 2050 across the Chino Basin.
- From 2018-2050 in SMA-1, heads in Layer 5 at the PX and MVWD-28 locations increase immediately and significantly at the start of the projection. This immediate increase in heads is due to less projected pumping at several wells in Northwest MZ-1 that are screened across Layer 5. However, by 2030, heads begin to gradually decline through 2050, but remain above their initial 2019 heads.

PROJECTED AQUIFER-SYSTEM COMPACTION AND LAND SUBSIDENCE UNDER SMA-1

The changes in hydraulic heads under SMA-1 by CVM layer were simulated with the 1D Models to project the potential future aquifer-system compaction (*i.e.,* land subsidence) in Northwest MZ-1 from FY 2018 through 2050. For the historical period from FY 1930 through 2017, aquifer-system compaction was simulated during the calibration of the 1D Models.[7] This section describes the results and interpretations of the 1D Model simulations:

- Figures 9 and 10 are time-series charts of the simulated hydraulic heads versus aquifer system compaction by CVM model layer at the PX and MVWD 28 locations, respectively. The charts span the historical simulation period (1930-2017) and the projection period for SMA-1 (2018-2050) to depict the long-term progression of historical and projected aquifer-system compaction. The aquifer-system compaction for CVM layers 2 and 4 (relatively thin aquitard layers) was added to layers 3 and 5, respectively, since layers 2 and 4 are adjacent to and mechanically respond to the head changes in layers 3 and 5.
- Figures 11 and 12 are time-series charts of the simulated hydraulic heads versus aquifer system compaction by CVM model layer at the PX and MVWD 28 locations, respectively, for the projection period for SMA-1 only (2018-2050). These charts provide finer detail of the projected aquifer-system compaction.

The following observations and interpretations are made from inspection of these figures that depict the 1D Model simulation results in Northwest MZ-1:

- From 1930-1977, aquifer-system compaction occurred at its highest rates in response to the persistent declines in heads. Total compaction by 1977 was about six (6) feet at PX and about three (3) feet at MVWD-28. Compaction was greatest in Layers 1, 2, and 3 because shallow pumping dominated during this period.
- From 1978-2017, the rates of aquifer-system compaction in Layers 1, 2, and 3 slowed because of the stabilization of heads after 1978, but delayed drainage of the aquitards in these layers continued. The rates of compaction during this period were highest in Layers 4 and 5 due to the continued declines in heads in Layer 5 caused by increased pumping from Layers 3 and 5. Total compaction from 1930 to 2017 was about nine (9) feet at PX and about 5.5 feet at MVWD-28.

- From 2018-2050 under SMA-1, aquifer system compaction is projected to continue to occur at relatively slow but constant rates. Total compaction during 2018-2050 is projected to be 0.86 ft at PX (about 0.03 ft/yr) and 0.75 ft at MVWD-28 (about 0.02 ft/yr). The highest rates of compaction are projected to occur in Layer 5, even though heads in Layer 5 are projected increase under SMA-1. The persistence of aquifer-system compaction during the projection period is due to the delayed drainage of the aquitard layers, where pore pressures in the clay-rich sediments are continuing to equilibrate with the historical head declines that occurred in the coarse-grained aquifer sediments.

Conclusions and Recommendations

The main conclusions and recommendations from this investigation are:

- Under SMA-1, the 1D Model simulations indicate that aquifer-system compaction, and its resulting land subsidence, will continue in Northwest MZ-1 at gradual, constant rates of about 0.02 to 0.03 ft/yr through at least 2050. These rates of projected compaction through 2050 are consistent with the observed current rates of land subsidence in Northwest MZ-1.

- These constant rates of aquifer-system compaction in Northwest MZ-1 are projected to occur even though heads in Layer 5 are assumed to increase by 30-60 ft in SMA-1. This indicates that the compaction is due to the delayed drainage of aquitard layers, where pore pressures in the clay-rich sediments are continuing to equilibrate with head declines that occurred historically within the coarse-grained aquifer sediments.

- The highest rates of compaction are occurring below Layer 1—particularly within in Layers 4 and 5 where hydraulic heads are the lowest. These rates of compaction are projected to continue to occur through 2050.

- Pursuant to the SMP, these persistent rates of compaction should be slowed to tolerable levels or completed abated, if possible. The only way to slow or completely abate the compaction is to increase heads and maintain them at higher elevations—particularly within Layers 3 and 5, where heads are lowest and the rates of compaction are highest.

- The Watermaster should establish a “Northwest MZ-1 Guidance Level” of **630 ft-amsl** for hydraulic heads in Layers 3 and 5 at the PX location. Figure 13 displays this Guidance Level, which approximates the current and projected heads in Layer 1 where the current and projected rates of compaction are the lowest. The Guidance Level is an aspirational Watermaster recommendation that, if achieved, would likely slow the rates of compaction and subsidence to more tolerable levels over time.

- Compliance with the Guidance Level should be measured at the PX-2/3 piezometer. Figure 2 shows that the PX-2/3 piezometer is screened across the uppermost portion of Layer 5 at the PX location, and hence, is generally representative of heads in Layers 3 and 5.

- The methods to achieve the Guidance Level have not yet been developed, nor has the effectiveness of these methods to comply with the Guidance Level been simulated and evaluated. The methods to achieve the Guidance Level could include but are not limited to: voluntary modification of pumping patterns; in-lieu recharge; wet-water recharge via spreading and/or injection; or a combination of methods. These methods could necessitate: voluntary modification of water-supply plans of the purveyors in the Chino Basin; modification of Watermaster practices for recharge and replenishment; and/or the implementation of regional-scale storage or conjunctive-use programs. The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered “preliminary” until such work is performed.

- Additional SMAs should be developed and evaluated with the 1D Models to generate the necessary information to establish a Guidance Level in the *Subsidence Management Plan for Northwest MZ-1*. The additional SMAs could be developed during Watermaster’s upcoming groundwater modeling efforts associated with the *2025 Safe Yield Reevaluation* and the development of the *Storage and Recovery Master Plan*. The GLMC should participate in the scenario building exercises associated with these Watermaster efforts to develop the SMAs, so that the scenarios include various methods to achieve the Guidance Level. Then, the 1D Models should be used to evaluate the potential future subsidence in Northwest MZ-1 under the SMAs. These model results and evaluations will support the establishment of a Guidance Level in the *Subsidence Management Plan for Northwest MZ-1*. It should be noted that future monitoring and analyses always hold the potential for changes to the Guidance Level, consistent with the adaptive management approach called for in the Chino Basin Subsidence Management Plan.

Table 1. Projected Pumping at Wells in Northwest MZ-1 for Subsidence Management Alternative #1

Well Name	Well Owner	Well Layers	Historical Pumping FY 2010-18 (afy)	Annual Projected Pumping by Fiscal Year[1] (af)																					
				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2	Pomona	1	1,362	0	1,190	1,190	1,190	1,200	1,200	1,200	1,200	1,200	1,210	1,210	1,210	1,210	1,220	1,210	1,220	1,220	1,220	1,220	1,220	1,220	1,220
5B	Pomona	1,3	725	500	850	850	850	850	850	850	850	850	860	860	860	860	860	860	860	860	870	860	860	860	870
6	Pomona	1,3	101	640	900	890	900	900	900	900	900	900	910	910	910	910	910	910	910	910	920	910	910	910	920
10	Pomona	1,3	1,258	1,130	1,000	990	1,000	1,000	1,000	1,000	1,000	1,000	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,020	1,020	1,020	1,020	1,020	1,020
15	Pomona	1	355	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Pomona	1	353	550	850	850	850	850	850	850	850	850	860	860	860	860	860	860	860	860	870	860	860	860	870
17	Pomona	1,3	235	420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Pomona	1	649	340	800	800	800	800	800	800	800	800	810	810	810	810	810	810	810	810	810	810	810	810	810
23	Pomona	1,3	864	410	900	890	900	900	900	900	900	900	910	910	910	910	910	910	910	910	920	910	910	910	920
25	Pomona	1,3	1,541	1,540	1,090	1,090	1,100	1,100	1,100	1,100	1,100	1,100	1,110	1,110	1,110	1,110	1,110	1,110	1,120	1,120	1,120	1,120	1,120	1,120	1,120
26	Pomona	1,3	569	270	500	500	500	500	500	500	500	500	500	500	500	500	510	510	510	510	510	510	510	510	510
27	Pomona	1,3	525	1,250	800	800	800	800	800	800	800	800	810	810	810	810	810	810	810	810	810	810	810	810	810
29	Pomona	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Pomona	1,3	1,296	1,490	1,190	1,190	1,190	1,200	1,200	1,200	1,200	1,200	1,210	1,210	1,210	1,210	1,220	1,210	1,220	1,220	1,220	1,220	1,220	1,220	1,220
35	Pomona	1,3	7	0	500	500	500	500	500	500	500	500	500	500	500	500	510	510	510	510	510	510	510	510	510
36	Pomona	1,3	1,007	730	800	800	800	800	800	800	800	800	810	810	810	810	810	810	810	810	810	810	810	810	810
Margarita #1	GSWC	1	447	530	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370
4	MVWD	1	247	290	190	190	180	180	180	180	180	180	180	180	180	190	190	190	190	190	190	190	190	190	190
5	MVWD	1,3	1,084	1,020	660	650	650	640	640	640	640	640	640	650	650	650	650	650	650	660	660	660	660	660	670
10	MVWD	1,3	165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	MVWD	1,3,5	1,997	2,480	800	790	790	780	780	770	780	780	780	780	790	790	790	790	800	800	800	800	800	810	810
26	MVWD	1,3,5	1,789	1,330	890	880	880	870	870	860	870	870	870	880	880	880	890	890	890	890	900	900	900	900	910
27	MVWD	1,3,5	384	370	100	100	90	90	80	80	80	80	90	90	90	100	100	100	110	110	110	110	120	120	120
28	MVWD	1,3,5	2,129	1,540	870	860	860	850	850	840	840	850	850	850	860	860	860	860	870	870	870	870	880	880	880
30	MVWD	1,3,5	182	330	100	100	90	90	80	80	80	80	90	90	90	100	100	100	110	110	110	110	120	120	120
31	MVWD	1,3,5	967	370	940	930	920	920	920	910	910	920	920	920	920	930	930	930	940	940	940	940	950	950	950
32	MVWD	1,3,5	495	310	100	100	90	90	80	80	80	80	90	90	90	100	100	100	110	110	110	110	120	120	120
33	MVWD	1,3,5	659	0	940	930	920	920	920	910	910	920	920	920	920	930	930	930	940	940	940	940	950	950	950
34	MVWD	1,3,5	244	0	940	930	920	920	920	910	910	920	920	920	920	930	930	930	940	940	940	940	950	950	950
Subtotal from Layers 1 and 3			*12,790*	*11,110*	*12,590*	*12,550*	*12,580*	*12,590*	*12,590*	*12,590*	*12,590*	*12,590*	*12,700*	*12,710*	*12,710*	*12,720*	*12,760*	*12,740*	*12,770*	*12,790*	*12,830*	*12,790*	*12,790*	*12,790*	*12,840*
Subtotal from Layers 1, 3, and 5			*8,845*	*6,730*	*5,680*	*5,620*	*5,560*	*5,530*	*5,500*	*5,440*	*5,460*	*5,500*	*5,530*	*5,540*	*5,560*	*5,620*	*5,630*	*5,630*	*5,710*	*5,710*	*5,720*	*5,720*	*5,790*	*5,800*	*5,810*
Total			**21,635**	**17,840**	**18,270**	**18,170**	**18,140**	**18,120**	**18,090**	**18,030**	**18,050**	**18,090**	**18,230**	**18,250**	**18,270**	**18,340**	**18,390**	**18,370**	**18,480**	**18,500**	**18,550**	**18,510**	**18,580**	**18,590**	**18,650**

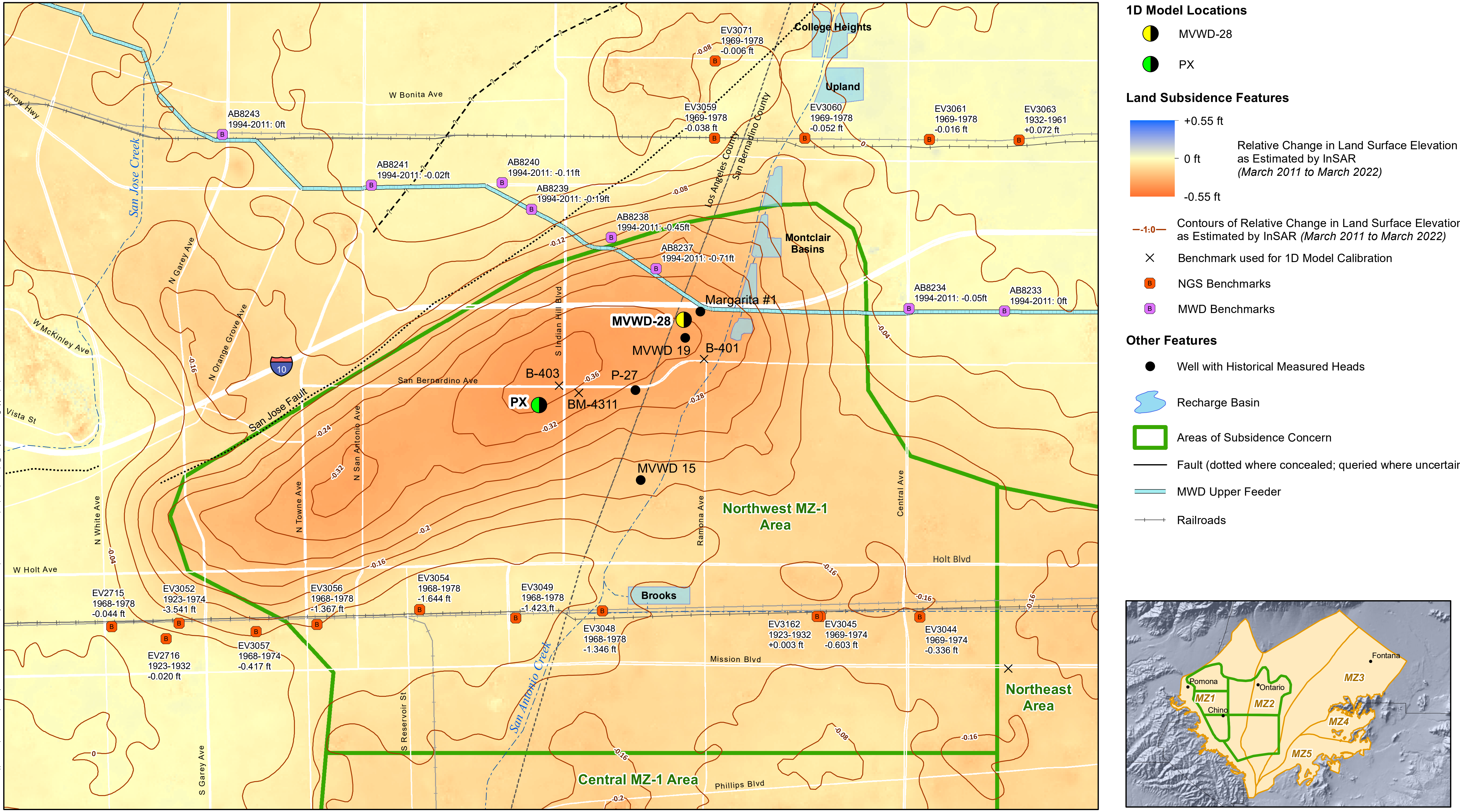
[1] Annual pumping is constant after FY 2040.

Table 2. Projected Managed Recharge Near Northwest MZ-1 for the Baseline Management Alternative

Managed Recharge Type	Historical Recharge FY 2010-18 (afy)	Annual Projected Recharge Volume Near Northwest MZ-1 by Fiscal Year[1,2] (af)																						
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Stormwater	1,528	2,520	2,500	2,520	2,620	2,610	2,590	2,610	2,610	2,610	2,590	2,610	2,610	2,610	2,590	2,610	2,610	2,610	2,590	2,610	2,610	2,610	2,580	2,600
Recycled Water	1,177	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
Imported Water	6,748	0	0	0	0	0	0	0	0	10	150	350	510	320	760	1,200	1,630	2,060	2,380	2,690	3,010	3,330	3,550	2,810
Total	**9,453**	**4,170**	**4,150**	**4,170**	**4,270**	**4,260**	**4,240**	**4,260**	**4,260**	**4,270**	**4,390**	**4,610**	**4,770**	**4,580**	**5,000**	**5,460**	**5,890**	**6,320**	**6,620**	**6,950**	**7,270**	**7,590**	**7,780**	**7,060**

[1] Tabulated recharge includes recharge in College Heights Basins, Upland Basin, Montclair Basins, Brooks Basin, and MVWD ASR wells. No imported water recharge is projected to occur via ASR wells.

[2] Annual managed recharge is constant from FY 2041 through FY 2050.



0 1 2 Miles

0 2 4 Km

Prepared by:

WEST YOST
Water. Engineered.

Draft

Figure 1

Locations of PX and MVWD-28 1D Models and Historical Elevation Surveys at Benchmarks

Chino Basin Watermaster
Ground-Level Monitoring Committee
Subsidence Management Plan for Northwest MZ-1

Figure 2. PX Site: CVM Layers, Borehole Lithology, 1D Model Cells, and Resistivity Log

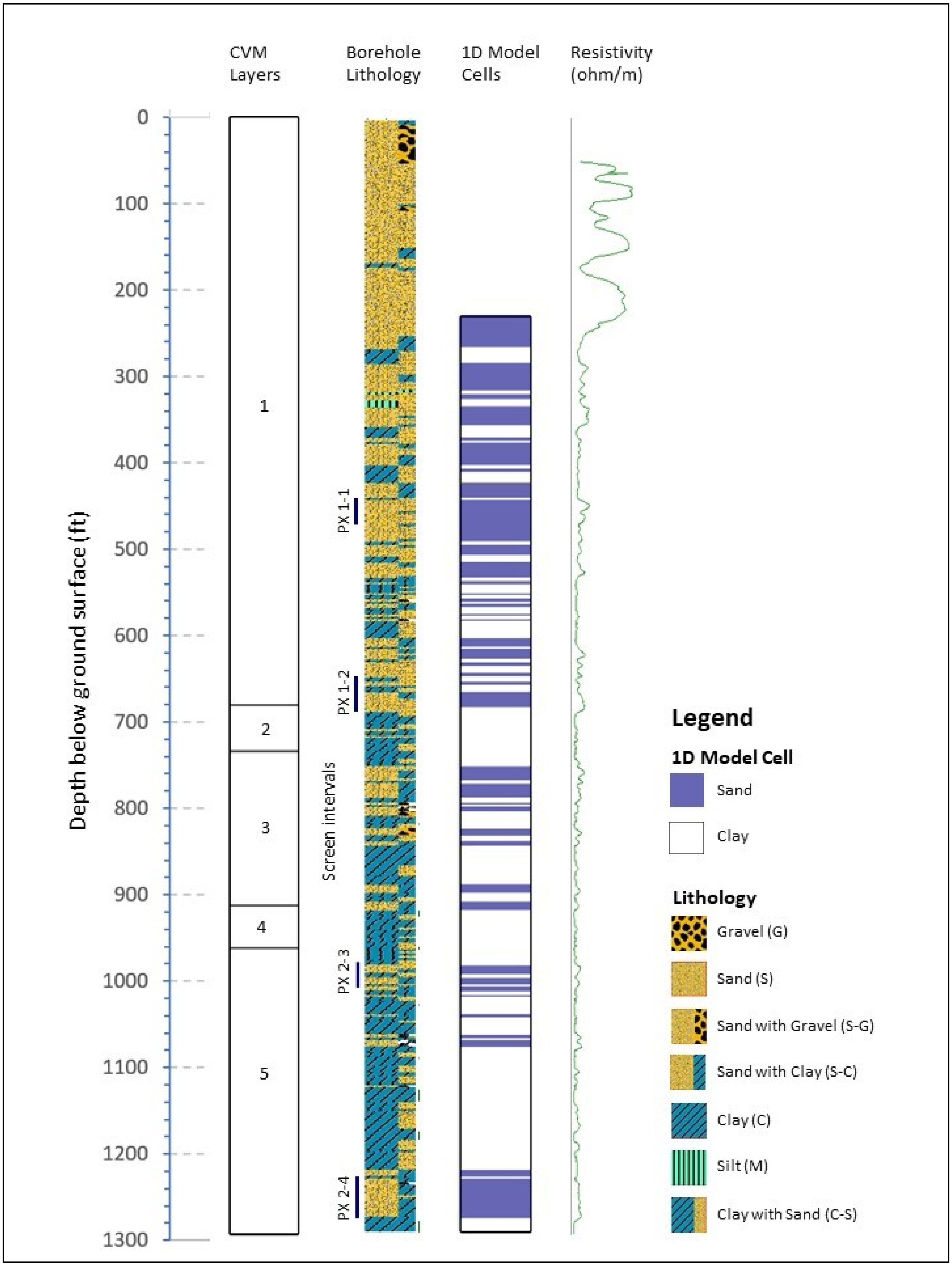
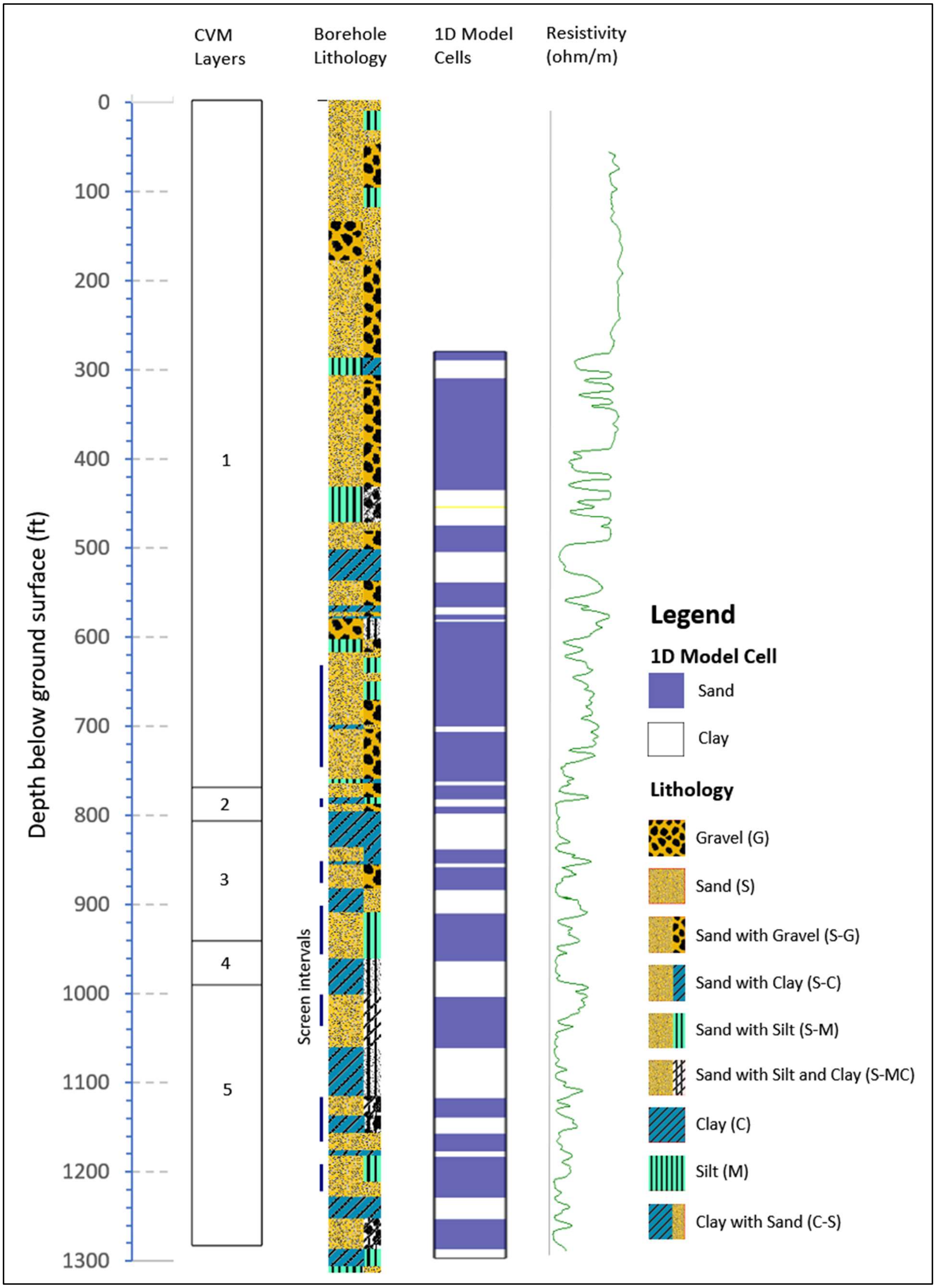
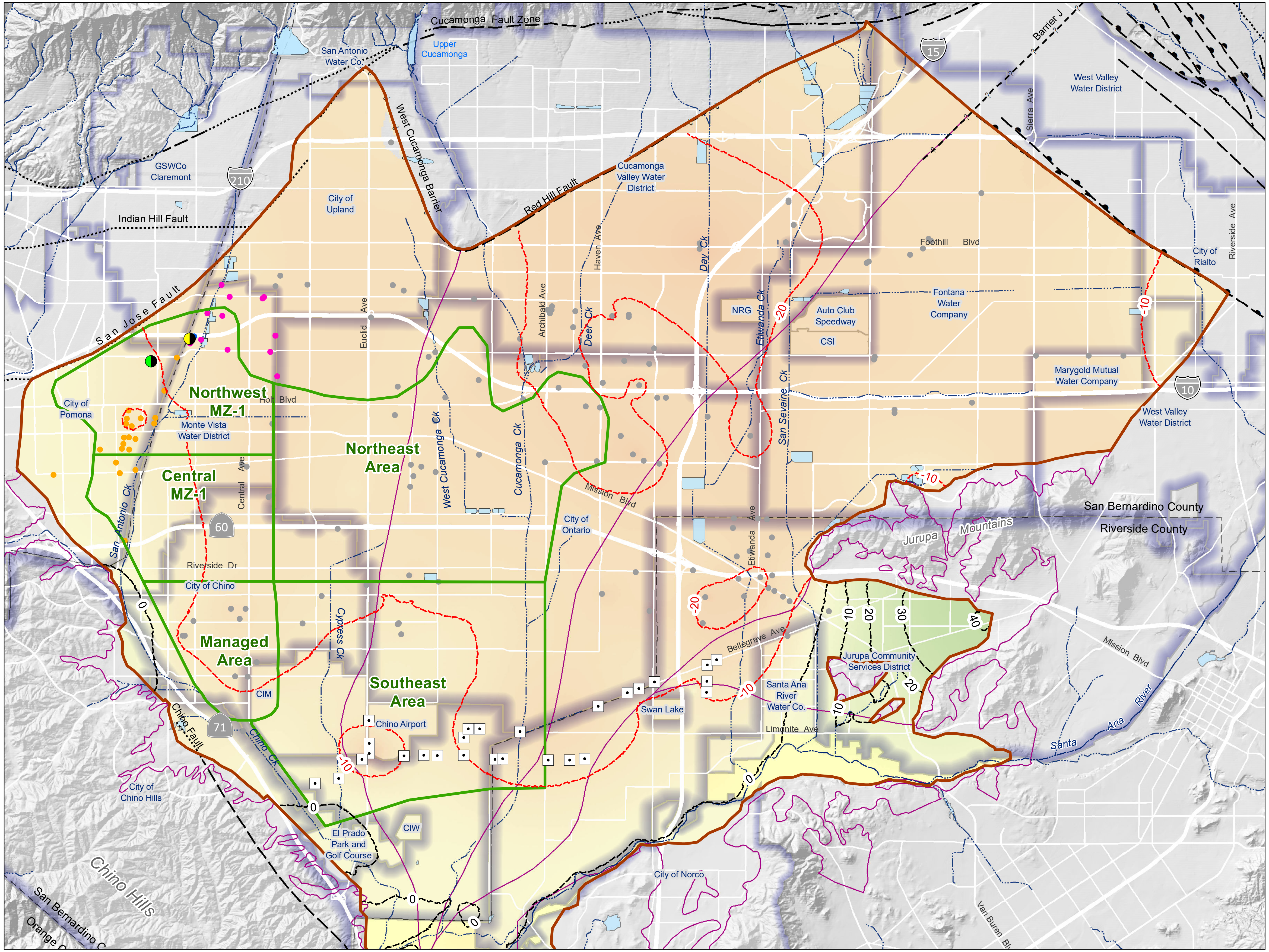


Figure 3. MVWD-28 Site: CVM Layers, Borehole Lithology, 1D Model Cells, and Resistivity Log





Contour of Difference in Hydraulic Head (ft) Positive Change *July 2018 through June 2050 - SMA-1*

Contour of Difference in Hydraulic Head (ft) Negative Change *July 2018 through June 2050 - SMA-1*

Difference in Hydraulic Head (ft)
July 2018 through June 2050 - SMA-1

100 — *Increasing*
0
-100 — *Decreasing*

1D Model Locations

- MVWD-28
- PX

Wells

- Monte Vista Water District
- City of Pomona
- Golden State Water Co.
- Other Appropriative Pool
- Chino Desalter Wells

Other Features

- Streams & Flood Control Channels
- Flood Control & Conservation Basins
- Areas of Subsidence Concern
- Water Service Area
- Chino Basin Part of the Active CVM MODFLOW Domain
- OBMP Management Zones

Prepared by:
WEST YOST

Author: GR
Date: 2/21/2023
File: Figure 2 SYR_2050-2018_L1.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 Km

Prepared for:

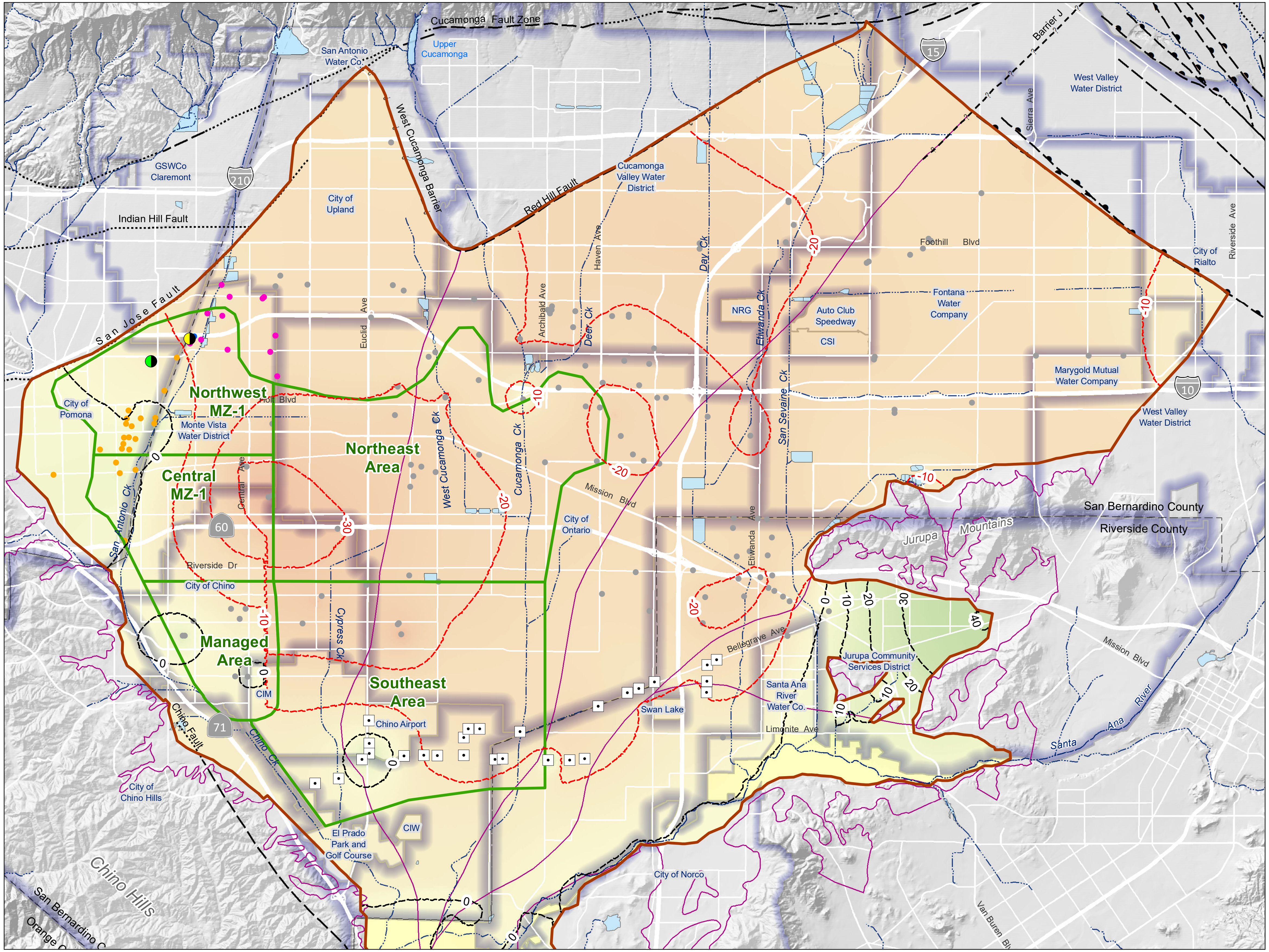
Evaluation of Land Subsidence in Northwest MZ-1 under SMA-1

CHINO BASIN WATERMASTER — Partners in Basin Management

Projected Difference in Hydraulic Head for Layer 1
Subsidence Management Alternative #1
July 2018 through June 2050

Draft

Figure 4



Contour of Difference in Hydraulic Head (ft) Positive Change *July 2018 through June 2050 - SMA-1*

Contour of Difference in Hydraulic Head (ft) Negative Change *July 2018 through June 2050 - SMA-1*

Difference in Hydraulic Head (ft)
July 2018 through June 2050 - SMA-1

100 — *Increasing*
0
-100 — *Decreasing*

1D Model Locations

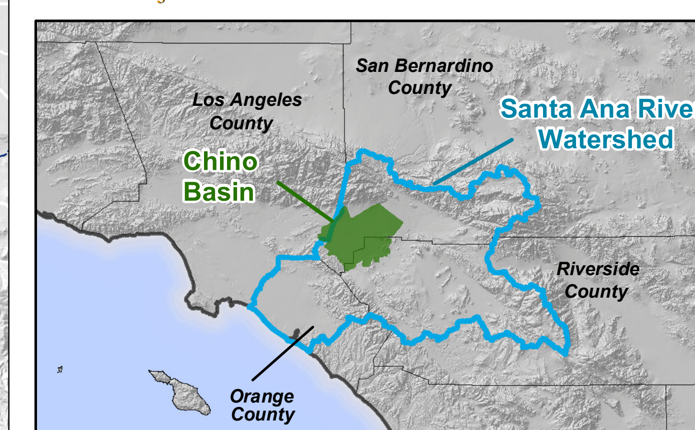
- MVWD-28
- PX

Wells

- Monte Vista Water District
- City of Pomona
- Golden State Water Co.
- Other Appropriative Pool
- Chino Desalter Wells

Other Features

- Streams & Flood Control Channels
- Flood Control & Conservation Basins
- Areas of Subsidence Concern
- Water Service Area
- Chino Basin Part of the Active CVM MODFLOW Domain
- OBMP Management Zones



Prepared by:

WEST YOST

Author: GR
Date: 2/21/2023
File: Figure 3 SYR_2050-2018_L3.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 Km

Prepared for:

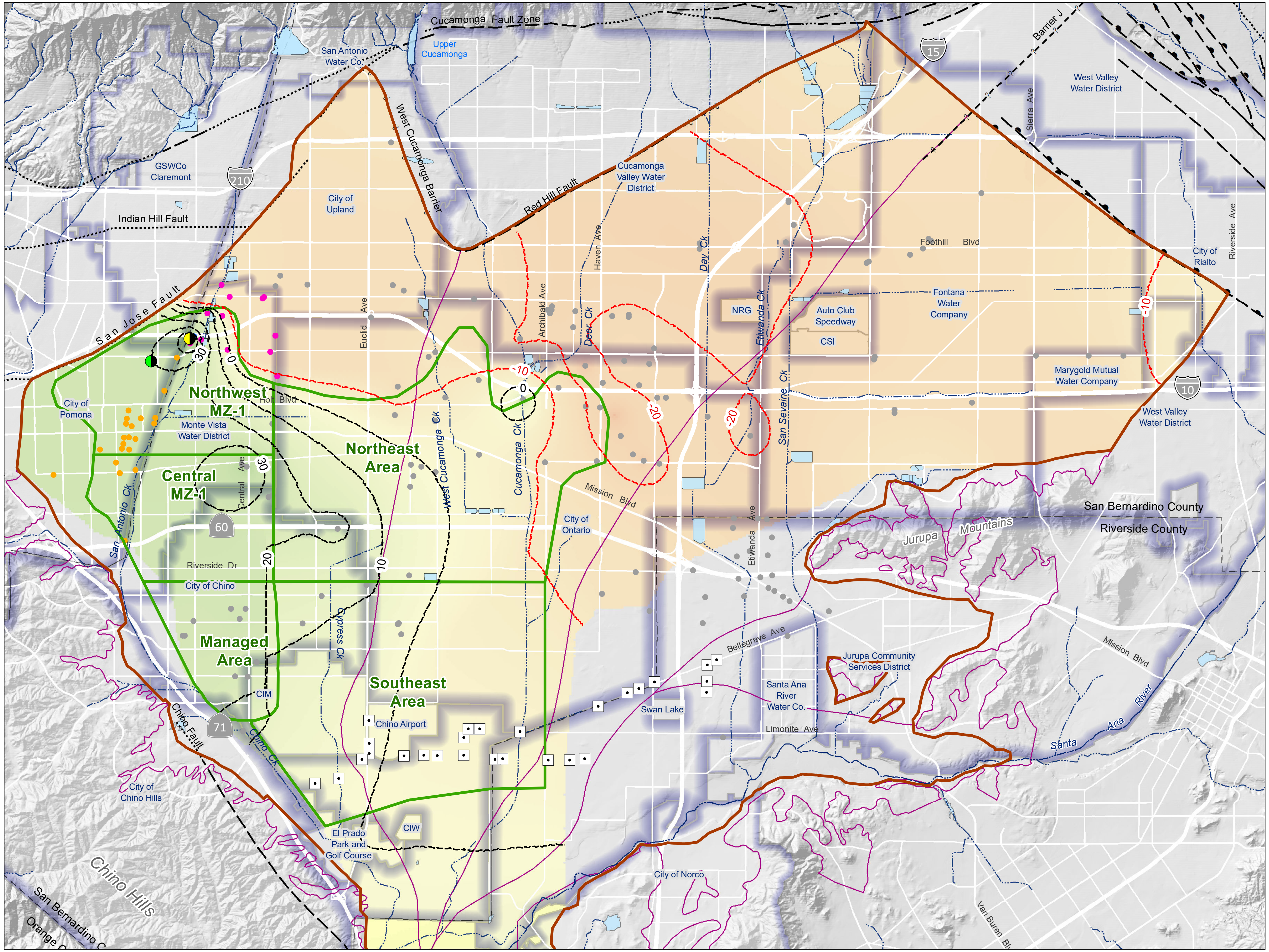
Evaluation of Land Subsidence in Northwest MZ-1 under the SMA-1

CHINO BASIN WATERMASTER — Partners in Basin Management

Projected Difference in Hydraulic Head for Layer 3
Subsidence Management Alternative #1
July 2018 through June 2050

Draft

Figure 5



Contour of Difference in Hydraulic Head (ft) Positive Change *July 2018 through June 2050 - SMA-1*

Contour of Difference in Hydraulic Head (ft) Negative Change *July 2018 through June 2050 - SMA-1*

Difference in Hydraulic Head (ft)
July 2018 through June 2050 - SMA-1

100 — *Increasing*
0
-100 — *Decreasing*

1D Model Locations

- MVWD-28
- PX

Wells

- Monte Vista Water District
- City of Pomona
- Golden State Water Co.
- Other Appropriative Pool
- Chino Desalter Wells

Other Features

- Streams & Flood Control Channels
- Flood Control & Conservation Basins
- Areas of Subsidence Concern
- Water Service Area
- Chino Basin Part of the Active CVM MODFLOW Domain
- OBMP Management Zones

Prepared by:

WEST YOST

Author: GR
Date: 2/21/2023
File: Figure 4 SYR_2050-2018_L5.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 Km

Prepared for:

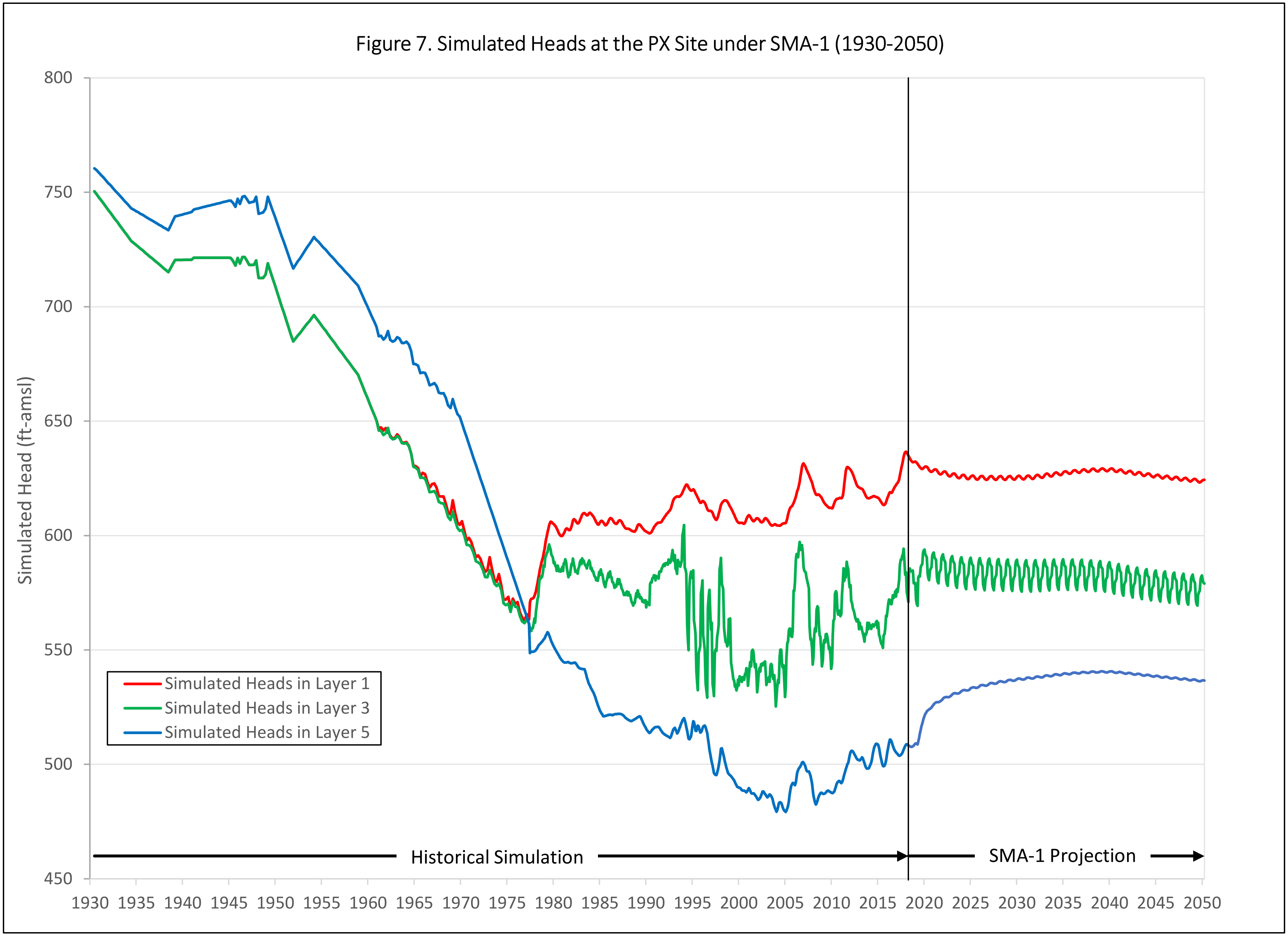
Evaluation of Land Subsidence in Northwest MZ-1 under SMA-1

Projected Difference in Hydraulic Head for Layer 5

Subsidence Management Alternative #1
July 2018 through June 2050

Draft

Figure 6



WEST YOST

941-80-23-25

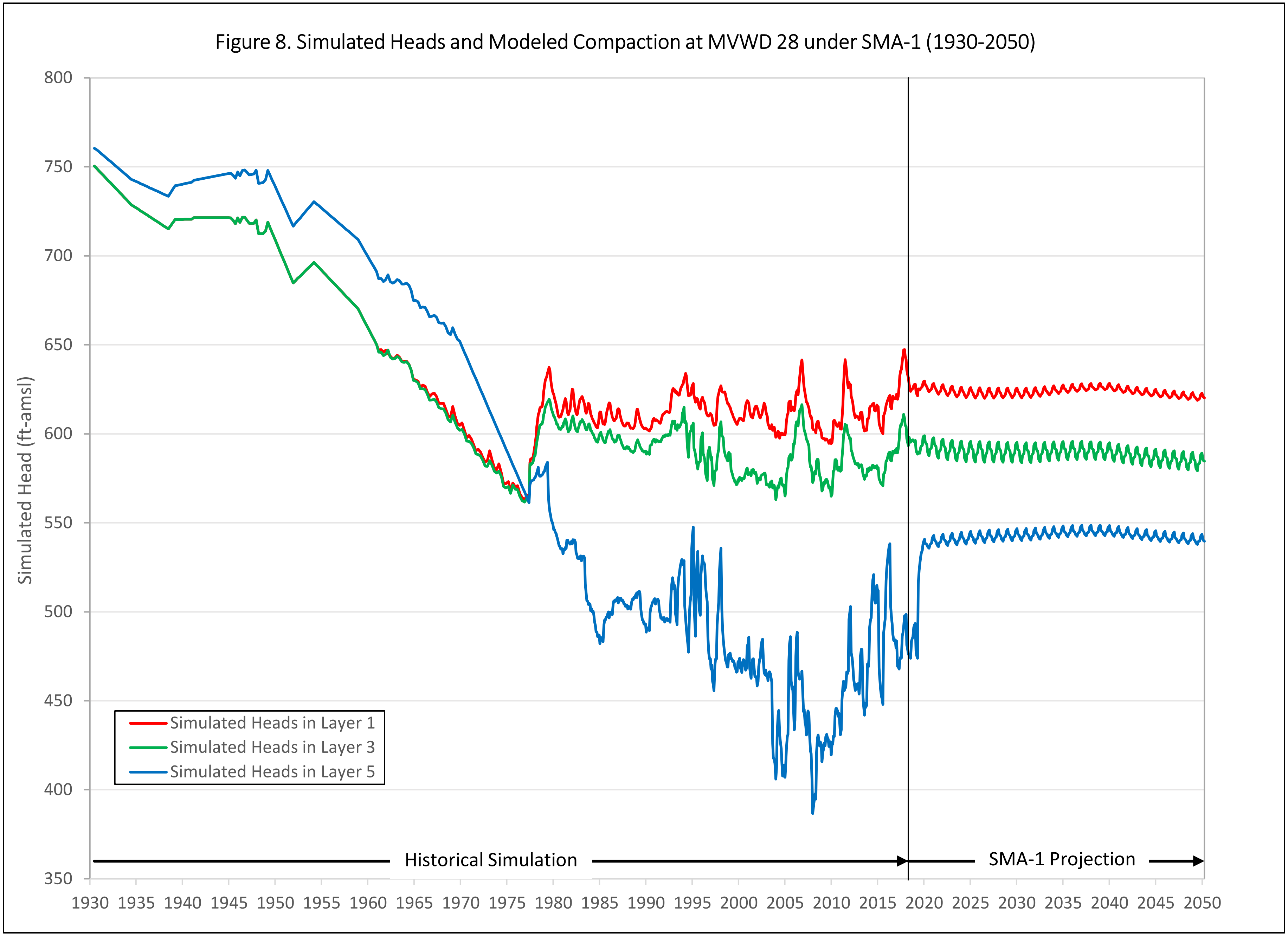


Figure 8. Simulated Heads and Modeled Compaction at MVWD 28 under SMA-1 (1930-2050)
Simulated Head (ft-amsl)
800
750
700
650
600
550
500
450
400
350
1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Simulated Heads in Layer 1
Simulated Heads in Layer 3
Simulated Heads in Layer 5
Historical Simulation
SMA-1 Projection

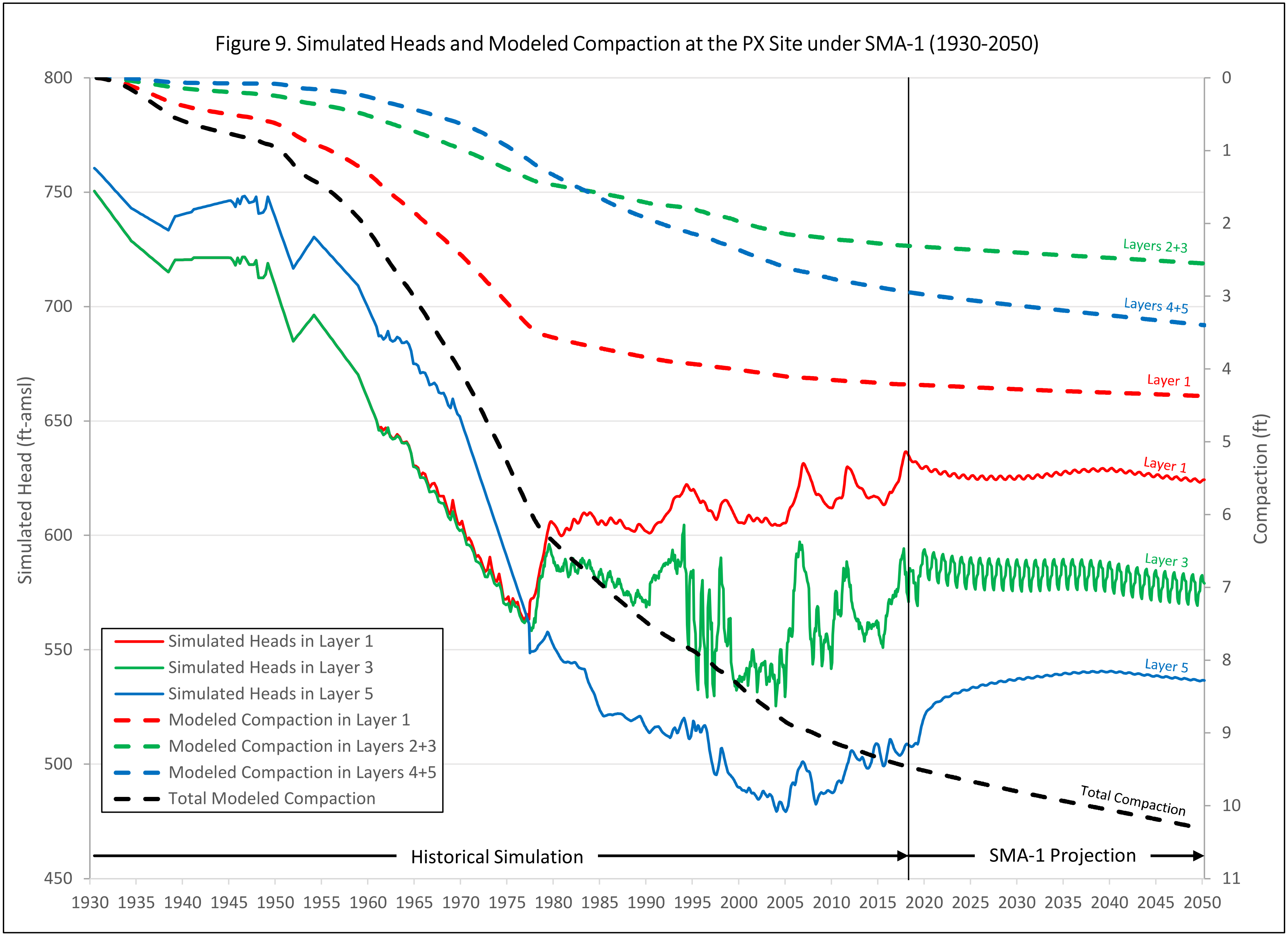
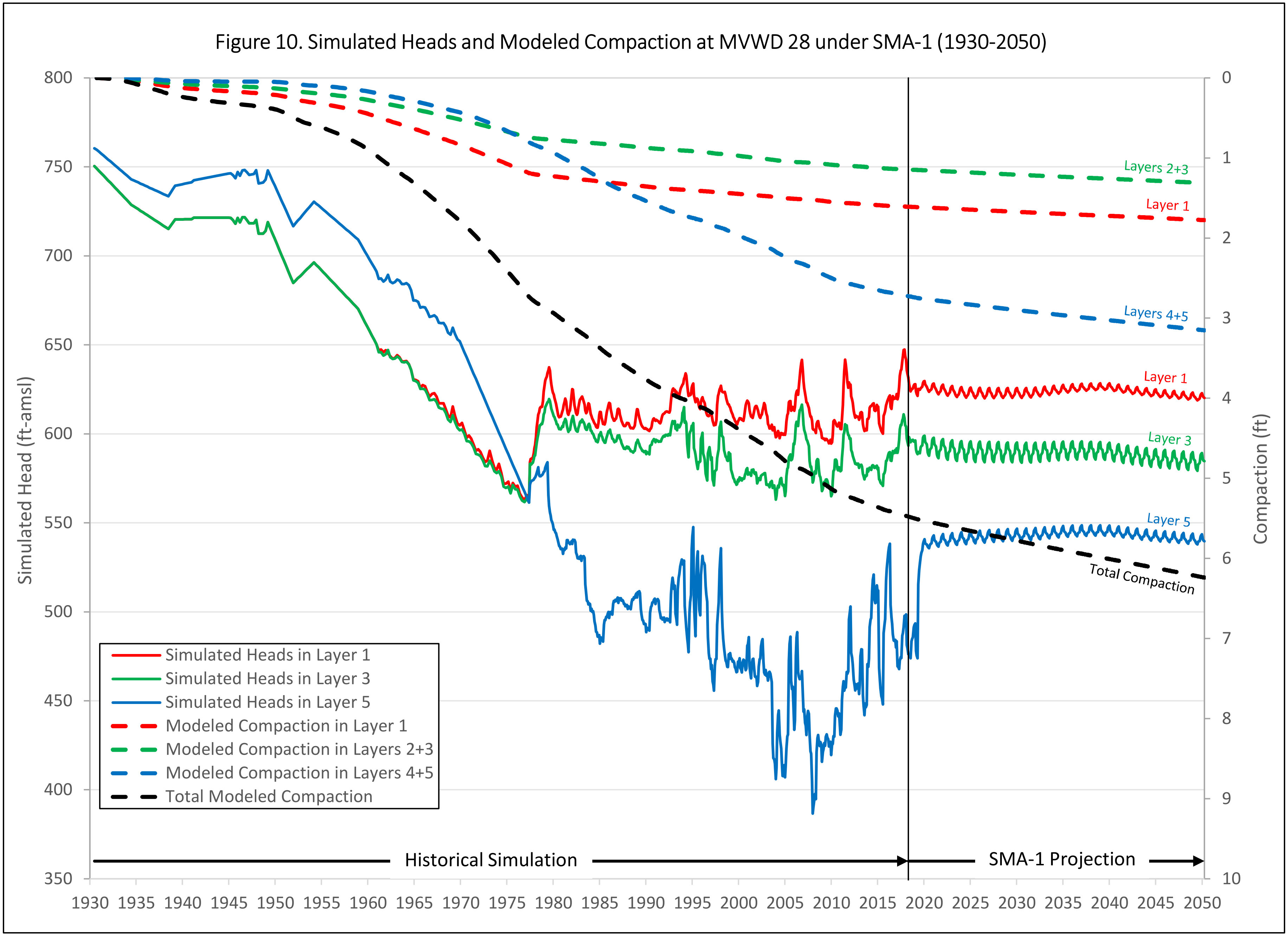


Figure 9. Simulated Heads and Modeled Compaction at the PX Site under SMA-1 (1930-2050)
Simulated Head (ft-amsl)
Compaction (ft)
800
750
700
650
600
550
500
450
0
1
2
3
4
5
6
7
8
9
10
11
1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Layers 2+3
Layers 4+5
Layer 1
Layer 1
Layer 3
Layer 5
Total Compaction
Simulated Heads in Layer 1
Simulated Heads in Layer 3
Simulated Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction
Historical Simulation
SMA-1 Projection



WEST YOST

941-80-23-25

Ground-Level Monitoring Committee
Subsidence Management Alternative #1
Last Revised: 08-30-2023

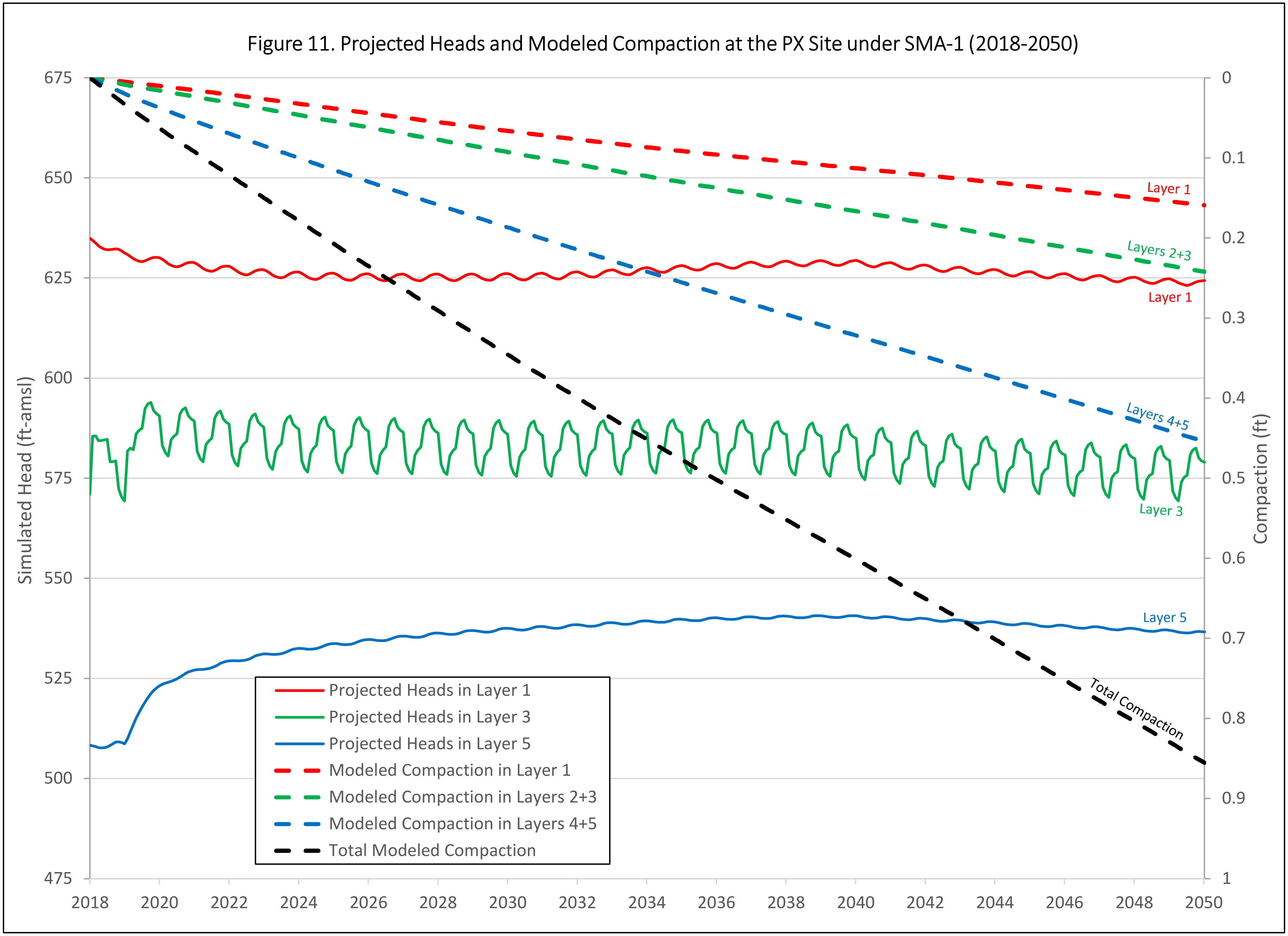


Figure 11. Projected Heads and Modeled Compaction at the PX Site under SMA-1 (2018-2050)
Simulated Head (ft-amsl)
Compaction (ft)
675
650
625
600
575
550
525
500
475
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Layer 1
Layers 2+3
Layer 1
Layers 4+5
Layer 3
Layer 5
Total Compaction
Projected Heads in Layer 1
Projected Heads in Layer 3
Projected Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction

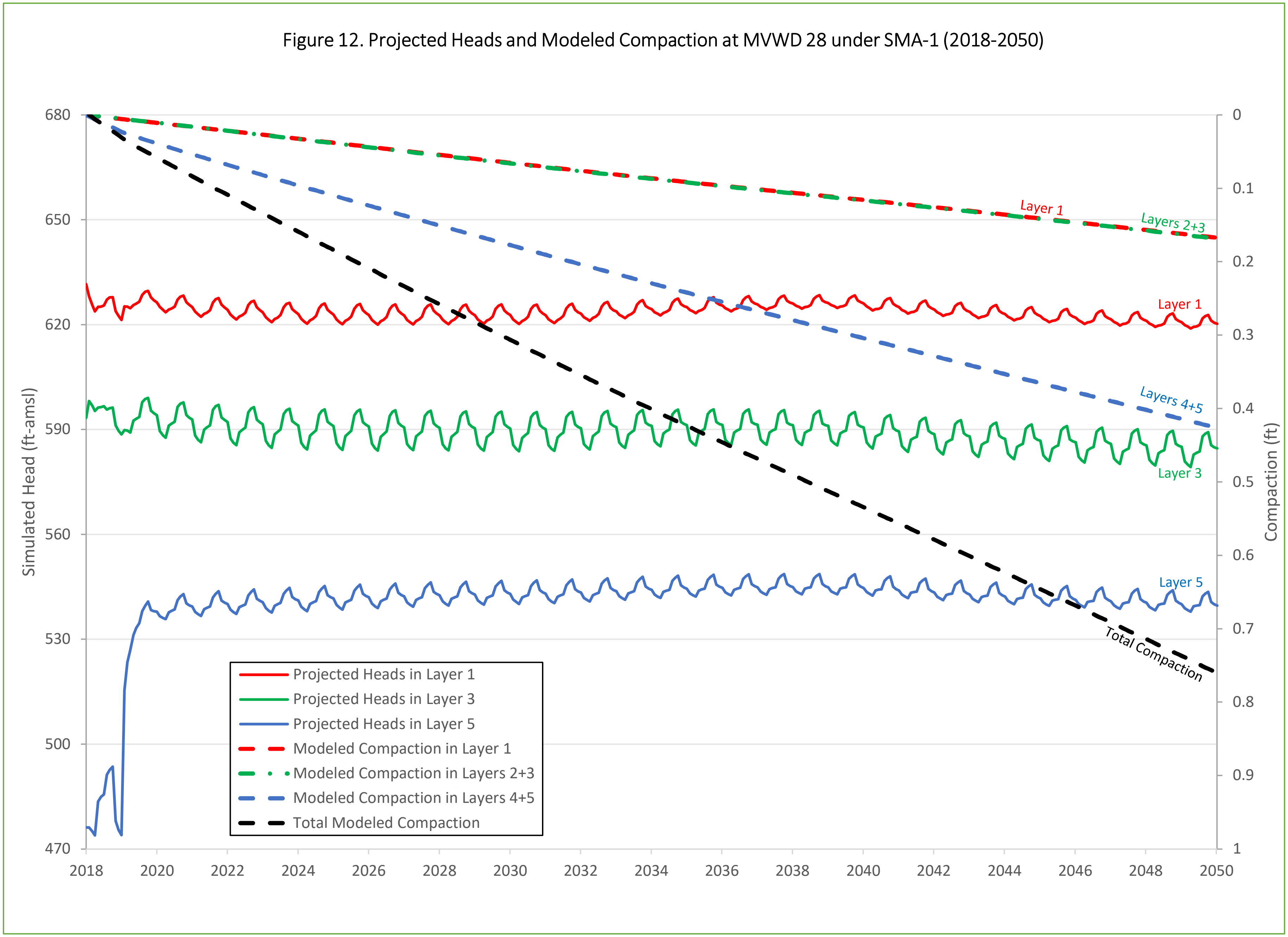


Figure 12. Projected Heads and Modeled Compaction at MVWD 28 under SMA-1 (2018-2050)
Simulated Head (ft-amsl)
Compaction (ft)
680
650
620
590
560
530
500
470
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Layer 1
Layers 2+3
Layer 1
Layers 4+5
Layer 3
Layer 5
Total Compaction
Projected Heads in Layer 1
Projected Heads in Layer 3
Projected Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction

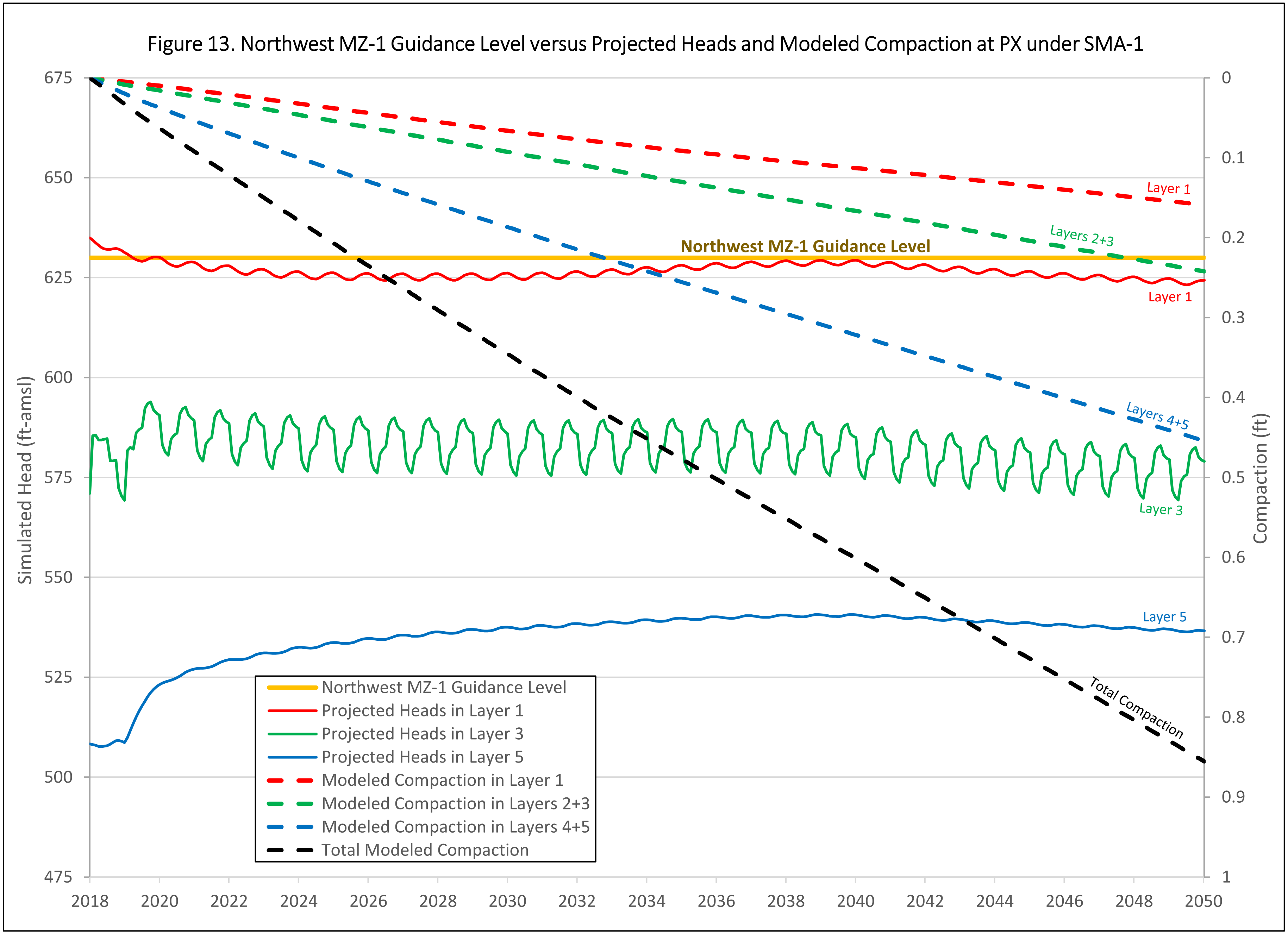


Figure 13. Northwest MZ-1 Guidance Level versus Projected Heads and Modeled Compaction at PX under SMA-1
Simulated Head (ft-amsl)
Compaction (ft)
675
650
625
600
575
550
525
500
475
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Northwest MZ-1 Guidance Level
Layer 1
Layers 2+3
Layer 1
Layers 4+5
Layer 3
Layer 5
Total Compaction
Northwest MZ-1 Guidance Level
Projected Heads in Layer 1
Projected Heads in Layer 3
Projected Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction

STATE OF CALIFORNIA/WSP USA (RICHARD REES, PG, CHG)

Comment 1 – Guidance Level

We note that the preliminary proposed "Guidance Level" for the area is very conservative, with proposed hydraulic pressure heads in Layers 3 and 5 that have not been observed since the mid-1960s to early 1970s. The TM states that the "The methods to achieve the Guidance Level have not yet been developed, nor has the effectiveness of these methods to comply with the Guidance Level been simulated and evaluated. Hence, the Guidance Level proposed herein should be considered 'preliminary' until such work is performed." Consider adding that it is unknown if it is practical to achieve the Guidance Level.

Response:

The Conclusions and Recommendation section has been revised. The second to last bullet now includes the sentence:

"The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered "preliminary" until such work is performed."

Comment 2 – Figure 5

Figure 5 – contours of the negative differences in hydraulic heads south-southeast of the Central MZ-1 are odd, with the negative 10-foot and negative 20-foot contours overlapping. Please verify that this is correctly contoured.

Response:

The figure is correctly contoured. The overlapping and terminal contours are an artifact of the Riley Barrier, which is a groundwater barrier within the deep aquifer system that causes abrupt offsets in hydraulic head.

MONTE VISTA WATER DISTRICT (JUSTIN SCOTT-COE)

Comment 1 – General Comment

In general, the District recommends additional analysis before the recommendation of “preliminary” guidance levels to Chino Basin Watermaster (Watermaster). The District recommends removing the recommendation to Watermaster prior to assessing the guidance level further versus a No Action alternative and establishing on-the-ground monitoring at the extensometer. Understanding how guidance levels will affect wellfield operations, water levels, and projected subsidence should come ahead of the release of guidance levels or recommendations to establish guidance levels.

Response:

The preliminary “Guidance Level” is the Watermaster Engineer’s best current estimate for depth-specific hydraulic heads in Northwest MZ-1 to reduce or abate the future occurrence of subsidence.

The TM has been revised to recognize that: “The methods to achieve the Guidance Level have not yet been explored and developed, nor has the effectiveness of these methods to comply with the Guidance Level been simulated and evaluated….The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered “preliminary” until such work is performed.”

We encourage the parties to begin to explore potential methods to achieve the Guidance Level during the 2025 Safe Yield Reevaluation and the development of the Storage and Recover Master Plan.

In the meantime, the monitoring program in Northwest MZ-1 is planned to proceed and the additional data collected (e.g., hydraulic heads, ground motion, etc.) can be used in the future to verify and/or improve the 1D Models and refine the Guidance Level.

Comment 2 – Pg 4 “However, the GLMC subsequently recommended to...”

As expressed by the District in prior correspondence and agreed to by Watermaster, the GLMC serves as a gathering of stakeholder representatives for the provision of advice to Watermaster. The GLMC has neither decision-making authority nor ability to make recommendations or take any other formal action. Therefore, the District requests that this language be revised to avoid the suggestion that this recommendation represents the collective perspective of GLMC.

Response:

The text has been modified to read:

“However, with input from the GLMC, the Watermaster Engineer subsequently recommended to use the 1D Models directly to develop the *Subsidence Management Plan for Northwest MZ-1*.”

Comment 3 – Pg 5 Develop SMA-1 with review and input from the GLMC; Pg 6 Pumping Projections; Table 1

In correspondence dated April 7, 2023, the District provided projected pumping requirements as part of its participation in the GLMC's review of Subsidence Management Alternative 1 (SMA-1). These projected pumping requirements included projected pumping of 2,100 acre-feet per year (AFY) of City of Chino Hills production rights consistent with the agencies' wholesale water supply agreement, current practice, and future plans. In total, the SMA-1 appears to include ~2,250 AFY less production than the District's projections (8,600 AFY as reflected in the District's correspondence vs. 6,350 AFY as reflected in Table 1 for 2023). Please revise the TM's language to reflect the receipt of the District's input, and consider updating Table 1 and SMA-1 to reflect the District's actual pumping projections.

Response:

SMA-1 is equivalent to the planning scenario that was simulated to support the 2020 Safe Yield Recalculation (2020 SYR) using the 2020 CVM. The 2020 SYR was intended to represent and simulate the Parties' projected pumping, recharge, and use of storage through 2050. This scenario spanned from fiscal year (FY) 2018 through 2050 and included the cultural conditions (e.g., land use, water supply plans) that were assumed based on the best-available planning data at the time of the 2020 SYR. We understand that pumping projections in SMA-1 are not the current pumping projections of the parties. However, the advantage of using 2020 SYR as the planning scenario for SMA-1 is that the CVM modeling is complete and the simulated hydraulic heads by model layer are readily available for use as input data for the 1D Models.

Updated pumping projections (as well as other planning information, such as managed recharge and use of managed storage) will be used to develop and simulate subsequent SMAs using updated versions of the CVM and the 1D Models. Such modeling exercises can be conducted in concert with the 2025 Safe Yield Reevaluation and the development of the Storage and Recovery Master Plan.

Comment 4 – Pg 5 Evaluate model results and develop recommendations

The District continues to be concerned about the lack of physical evidence and means of verification of the conceptual model. The model has projected 7 to 9 feet of subsidence over the historical period as a result of lowering of water levels from 1930 through 1978. Since this period, water levels have stabilized and are projected to recover, while the model continues to project compaction from delayed depressurization. The current projections are dependent upon the model estimates of the timing of this depressurization from 50+ years ago, which are related to the thickness/uniformity/parameterization of the clay units in the model. Lack of observational data increases the uncertainty in the modeling projections.

Extensometer data could provide some measurement/monitoring of current conditions but, so far, has not been successful in Northwest MZ-1. The District recommends developing this baseline data prior to making recommendations solely based on the 1-D Modeling.

Response:

Although the new extensometers at the PX facility are not yet providing reliable data, an extensive database of historical data in Northwest MZ-1 were used to construct and calibrate the 1D Models, including: detailed borehole lithology data at the PX and MVWD-28 wells, hydraulic heads at wells (1930-present), InSAR estimates of vertical ground motion (1992-present), and ground-level surveys (1923-present).

It will always be the case that historical data (i.e., head data or vertical ground motion data) will be limited, and these limited data create some degree of uncertainty in the model simulations. That said, based on the results of the 1D Model calibration and the sensitivity analysis, the Watermaster Engineer and the majority of the technical consultants on the GLMC stated that the 1D Models are sufficiently calibrated to provide a useful tool for evaluating potential future subsidence under future planning scenarios. The GLMC consultant for MVWD concurred verbally at the December 13, 2022 GLMC meeting.

Comment 5 – Pg 5 Evaluate model results and develop recommendations

The District recommends a more comprehensive evaluation of the guidance level prior to making recommendations. Understanding the difference between the alternative management actions is key to understanding if the proposed guidance will be effective. The District recommends running an alternative with the guidance levels in place to show the difference between the "No Action" and guidance level alternative.

Response:

We agree that additional SMAs should be developed, simulated with the CVM and 1D Models, and evaluated to refine the "preliminary" Guidance Level. As a start, such modeling exercises can be conducted in concert with the 2025 Safe Yield Reevaluation and the development of the Storage and Recovery Master Plan.

Comment 6 – Pg 7 Hydrologic Response of the Aquifer System to SMA-1; Tables 1 and 2

Is it possible to include groundwater levels, groundwater pumping, and recharge information to understand the difference between projected conditions and current conditions? A brief discussion on recent operations and how they have affected conditions in Northwest MZ-1 will aid discussion of model updates in the next round of modeling.

Response:

Tables 1 and 2 contain a column that describes historical pumping and recharge (average for 2010-2018) to compare against remaining columns in the tables that describe the projected pumping and recharge (2019-2040). This was done to "understand the difference between projected conditions and current conditions."

We agree that subsequent SMAs and updates to the 1D Models should leverage new information on recent operations (pumping and recharge).

Comment 7 – Pg 9 Bullet 2 Conclusions and Recommendations

Does this lack of sensitivity to increases in head indicate that additional increases in Layer 5 will also be relatively insensitive? (e.g. modeled subsidence will not change significantly by implementing preliminary guidance levels?

Response:

This observation in the 1D Model results does not necessarily indicate that the compaction in Layer 5 is insensitive to changes in head. Additional model runs are necessary to determine such sensitivity. What this observation does indicate is that the compaction is due to the delayed drainage of aquitard layers, where pore pressures in the clay-rich sediments are continuing to equilibrate with head declines that occurred historically within the coarse-grained aquifer sediments. A subsequent SMA should be developed and simulated with the CVM and the 1D Models that purposefully increases heads in Layer 5 to estimate the effectiveness of the SMA to slow or stop the delayed drainage of the aquitards.

Comment 8 – Pg 9 Bullet 5 Conclusions and Recommendations

The District recommends removing the discussion of preliminary guidance at this time. As mentioned above, several critical steps have not been taken. The District recommends 1) establishing baseline monitoring at the extensometer to understand if current modeled compaction is consistent with measurement data from Northwest MZ-1; and 2) conducting analyses to understand if the 1-D Model projects the guidance to be effective relative to a “No action” alternative. The preliminary guidance lacks analysis of the costs and benefits of action vs. no action. Qualitative statements regarding vertical gradients between the aquifer layers in the area are not sufficient to establish guidance levels which have significant operational requirements and cost to achieve.

Response:

The Guidance Level proposed in the TM is both “preliminary” and provides “guidance” to the parties to direct future analysis, which is consistent with the objectives of the Chino Basin Subsidence Management Plan. The Guidance Level carries no regulatory effect. The preliminary Guidance Level is intended to assist the parties in planning for and making initial management decisions, not obligate them to any specific course of action.

Regarding the District’s recommendations:

1. The 1D Model calibrations utilized an extensive historical dataset of vertical ground motion to establish the ability of the 1D Models to simulation aquifer-system compaction and land subsidence. For example, the 1D Models sufficiently matched the historical InSAR estimates of vertical ground motion from 1990-2018.
2. We agree that additional analyses are necessary to evaluate various subsidence management strategies, their effectiveness at slowing or stopping the land subsidence, and their practicality of implementation. Specifically, subsequent SMAs should be developed and simulated with the CVM and the 1D Models that purposefully increases heads in Layer 5 to estimate the effectiveness of the SMA to slow or stop the delayed drainage of the aquitards. In addition, the costs and practicality of such SMAs will need to be evaluated before any Guidance Level is

finalized in the Chino Basin Subsidence Management Plan. This section of the TM has been revised to add the sentence: "The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered "preliminary" until such work is performed."

Comment 9 – Pg 9 Bullet 6 Conclusions and Recommendations

Future efforts need to be accompanied by monitoring at the extensometer and via other methods to assess the underlying conceptual model. Is delayed depressurization actually occurring and at levels projected by the 1-D Model given the absence of physical evidence?

Response:

There is sufficient physical evidence demonstrating delayed drainage of aquitards, consistent with the 1D Model results. Specifically, there is a long history of monitoring of groundwater levels and vertical ground motion by InSAR (1992-present) and ground-level/GPS surveys (1923-present)—all of which indicate gradual and persistent land subsidence in Northwest MZ-1 due to delayed drainage of aquitards. These monitoring efforts, including annual evaluation of the monitoring data, are ongoing and planned for the future.

The 1D Models are simulating the delayed drainage of aquitards at rates consistent with the recent monitoring data.

Comment 10 – Pg 9 Bullet 7 Conclusions and Recommendations

The District recommends removing this bullet point from this report, which focuses on the 1-D Model. If modeling and analysis (contour maps, vertical distribution, particle tracking, etc.) of existing contamination has been conducted, it should be documented more fully, perhaps in a stand-alone report or in future work. Absent presentation of supporting data, it is out of place here.

Response:

The bullet has been removed from the TM.

Comment 11 – Pg 10 Bullet 8 Conclusions and Recommendations

The analysis contemplated in this bullet point needs to be conducted prior to releasing a "preliminary" guidance level.

Response:

See response to Comment 1.

Comment 12 – Pg 10 Bullet 10 Conclusions and Recommendations

Ongoing monitoring data at the extensometer should also be mentioned here. In the last sentence, the District recommends removing mention of "finalization." These analyses are necessary to draft "preliminary" guidance levels, in addition to better understanding current conditions with monitoring.

Response:

The word "finalize" has been changed to "establish" in this bullet. A sentence was added to the end of this bullet: "It should be noted that future monitoring and analyses always hold the potential for changes to the Guidance Level, consistent with the adaptive management approach called for in the Chino Basin Subsidence Management Plan."

Comment 13 – Figures 2 and 3

How does the simplification of the logs into clay and sand units in the 1-D Model affect the delayed depressurization the model is showing? Does the conceptualization of the clay units exaggerate the delayed depressurization? The distribution of the clay is quite different between the two locations (see differences between MVWD-28 and PX locations), and the presence of interbedded sand should tend to decrease the likelihood of delayed depressurization/compaction.

Response:

Numerical models are always a simplification of the natural world. However, model calibration is designed to quantify the ability of a model to simulate historical monitoring data. These 1D Models have been sufficiently calibrated to historical measurements of vertical ground motion. Therefore, we do not believe the 1D Models are "exaggerating" aquitard compaction.

The underlying geology is different between the two 1D Model locations, which in part, accounts for the differing degrees of aquitard compaction as simulated by the 1D Models and land subsidence as shown by the monitoring data.

Comment 14 – Figures 11 and 12

Layers 1 and Layer 4 and 5 modeled compaction are very similar between the two sites (MVWD-28 and PX), with Layer 2+3 compaction accounting for most of the difference in the projected compaction. In the lithology logs in Figures 2 and 3, the PX site has significantly more clay relative to the MVWD-28 site in Layers 1 and Layer 4 and 5. What explains the lack of difference in projected compaction in these layers between the sites given how different the lithology is between the two sites?

Response:

This observation has not been investigated in detail. During 1D Model calibration, there was a significant difference between total simulated compaction from 1930-2018 at the PX (about 9 ft) compared to total simulated compaction at MVWD-28 (about 6 ft).

The observation that projected compaction from 2019-2040 is similar between the two 1D Models, suggests that the delayed drainage and compaction of aquitards is occurring preferentially in various thicker aquitards at each location. However, no analyses have been performed to verify this hypothesis. This is a potential subject of future study and possible incorporation into the 1D Models and/or Guidance Level.

Comment 15 – Figures 13

We recommend removing this figure until additional analysis is conducted as discussed in comments regarding Conclusions and Recommendation?

Response:

This figure should remain to illustrate the “preliminary” Guidance Level.