SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

GROUNDWATER SUSTAINABLITY PLAN FOR THE SPADRA BASIN

Final Report | January 2022

WEST YOST
Water. Engineered.

SPADRA BASIN
GROUNDWATER SUSTAINABILITY
AGENCY

FINAL REPORT | JANUARY 2022

Groundwater Sustainability Plan for the Spadra Basin

PREPARED FOR

SPADRA BASIN
GROUNDWATER SUSTAINABILITY
AGENCY

PREPARED BY

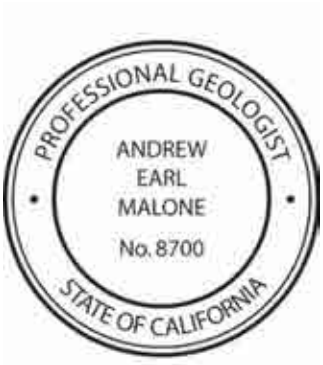
WEST YOST
Water. Engineered.

Groundwater Sustainability Plan for the Spadra Basin

Prepared for

Spadra Basin Groundwater Sustainability Agency

Project No. 954-80-20-01



QA/QC Review: Andy Malone — 1/17/2022

Date

Project Manager: Veva Weamer — 1/17/2022

Date

WEST YOST
Water. Engineered.

FINAL REPORT | JANUARY 2022

Table of Contents

EXECUTIVE SUMMARY ES-1

Introduction ES-1

Plan Area and Basin Setting ES-1

Plan Area ES-1

Basin Setting ES-2

Sustainable Management Criteria ES-3

Monitoring Network ES-5

Projects and Management Actions to Achieve Sustainability ES-6

GSP Implementation ES-7

SECTION 1 Introduction 1-1

1.1 Purpose of the groundwater sustainability plan 1-1

1.2 Agency Information 1-1

1.2.1 Organization and Management Structure of the GSA 1-2

1.2.2 Legal Authority of the GSA 1-3

1.3 Notice and Communication with Stakeholders 1-3

1.3.1 Beneficial Uses and Users of Groundwater 1-4

1.3.2 Notice 1-4

1.3.3 Communication and Stakeholder Involvement 1-5

1.3.3.1 Stakeholder Identification and Engagement 1-5

1.3.3.2 Opportunity for Public and Stakeholder Participation 1-5

1.3.3.3 Decision-making process 1-6

1.3.4 Meetings 1-6

1.3.5 Comments 1-7

1.4 GSP Organization 1-8

SECTION 2 Plan Area and Basin Setting 2-1

2.1 Plan Area 2-1

2.1.1 Jurisdictional Area and Other Features 2-1

2.1.2 Existing Water Resources Monitoring and Management Programs 2-4

2.1.2.1 Urban Water Management Plans 2-4

2.1.2.2 LA Basin Plan 2-5

2.1.2.3 Groundwater Monitoring 2-6

2.1.3 Land Use, Water Use, and Disposal in the Spadra Basin 2-9

2.1.3.1 Land Use and Source Waters 2-9

2.1.3.2 Outdoor Water Use and Return Flows 2-12

2.1.3.3 Disposal of Water 2-12

2.1.3.4 Permitting of New Wells and Destruction of Wells 2-15

2.2 Basin Setting 2-15

2.2.1 Surface-Water Hydrology 2-15

2.2.1.1 Tributary Sub-watersheds 2-15

2.2.1.2 Precipitation 2-17

Table of Contents

2.2.2 Hydrogeologic Conceptual Model 2-18
2.2.2.1 Geologic Setting 2-18
2.2.2.2 Basin Boundaries 2-22
2.2.2.3 Stratigraphy 2-22
2.2.2.3.1 Consolidated Bedrock 2-23
2.2.2.3.2 Water-Bearing Sediments 2-23
2.2.2.4 Bottom of the Aquifer 2-24
2.2.2.5 Hydrostratigraphy and Aquifer Systems 2-26
2.2.2.6 Initial Estimates of Aquifer Properties 2-29
2.2.2.7 Groundwater Recharge 2-38
2.2.2.8 Groundwater Discharge 2-38
2.2.2.9 Groundwater Flow 2-39
2.2.2.10 Groundwater Pumping 2-45
2.2.2.11 Groundwater Levels and Storage 2-45
2.2.2.12 Initial Estimate of Developed Yield: 1977-2018 2-50
2.2.3 Groundwater Quality 2-51
2.2.3.1 TDS 2-53
2.2.3.2 Nitrate 2-60
2.2.3.3 PCE and TCE 2-60
2.2.3.4 1,1-DCE 2-60
2.2.3.5 Perchlorate 2-62
2.2.3.6 1,2,3-Trichloropropane 2-62
2.2.3.7 Point-Source Contamination in the Spadra Basin 2-62
2.2.3.7.1 Teledyne Cast Parts 2-63
2.2.3.7.2 Spadra Landfill 2-63
2.2.3.7.3 Calsol Inc. 2-64
2.2.4 Ground Levels 2-64
2.2.5 Surface Water and Groundwater Dependent Ecosystems 2-67
2.2.6 Water Budget 2-69
2.2.6.1 Historical and Current Water Budget 2-69
2.2.6.1.1 Recharge Components 2-72
2.2.6.1.2 Discharge Components 2-72
2.2.6.1.3 Change in Groundwater Storage 2-73
2.2.6.1.4 Sustainable Yield 2-75
2.2.6.2 Future Water Budget 2-75
2.2.7 Data Gaps 2-75

SECTION 3 Sustainability Management Criteria 3-1

3.1 SGMA Definitions of Sustainable Management Criteria 3-1

3.2 Sustainability Indicators Applicable to the Spadra Basin 3-3

3.3 Undesirable Results, Minimum Thresholds, and Measurable Objectives for the Spadra Basin Sustainability Indicators 3-4
3.3.1 Chronic Lowering of Groundwater Levels 3-4
3.3.1.1 Undesirable Results 3-4

Table of Contents

3.3.1.2 Minimum Thresholds 3-5
3.3.1.3 Measurable Objectives 3-8
3.3.2 Reduction of Groundwater Storage 3-10
3.3.2.1 Undesirable Results 3-10
3.3.2.2 Minimum Thresholds 3-11
3.3.2.3 Measurable Objectives 3-12
3.3.3 Degraded Water Quality 3-12
3.3.3.1 Undesirable Results 3-12
3.3.3.2 Minimum Thresholds 3-13
3.3.3.3 Measurable Objectives 3-21
3.3.4 Land Subsidence 3-23
3.3.4.1 Undesirable Results 3-23
3.3.4.2 Minimum Thresholds 3-24
3.3.4.3 Measurable Objectives 3-24
3.4 Sustainability Goal 3-25
3.5 Interim Milestones 3-26
SECTION 4 Monitoring Program 4-1
4.1 Description of the Monitoring Program 4-1
4.1.1 Groundwater Monitoring 4-1
4.1.1.1 Groundwater Levels 4-3
4.1.1.1.1 Representative Monitoring 4-4
4.1.1.1.2 Monitoring Protocols 4-4
4.1.1.2 Groundwater Quality 4-6
4.1.1.2.1 Representative Monitoring 4-7
4.1.1.2.2 Monitoring Protocols 4-8
4.1.1.3 Groundwater Production 4-9
4.1.1.3.1 Monitoring Protocols 4-9
4.1.1.3.2 Representative Monitoring 4-9
4.1.2 Surface Water Monitoring 4-9
4.1.2.1 Representative Monitoring 4-10
4.1.2.2 Monitoring Protocols 4-10
4.1.3 Land Subsidence 4-10
4.1.3.1 Representative Monitoring 4-11
4.1.3.2 Monitoring Protocols 4-11
4.2 Data Management 4-11
4.3 Assessment and Improvement of Monitoring Program 4-12
SECTION 5 Projects and Management Actions Achieve Sustainability 5-1
5.1 Development of the Baseline Scenario 5-1
5.1.1 Planning Period 5-2
5.1.2 Assumed Land Use and Hydrology for the Planning Period 5-2
5.1.2.1 Land Use 5-2
5.1.2.2 Hydrology 5-4

Table of Contents

5.1.2.2.1 Cultural Conditions, Climate Change, and Estimated Recharge 5-4
5.1.3 Pumping and Artificial Recharge over the Planning Period 5-6
5.1.3.1 Sources of Water Supply 5-6
5.1.3.1.1 Spadra Basin Groundwater 5-6
5.1.3.1.2 Six Basin Groundwater 5-7
5.1.3.1.3 Chino Basin Groundwater 5-8
5.1.3.1.4 Puente Basin Groundwater 5-9
5.1.3.1.5 Central Basin Groundwater 5-11
5.1.3.1.6 Main San Gabriel Basin Groundwater 5-12
5.1.3.1.7 San Antonio Creek Surface Water 5-13
5.1.3.1.8 Imported Water 5-14
5.1.3.1.9 Recycled Water 5-16
5.1.3.2 Water Demands and Water-Supply Plans 5-17
5.1.3.2.1 City of Pomona 5-17
5.1.3.2.2 Walnut Valley Water District 5-20
5.1.3.2.3 California Polytechnic University Pomona 5-20
5.1.3.3 Aggregate Water-Supply Plan for the Spadra Basin Pumping 5-23
5.1.3.4 Groundwater Pumping 5-23
5.1.3.5 Artificial Recharge 5-25

5.2 Evaluation of the Baseline Scenario 5-25
5.2.1 Groundwater-Level Response 5-25
5.2.1.1 Groundwater Elevations and Groundwater-Flow Directions 5-25
5.2.1.2 Groundwater Elevations at Wells 5-32
5.2.1.2.1 Pumping Sustainability 5-32
5.2.1.2.2 Sustainable Management Criteria 5-32
5.2.2 Water Budget 5-43
5.2.3 Storage 5-45
5.2.4 Land Subsidence 5-48
5.2.5 Developed Yield 5-48
5.2.6 Conclusions and Recommendations 5-48

5.3 Development of the Basin Optimization Scenarios 5-49
5.3.1 Potential Projects and Management Plan Concepts 5-49
5.3.2 Basin Optimization Scenarios 5-52
5.3.2.1 Basin Optimization Scenario 1 – Sustainability through Substitution 5-53
5.3.2.2 Basin Optimization Scenario 2 – Sustainability through Recharge 5-55
5.3.2.3 Basin Optimization Scenario 3 – Maximum Beneficial Use 5-56

5.4 Evaluation of the Basin Optimization Scenarios 5-58
5.4.1 Groundwater Level Response 5-66
5.4.1.1 Groundwater Elevation and Groundwater-Flow Directions 5-66
5.4.1.1.1 Groundwater Elevations at Wells 5-75
5.4.2 Sustainable Management Criteria 5-91
5.4.3 Pumping Sustainability 5-92
5.4.4 Change in Storage 5-93

Table of Contents

5.4.5 Subsurface Outflow to the Chino Basin 5-93
5.4.6 Subsurface Outflow to the Puente Basin 5-96
5.4.7 Sustainable Yield 5-96

5.5 Cost analyses of the Baseline and Basin Optimization Scenarios 5-96
5.5.1 Water Supply Cost for Baseline Scenario 5-99
5.5.2 Water Supply Cost for Basin Optimization Scenarios 5-101

5.6 Conclusions and Recommendations 5-104

SECTION 6 Plan Implementation 6-1

6.1 GSP Implemention 6-1
6.1.1 Administrative and Legal Services 6-1
6.1.2 Monitoring 6-1
6.1.3 Annual Reporting 6-1
6.1.4 Five-Year Evaluation Reporting 6-2
6.1.5 Planning and Implementation of Projects and Management Actions 6-4

6.2 Estimate of GSP Implementation Cost 6-5
6.2.1 Administrative Costs 6-7
6.2.2 Monitoring/Reporting Costs 6-7
6.2.3 Projects and Management Actions Costs 6-8

6.3 GSP Funding and Financing 6-8

6.4 Schedule for Implementation 6-8

SECTION 7 References 7-1

LIST OF TABLES

Table ES-1. Summary Table of the Minimum Thresholds and Measurable Objectives Set for the Sustainability Indicators for the Spadra Basin 5

Table 1-1. Spadra Basin GSA Executive Committee Meetings 1-7

Table 1-2. Spadra Basin GSA Advisory Committee Meetings 1-7

Table 1-3. Preparation Checklist for Spadra Basin GSP 1-9

Table 2-1. Summary of Groundwater Data Collected in the Last Ten Years (2010-2019) at Spadra Basin Wells 2-6

Table 2-2. Active Daily-Precipitation Gages in the Spadra Basin 2-17

Table 2-3 Groundwater Pumping in the Spadra Basin 1977-2018 2-46

Table 2-4. Groundwater in Storage and Change in Storage in the Spadra Basin (1977-2018) 2-50

Table 2-5. Exceedances of Groundwater Quality Standards in the Spadra Basin 2000-2019 2-52

Table 2-6. Methods, Data, and Information Used to Estimate the Water Budget for the Spadra Basin 2-70

Table 2-7. Water Budget for the Spadra Basin – Fiscal Year 1978-2018 2-71

Table of Contents

Table 3-1. Minimum Thresholds for Groundwater Levels in the Spadra Basin 3-6
Table 3-2. Measurable Objectives for Groundwater Levels in the Spadra Basin 3-10
Table 3-3. Minimum Thresholds for Groundwater Quality in the Spadra Basin 3-20
Table 3-4. Measurable Objectives for Groundwater Quality in the Spadra Basin 3-22
Table 3-5. Interim Milestones for Groundwater Levels in the Spadra Basin 3-26
Table 4-1. Wells to be Monitored by the GSA for Groundwater Levels and Groundwater Quality 4-3
Table 4-2. Analyte List for Groundwater Quality Monitoring 4-7
Table 5-1. 2019 and projected (2020-2070) Water Demand and Supply Plans of the Water Purveyors in the Spadra Basin 5-18
Table 5-2. Water Budget for Spadra Basin – Baseline Scenario Fiscal Year 2019-2079 5-44
Table 5-3. Proposed Projects and Management Actions for the Spadra Basin 5-50
Table 5-4. Summary of Basin Optimization Scenarios vs. Baseline Scenario 5-58
Table 5-5. Summary of Operational Assumptions for the Basin Optimization Scenarios and Facilities 5-62
Table 5-6a. Water Budget for Spadra Basin – Basin Optimization Scenario 1 – Fiscal Year 2019-2079 5-63
Table 5-6b. Water Budget for Spadra Basin – Basin Optimization Scenario 2 – Fiscal Year 2019-2079 5-64
Table 5-6c. Water Budget for Spadra Basin – Basin Optimization Scenario 1 – Fiscal Year 2019-2079 5-65
Table 5-7. Aggregate Melded Unit Costs of Water Supply for the Baseline and Basin Optimization Scenarios 5-102
Table 5-8. Summary of the Evaluation of Basin Optimization Scenarios Compared to the Baseline Scenario 5-106
Table 6-1. Cost of the Spadra Basin GSP Implementation 6-6
Table 6-2. General Schedule for Spadra Basin GSP Implementation – 20 Years 6-9

LIST OF FIGURES

Figure 2-1. The Spadra Basin and Nearby Groundwater Basins 2-2
Figure 2-2. Water Purveyors and Jurisdictional Boundaries in the Spadra Basin Area 2-3
Figure 2-3. Wells in the Spadra Basin 2-7
Figure 2-4. Groundwater Monitoring in the Spadra Basin 2-8
Figure 2-5. Land Use in the Spadra Basin -- 1949, 1975, 1990, and 2017 2-10
Figure 2-6. Land Use Changes by Type -- 1949 to 2017 2-11

Table of Contents

Figure 2-7. Current Wastewater Disposal and Recycled Water Facilities 2-13
Figure 2-8. Watersheds Tributary to the Spadra Basin 2-16
Figure 2-9. Annual Precipitation and CDFM - Spadra Basin and Tributary Watersheds -- Water Year 1896 to 2019 2-19
Figure 2-10. Box and Whisker Plot of Average Monthly Precipitation -- Spadra Basin and Tributary Watersheds -- Water Year 1896 to 2019 2-20
Figure 2-11. Geologic Map of the Spadra Basin Area 2-21
Figure 2-12. Hydrologic Soil Types of the Soil Conservation Service 2-25
Figure 2-13. Depth to the Bottom of the Aquifer 2-27
Figure 2-14. Elevation of the Bottom of the Aquifer and Location of Hydrogeologic Cross Sections 2-28
Figure 2-15a. Hydrogeologic Cross-Section A-A 2-30
Figure 2-15b. Hydrogeologic Cross-Section B-B 2-31
Figure 2-15c. Hydrogeologic Cross-Section C-C 2-32
Figure 2-15d. Hydrogeologic Cross-Section D-D 2-33
Figure 2-15e. Hydrogeologic Cross-Section E-E 2-34
Figure 2-16. Initial Estimates of Specific Yield of the Water-Bearing Sediments 2-36
Figure 2-17. Initial Estimates of Horizontal Hydraulic Conductivity 2-37
Figure 2-18a. Groundwater Elevation and Flow Directions -- Fall 2018 2-40
Figure 2-18b. Groundwater Elevation and Flow Directions -- Fall 1977 2-41
Figure 2-18c. Groundwater Elevation and Flow Directions -- Fall 2008 2-42
Figure 2-18d. Groundwater Elevation and Flow Directions -- Fall 2015 2-43
Figure 2-19. Precipitation, Groundwater Pumping, Groundwater Levels in the Spadra Basin 2-47
Figure 2-20. Change in Groundwater Levels – Fall 1977 to Fall 2018 2-49
Figure 2-21. Total Dissolved Solids in Groundwater – Maximum Concentration (2000-2019) 2-54
Figure 2-22. Nitrate-Nitrogen in Groundwater – Maximum Concentration (2000-2019) 2-55
Figure 2-23. Tetrachloroethene (PCE) in Groundwater – Maximum Concentration (2000-2019) 2-56
Figure 2-24. Trichloroethene (TCE) in Groundwater – Maximum Concentration (2000-2019) 2-57
Figure 2-25. 1,1- Dichloroethane (1,1-DCE) in Groundwater – Maximum Concentration (2000-2019) 2-58
Figure 2-26. Perchlorate in Groundwater – Maximum Concentration (2000-2019) 2-59
Figure 2-27. Point Source Groundwater Contamination Sites – Open Cleanup Sites in the Spadra Basin 2-61
Figure 2-28. Vertical Ground Motion -- Various Years 1992-2019 2-66
Figure 2-29. Shallowest Depth to Groundwater – Fall 2008 2-68

Table of Contents

Figure 2-30. Total Recharge, Discharge, and Change in Storage in the Spadra Basin During the Calibration Period (1978-2018) 2-74
Figure 3-1. Sustainable Management Criteria for Chronic Lowering of Groundwater Levels 3-7
Figure 3-2. Sustainable Management Criteria for Reduction of Groundwater in Storage 3-9
Figure 3-3a. Sustainable Management Criteria for Degraded Water Quality – TDS 3-14
Figure 3-3b. Sustainable Management Criteria for Degraded Water Quality – Nitrate 3-15
Figure 3-3c. Sustainable Management Criteria for Degraded Water Quality – Perchlorate 3-16
Figure 3-3d. Sustainable Management Criteria for Degraded Water Quality – TCE 3-17
Figure 3-3e. Sustainable Management Criteria for Degraded Water Quality – PCE 3-18
Figure 3-3f. Sustainable Management Criteria for Degraded Water Quality – 1,1-DCE 3-19
Figure 3-4a. Five-Year Interim Milestones at Industry 3-28
Figure 3-4b. Five-Year Interim Milestones at CPP-4 3-29
Figure 3-4c. Five-Year Interim Milestones at P-28 3-30
Figure 3-4d. Five-Year Interim Milestones at CPP-1 3-31
Figure 3-4e. Five-Year Interim Milestones at P-19 3-32
Figure 3-4f. Five-Year Interim Milestones at OMW-3 3-33
Figure 3-4g. Five-Year Interim Milestones at MW-5 3-34
Figure 4-1. Spadra Basin GSP Monitoring Network 4-2
Figure 5-1. Current and Projected Land Use in the Spadra Basin 5-3
Figure 5-2. Historical Precipitation for Spadra Basin and Tributary Watersheds - Hydrologic Period 1950-2011 Used for the Baseline Scenario 5-5
Figure 5-3. Historical and Projected Water Supplies of the City of Pomona 5-19
Figure 5-4. Historical and Projected Water Supplies of the Walnut Valley Water District 5-21
Figure 5-5. Historical and Projected Water Supplies of the California Polytechnic University Pomona 5-22
Figure 5-6. Historical and Projected Groundwater Pumping in the Spadra Basin – Baseline Scenario 5-24
Figure 5-7. Groundwater Elevation for the Initial Conditions – July 2018 5-26
Figure 5-8. Groundwater Elevation for the Period of Highest Groundwater Levels for the Baseline Scenario – July 2024 5-28
Figure 5-9. Groundwater Elevation for the Period of Lowest Groundwater Levels for the Baseline Scenario – June 2079 5-29
Figure 5-10. Groundwater-Level Change: Initial Condition vs. Highest Groundwater Levels – Baseline Scenario (July 2018 – June 2024) 5-30
Figure 5-11. Groundwater-Level Change: Initial Condition vs. Lowest Groundwater Levels – Baseline Scenario (July 2018 – June 2079) 5-31

Table of Contents

Figure 5-12a. Historical and Projected Groundwater Elevations for the Baseline Scenario at Industry 5-34
Figure 5-12b. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-4 5-35
Figure 5-12c. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-3 5-36
Figure 5-12d. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-2 5-37
Figure 5-12e. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-28 5-38
Figure 5-12f. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-1 5-39
Figure 5-12g. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-19 5-40
Figure 5-12h. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-31 5-41
Figure 5-12i. Historical and Projected Groundwater Elevations for the Baseline Scenario at OMW-3 5-42
Figure 5-13. Cumulative Change in Storage and Subsurface Outflow to Chino Basin – Basin Alternative 5-46
Figure 5-14. Cumulative Change in Storage and Subsurface Outflow to Puente Basin – Basin Alternative 5-47
Figure 5-15. Map of Proposed Locations for New Projects for the Spadra Basin 5-51
Figure 5-16. Map of Potential Locations for New Wells and Facilities for Basin Optimization Scenarios 5-54
Figure 5-17a. Location Map of Facilities for Basin Optimization Scenario 1 5-59
Figure 5-17b. Location Map of Facilities for Basin Optimization Scenario 2 5-60
Figure 5-17c. Location Map of Facilities for Basin Optimization Scenario 3 5-61
Figure 5-18a. Groundwater Elevation and Flow Direction – Baseline Scenario 5-67
Figure 5-18b. Groundwater Elevation and Flow Direction – Basin Optimization Scenario 1 5-68
Figure 5-18c. Groundwater Elevation and Flow Direction – Basin Optimization Scenario 2 5-69
Figure 5-18d. Groundwater Elevation and Flow Direction – Basin Optimization Scenario 3 5-70
Figure 5-19a. Change in Groundwater Elevation – Baseline Scenario 5-71
Figure 5-19b. Change in Groundwater Elevation – Basin Optimization Scenario 1 5-72
Figure 5-19c. Change in Groundwater Elevation – Basin Optimization Scenario 2 5-73
Figure 5-19d. Change in Groundwater Elevation – Basin Optimization Scenario 3 5-74
Figure 5-20a. Difference in Groundwater Elevation – Basin Optimization Scenario 1 5-76

Table of Contents

Figure 5-20b. Difference in Groundwater Elevation – Basin Optimization Scenario 2 5-77
Figure 5-20c. Difference in Groundwater Elevation – Basin Optimization Scenario 3..... 5-78
Figure 5-21. Well with Time Series of Model-Predicted Groundwater Elevations 5-79
Figure 5-22a. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at Industry..... 5-80
Figure 5-22b. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-4..... 5-81
Figure 5-22c. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-3..... 5-82
Figure 5-22d. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-2..... 5-83
Figure 5-22e. Historical and Projected Groundwater Elevations for Baselineand Basin Optimization Scenarios at P-28..... 5-84
Figure 5-22f. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-1..... 5-85
Figure 5-22g. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at P-19..... 5-86
Figure 5-22h. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at OMW-3. 5-87
Figure 5-22i. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Well 4..... 5-88
Figure 5-22j. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Well 5..... 5-89
Figure 5-22k. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Injection Well 3. 5-90
Figure 5-23. Cumulative Change in Storage for the Baseline and Basin Optimization Scenarios..... 5-94
Figure 5-24. Subsurface Outflow to Chino Basin for the Baseline and Basin Optimization Scenarios 5-95
Figure 5-25. Subsurface Outflow to Puente Basin for the Baseline and Basin Optimization Scenarios 5-97
Figure 5-26. Sustainable Yield for the Basin Optimization Scenarios..... 5-98
Figure 5-27. Melded Unit Cost of Water Supply for Spadra Basin Water Purveyors for the Baseline Scenario..... 5-100
Figure 5-28. Aggregate Melded Unit Cost of Water Supply for the Baseline and Basin Optimization Scenarios 5-103

Table of Contents

LIST OF APPENDICES

Appendix A. Proposition 1 Sustainable Groundwater Planning Grant

Appendix B. Memorandum of Agreement – Spadra Basin GSA

Appendix C. Bylaws for Spadra Basin GSA

Appendix D. Beneficial Uses and Users of Groundwater in Spadra Basin

Appendix E. Public Notices

Appendix F. Spadra Basin GSA Stakeholder Engagement Plan

Appendix G. Comments and Responses on the Draft TMs 1 through 5

Appendix H. Comments and Responses on the Draft GSP

Appendix I. TM 2 – Construction and Calibration of the Spadra Basin Groundwater Model

Appendix J. Standard Operating Procedures for Groundwater-Level Monitoring

Appendix K. Cost Model for the Baseline Scenario

Appendix L. Cost Model for Basin Optimization Scenarios 1, 2, and 3

LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg	Micrograms per Kilogram
µgl	Micrograms per Liter
1,1,1-TCA	1,1,1-Trichloroethane
1,1-DCE	1,1-Dichloroethene
1,2,3-TCP	1,2,3-Trichloropropane
af	Acre-Feet
afy	Acre-Feet Per Year
AGR	Agricultural Supply
AMP	Adaptive Monitoring Plan
application	Application for Well/Exploration Hole Permit
CASGEM	California Statewide Groundwater Elevation Monitoring
CBWM	Chino Basin Watermaster
CCR	California Code of Regulations
CDFM	Cumulative Departure from the Mean
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CFI	Consolidated Foundries Incorporated
CIMIS	California Irrigation Management Information System
cis-1,2 DCE	cis-1,2 Dichloroethene
CIWQS	California Integrated Water Quality System Project
CPP	California State Polytechnic University of Pomona
CRA	Colorado River Aqueduct

CVM	Chino Valley Model
DCA	1,1-Dichloroethane
DDW	State Water Resources Control Board Division of Drinking Water
DEM	Digital Elevation Model
DIPAW	Deep Infiltration of Precipitation and Applied Water
DLR	Detection Limit for The Purposes of Reporting
DTSC	California Department of Toxic Substances
DWR	California Department of Water Resources
EDDs	Electronic Data Deliverables
EPA	Environmental Protection Agency
ET	Evapotranspiration
FEIR	Environmental Impact Report
ft	Foot or Feet
ft/d	Feet per Day
ft-amsl	Feet Above Mean Sea Level
ft-bgs	Feet Below Ground Surface
GAMA	Groundwater Ambient Monitoring and Assessment
GDEs	Groundwater-Dependent Ecosystems
gpm	Gallons per Minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HSPF	Hydrological Simulation Program-FORTRAN
IND	Industrial Services Supply
InSAR	Interferometric Synthetic-Aperture Radar
LA Basin Plan	Water Quality Control Plan Los Angeles Region
LA Regional Board	California Regional Water Quality Control Board Los Angeles Region
LACPWD	Los Angeles County Public Works Department
LACSD	Los Angeles County Sanitation Districts
LADPH	Los Angeles County Department of Public Health
M&RP	Monitoring and Reporting Program
MCL	Maximum Contaminant Level
Metropolitan	Metropolitan Water District of Southern California
mgd	Million Gallons per Day
mgl	Milligrams per Liter
Miramar WTP	Miramar Water Treatment Plant
MOA	Memorandum of Agreement
MS4 Permit	Municipal Separate Storm Sewer System Order No. R4-2012-0175
MTBE	Methyl Tert-Butyl Ether
MUN	Municipal and Domestic Supply
NCCAG	Natural Communities Commonly Associated with Groundwater
ND	Non Detect Concentration
NEXRAD	Next-Generation Radar
NL	Notification Level

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OEHHA	California Office of Environmental Health Hazard Assessment
OSY	Operating Safe Yield
PBWA	Puente Basin Water Agency
PCE	Tetrachloroethene
PFAS	Polyfluoroalkyl Substances
PHG	Public Health Goal
Pomona	City of Pomona
Pomona WRP	Pomona Water Reclamation Plant
PRISM	PRISM Climate Group
PROC	Industrial Process Supply
PVPA	Pomona Valley Protective Agency
QA/QC	Quality Assurance and Quality Control
Recycled Water Policy	Policy for Water Quality Control for Recycled Water
RO	Reverse Osmosis
San Gabriel SNMP	The San Gabriel Valley Basin SNMP
SASG	San Antonio Spreading Grounds
SAWCo	San Antonio Water Company
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Governments
SGMA	Sustainable Groundwater Management Act
SNMP	Salt and Nutrient Management Plan
State Water Board	State Water Resources Control Board
SVE	Soil Vapor Extraction
SWP	State Water Project
TCE	Trichloroethene
TDS	Total Dissolved Solids
TM	Technical Memorandum
TVMWD	Three Valleys Municipal Water District
µmhos/cm	Micromhos Per Centimeter
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USGS	United States Geological Survey
VIC	Variable Infiltration Capacity
VOC	Volatile Organic Compound
WDR	Waste Discharge Requirement
WEI	Wildermuth Environmental, Inc.
Weymouth WTP	Weymouth Water Treatment Plant
WQS	Water-Quality Standard
WRD	Water Replenishment District
WRP	Water Reclamation Plant

WRR	Water Reclamation Requirement
WTP	Water Treatment Plant
WVWD	Walnut Valley Water District

Executive Summary

INTRODUCTION

In 2014 the California legislature enacted the Sustainable Groundwater Management Act (SGMA)—the primary purpose of which is to achieve and/or maintain sustainability within the State's groundwater basins. SGMA called for the formation of one or more Groundwater Sustainability Agencies (GSA) to fully cover a basin; development of one or more Groundwater Sustainability Plans (GSP) for a basin; implement the GSP to achieve sustainability and avoid undesirable results; and periodic reporting to the California Department of Water Resources (DWR).

The Spadra Basin is a small, non-adjudicated subbasin of the San Gabriel Valley Basin (Basin 4-013 as defined by DWR). The DWR designated the San Gabriel Valley Basin as a "very low-priority" basin mainly because groundwater pumping rights across most of the basin have been adjudicated. SGMA does not require that a GSP be prepared for the basin, however the legislation "encourages and authorizes" basins designated as very low priority to be managed under a GSP.

The Walnut Valley Water District (WVWD) and the City of Pomona (Pomona) collectively formed the Spadra Basin GSA in February 2017 through a Memorandum of Understanding (MOU) and elected to prepare and adopt a GSP for the Spadra Basin with the main objective of encouraging collaborative management of the Basin between all pumpers and maximizing beneficial use of the basin in a sustainable fashion. The MOA between the WVWD and Pomona established an Executive Committee, Implementation Team, and Advisory Committee with roles to support both the development and implementation of the Spadra Basin GSP.

The Spadra Basin GSP was developed using a process that encouraged all interested stakeholders and the public to participate in its development. The Advisory Committee was formed of representatives from interested Spadra Basin stakeholders to oversee and provide guidance on the GSP development and implementation. The Advisory Committee meetings were the forum to present all content used to prepare the GSP in an open and transparent process, and to receive feedback from all interested stakeholders and the public. Five technical memorandums (TMs) that were interim milestones in the development of the GSP were prepared in sequence with input from interested stakeholders and the public along the way. The contents of the draft TMs were presented at Advisory Committee meetings, and stakeholders and the public had a review period to provide comments and suggested edits. All draft and final TMs were published on the GSA website documents page.

PLAN AREA AND BASIN SETTING

Plan Area

The Spadra Basin is approximately seven square miles (4,200 acres) located in eastern Los Angeles County in Southern California. The Spada Basin is a non-adjudicated groundwater basin and there is no formal basin management plan and no defined restrictions on groundwater pumping. The Spadra Basin is surrounded by four adjudicated groundwater basins: Puente Basin to the southwest; Main San Gabriel Basin to the northwest; Six Basins to the north; and Chino Basin to the east. Pomona, WVWD, and California State Polytechnic University of Pomona (CPP) are the local water purveyors with service area boundaries overlying the Spadra Basin. The water purveyors obtain water supplies from multiple sources including groundwater from Spadra Basin, groundwater from other basins, local surface water, treated

imported water from the State Water Project and Colorado River, and recycled water. There are nine wells owned and operated by Pomona, WVWD, and CPP that pump groundwater from the Spadra Basin.

Current land use in the Spadra Basin is predominantly urban (93 percent urban and six percent irrigated agriculture). Because most of the land surface is impervious, most of the rainfall exists the Basin as stormwater runoff in concrete-lined flood-control channels. The main channels that drain the Spadra Basin are the San Jose Creek and South San Jose Creek which merge, and then ultimately discharge to the San Gabriel River downstream from the Spadra Basin. The surface water runoff that exits the Spadra Basin in these channels is put to beneficial use by the downstream entities mainly for groundwater recharge, is consumptively used by riparian vegetation in unlined stream reaches, or flows to the ocean. Wastewater generated in the Spadra Basin is treated at the Pomona Water Reclamation Plant (WRP) located in the Spadra Basin, which is a regional facility that receives wastewater originating from an 82 square-mile area in the eastern portion of Los Angeles County. The Pomona WRP is owned and operated by the Los Angeles County Sanitation Districts (LACSD). Tertiary-treated wastewater from the Pomona WRP is either discharged to the South San Jose Creek where it exists the Spadra Basin or is reused for irrigation or commercial processes at sites within the Spadra Basin and Puente Basin.

Basin Setting

The Spadra Basin is a relatively narrow, alluvial-filled valley located between the San Jose Hills and Puente Hills. Basin stratigraphy consists of two main units: (i) unconsolidated water-bearing sediments, which are alluvial sediments consisting of interconnected layers of pervious gravels and sands, and less pervious silts and clay, and (ii) consolidated bedrock, which are older impermeable (non-water bearing) formations. Hydrogeologic cross-sections depict a narrow aquifer system along the central axis of the basin that has a saturated thickness of about 100-200 feet (ft) and thickens to about 400 ft to the east.

Groundwater Pumping, Groundwater Levels, and Groundwater in Storage

Historic groundwater conditions were evaluated from 1977 to 2018 using all available monitoring data from existing production wells. Historically, groundwater pumping ranged from a high of about 2,200 acre-feet per year (afy) in 1986 to a low of about 700 afy in 1991, and averaged 1,280 afy. Groundwater pumping declined over the last 10 years, with an average annual pumping of about 970 afy. Long-term trends in groundwater elevation are consistent at all wells across the basin suggesting that all wells are being influence by the same regional stresses of recharge and pumping. Groundwater levels appear to rise in response to hydrologic wet periods and fall in response to hydrologic dry periods. Over the study period, the lowest groundwater levels across the basin occurred in 1977 and the highest groundwater levels occurred around 2008. Changes in groundwater levels result in changes in groundwater storage. Over the historical period from 1977 to 2018, groundwater levels increased by about 25 to 35 ft across most the basin. The net change in groundwater elevation and estimates of the specific yield and aquifer thickness were used to estimate a total change in storage from 1977 to 2018 of + 9,278 acre-feet (af). An analysis of the change in storage for over this historical period was also performed through the development and calibration of a groundwater-flow model for the Spadra Basin, which computed a similar change in storage of 7,089 afy.

Groundwater Quality

Spadra Basin groundwater is generally of poor quality. Pumped groundwater is used primarily for non-potable uses. Constituents of concern include total dissolved solids (TDS), nitrate, trichloroethene (TCE), tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE), and perchlorate. Groundwater from Spadra

Basin that is used for potable supply often requires treatment or blending prior to use to comply with State Water Board's Division of Drinking Water (DDW) drinking-water standards.

Land Subsidence

The analysis of historical Interferometric Synthetic Aperture Radar (InSAR) estimates of vertical ground motion for portions of the Spadra Basin demonstrated that very little permanent land subsidence occurred within the Spadra Basin since the mid-1990s. It appears from these InSAR estimates that recent vertical ground motion is small in magnitude (e.g., less than +/- 0.1 ft) and elastic in nature. Vertical ground motion in the adjacent Chino Basin over this same period is much greater and is currently being studied and managed by the Chino Basin Watermaster. The aquifer systems of the Chino Basin and Spadra Basin are connected across their common boundary and changes in groundwater levels within one basin could cause changes in groundwater levels in the other, which could lead to aquitard compaction and associated land subsidence. Therefore, land subsidence is a potential undesirable result in the Spadra Basin and the Chino Basin from groundwater management activities in either basin.

Water Budget and Developed Yield

A water budget of the Spadra Basin over the 1977 to 2018 period was prepared through the development and calibration of a groundwater-flow model for the Spadra Basin. Groundwater inflows are primarily subsurface inflow from the saturated alluvium and fractures within the bordering bedrock of the San Jose and Puente Hills, and deep infiltration of precipitation and applied water. Groundwater discharge occurs primarily through groundwater pumping and subsurface outflow to the Puente Basin and the Chino Basin.

The "developed yield" of the Spadra Basin over the historical period (1977-2018), which is the annual average pumped from the groundwater basin, corrected for the change in storage, was estimated to be 1,432 afy from the water budget. The developed yield for the historical period was also estimated using the calculated change in storage from the change in water levels over this period and computed a similar developed yield estimate of 1,498 afy.

SUSTAINABLE MANAGEMENT CRITERIA

SGMA introduces several terms to measure sustainability including Undesirable Results, Sustainability Indicators, Minimum Thresholds, Measurable Objectives, and the Sustainability Goal.

The SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing Undesirable Results. Under the SGMA, Undesirable Results occur when the effects caused by groundwater conditions occurring throughout the basin cause significant and unreasonable impacts to any of the following six Sustainability Indicators:

- Chronic lowering of groundwater levels
- Reduction of groundwater storage
- Seawater intrusion
- Degraded water quality
- Land subsidence
- Depletions of interconnected surface water

The Sustainability Indicators of seawater intrusion and depletions of interconnected surface water are not relevant to the Spadra Basin. The applicable Sustainability Indicators to the Spadra Basin are: (1) chronic lowering of groundwater levels; (2) reduction of groundwater storage; (3) degraded water quality; and (4) land subsidence. The GSP describes the Undesirable Results for each of these Sustainability Indicators, and then established Minimum Thresholds and Measure Objectives that are the operating band of quantitative metrics for groundwater conditions that will achieve and maintain sustainability and avoid Undesirable Results.

Chronic Lowering of Groundwater Levels, Reduction of Groundwater Storage, and Land Subsidence

Seven wells located throughout the Spadra Basin were selected as representative sites to establish the Minimum Thresholds and Measurable Objectives for the chronic lowering of groundwater levels. The Minimum Thresholds were set as the lowest historical groundwater elevations at each well between the 1978 to 2018 period. These Minimum Thresholds are preliminary estimates based on the analysis of historical data from 1978 to 2018 and are based on the belief that Undesirable Results did not occur over this historical period. An Undesirable Result would occur if static groundwater elevations decline below a Minimum Threshold for an entire year at any well. The Measurable Objectives were set as the highest historical groundwater elevations at each well between 1978 to 2018. These Measurable Objectives establish a reasonable margin of operational flexibility between the Measurable Objectives and the Minimum Thresholds and will promote sustainable groundwater management by accommodating wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin. Tables 3-1 and 3-2 in Section 3 of the GSP summarize the Minimum Thresholds and Measurable Objectives for chronic lowering of groundwater levels for each representative monitoring well.

By proxy, the Minimum Thresholds defined for chronic lowering of groundwater levels at the wells throughout the basin will be used to assess the Sustainability Indicators of reduction of groundwater storage and land subsidence. The assessment of these proxy Minimum Thresholds can be compared to the storage calculations performed annually (for storage), and available data of vertical ground motion evaluated periodically as needed (for land subsidence).

Degraded Water Quality

Seven wells located throughout the Spadra Basin were selected as representative sites to establish the Minimum Thresholds and Measurable Objectives for degraded water quality. The Minimum Thresholds and Measurable Objectives were established for each contaminant of concern (total dissolved solids [TDS], nitrate, trichloroethene [TCE], tetrachloroethene [PCE], 1,1-dichloroethene [1,1-DCE], and perchlorate) and can differ at each well depending on multiple factors. The Minimum Thresholds are set dependent on the contaminant type and are protective of each well's beneficial use. The Measurable Objectives are set on the contaminant type, and if the current concentrations exceeded the proposed Minimum Thresholds. Tables 3-3 and 3-4 in Section 3 of the GSP summarize the Minimum Thresholds and Measurable Objectives for each representative monitoring well for degraded water quality.

Table ES-1. Summary Table of the Minimum Thresholds and Measurable Objectives Set for the Sustainability Indicators for the Spadra Basin

Sustainability Indicator	Minimum Threshold	Measurable Objective
Chronic Lowering of Groundwater Levels	Lowest historical groundwater elevation at representative wells over the period of 1978-2018	Highest historical groundwater elevation at representative wells over the period of 1978-2018
Reduction of Storage	By proxy, Minimum Thresholds set for Groundwater Levels	By proxy, Measurable Objectives set for Groundwater Levels
Degraded Water Quality	**Potable Wells:** TDS = 800 milligrams per liter (mgl) Nitrate-Nitrogen = 10 mgl Perchlorate = 6 micrograms per liter (µgl) TCE & PCE = 5 µgl 1,1-DCE = 6 µgl **Non-Potable Wells:** TDS = 1,500 mgl Nitrate-Nitrogen = 20 mgl Perchlorate = 12 µgl TCE & PCE = 5 µgl 1,1-DCE = 6 µgl	**TDS, Nitrate & Perchlorate:** lowest detected concentration historically at all representative sites in the basin, or better. **TCE, PCE, and 1,1-DCE:** 2015 concentration or better for wells where the current concentration is above the Primary MCL; and non-detect concentration at the wells where the current concentration is below the Primary MCL.
Land Subsidence	By proxy, Minimum Thresholds set for Groundwater Levels	By proxy, Measurable Objectives set for Groundwater Levels

Sustainability Goal of the Spadra Basin: In a collaborative effort between all Spadra Basin water purveyors, conjunctively use all water supplies available to the Spadra Basin to achieve and maintain groundwater sustainability, avoid Undesirable Results, maximize the beneficial use of the basin, and minimize cost.

MONITORING NETWORK

The Monitoring Program in Section 4 includes a discussion of the monitoring protocols for each data type and the relation to monitoring required for the assessment of the Sustainable Management Criteria. The monitoring program in the GSP is the first coordinated monitoring effort in the Spadra Basin and addresses data gaps described in the Basin Setting.

The GSP monitoring program is designed to collect data of sufficient quality, frequency, and distribution to characterize conditions in the basin and evaluate sustainability during GSP implementation. The monitoring program will allow the GSA to track short-term, seasonal, and long-term trends in groundwater conditions; evaluate conditions relative to Minimum Thresholds, Measurable Objectives, and Interim Milestones; update to the groundwater-flow model to evaluate groundwater conditions; and quantify changes in water budget.

The Spadra Basin monitoring program includes monitoring of groundwater (production, levels, and quality), surface water, and land subsidence. Groundwater monitoring is the primary component of the monitoring

program and includes collecting groundwater data at all existing wells in the basin, including a newly constructed monitoring well to fill a data gap.

The GSA will monitor for groundwater levels and production at 12 wells, which includes the seven wells established as representative monitoring sites for the Sustainability Indicators of chronic lowering of groundwater levels, reduced groundwater storage and land subsidence. The GSA will collect metered production data from the well owners. The GSA will monitor groundwater levels using a pressure transducer (if possible) that measures and records water levels once every 15 minutes. The GSA will monitor for groundwater quality at the seven wells established as representative monitoring sites for the Sustainability Indicator of degraded water quality. Any additional groundwater data for the remaining wells in the basin will be collected annually from the well owners by the GSA.

The effluent discharge and quality data measured at the Pomona WRP will be collected from the LACSD by the GSA annually. Monitoring of land subsidence will be conducted at a minimum of once every five years by the GSA via InSAR data made available by the DWR to verify that permanent land subsidence is not occurring.

All data collected will be compiled, checked for QA/QC to ensure data quality, and uploaded to the GSA's data management system.

PROJECTS AND MANAGEMENT ACTIONS TO ACHIEVE SUSTAINABILITY

Section 5 of the GSP identifies projects and management actions that the GSA identified to help avoid Undesirable Results and achieve the Sustainability Goal for the Spadra Basin. To do this, the GSA first developed and evaluated a Baseline Scenario that included the future expected water demands, water-supply plans, and groundwater management plans of the Spadra Basin water purveyors to understand the sustainability of expected future groundwater conditions in the absence of projects or management actions. The Spadra Basin Groundwater Model was used to simulate the Baseline Scenario and estimate the response of the groundwater basin over a 60-year planning period. The model results of the Baseline Scenario indicated that groundwater levels are projected to decline over the planning horizon by 20-25 ft, which would be below the Minimum Thresholds, and was therefore not considered sustainable.

Spadra Basin stakeholders used the model results of the Baseline Scenario to guide the development of several projects and management actions to achieve sustainability. Combinations of the proposed projects were included in three "Basin Optimization Scenarios" to achieve sustainability in the Spadra Basin over the planning period and/or maximize the beneficial use of the Basin. All three Basin Optimization Scenarios include the use of surplus recycled water from the Pomona WRP to achieve the objectives of the scenarios. Surplus recycled water is tertiary-treated effluent from the Pomona WRP that is not delivered for direct reuse to existing customers in the Spadra Basin and Puente Basin for irrigation or commercial purposes. The Basin Optimization Scenarios are:

- ***Basin Optimization Scenario 1 - Sustainability through Substitution***. This scenario includes reduced groundwater pumping and additional recycled water reuse.
- ***Basin Optimization Scenario 2 - Sustainability through Recharge***. This scenario includes artificial recharge of 500 afy of recycled water.

- ***Basin Optimization Scenario 3 - Maximum Beneficial Use.*** This scenario includes artificial recharge of 3,500 afy of recycled water, increasing production by a similar amount, and expansion of the CPP reverse osmosis (RO) plant. The pumped groundwater will be treated at the RO plant and used for potable water supplies, which reduces the demands for imported water and increases potable water-supply reliability.

The Spadra Basin Groundwater Model was used to simulate the Basin Optimization Scenarios to estimate the response of the groundwater basin over a 60-year planning period and evaluate sustainability. The conclusions of this analysis were that all Basin Optimization Scenarios are hydrologically feasible, and compared to the Baseline Scenario, all are expected to result in: (i) higher groundwater levels that do not decline below Minimum Thresholds or pumping sustainability metrics; (ii) no significant and unreasonable land subsidence or reductions of groundwater storage; (iii) higher Sustainable Yield; and (iv) no reductions in subsurface outflow to the neighboring groundwater basins. In other words, the Basin Optimization Scenarios will avoid Undesirable Results and achieve and maintain sustainability.

Cost models for the Baseline Scenario and the three Basin Optimization Scenarios were developed to estimate and evaluate the cost of the aggregate water-supply of the water purveyors in the Spadra Basin for each scenario. The aggregate melded unit cost of water for the three Basin Optimization Scenarios were compared to each other and to the Baseline Scenario; however, the Baseline Scenario cannot be directly compared to the Basin Optimization Scenarios because the Baseline Scenario is not sustainable like the Basin Optimization Scenarios. The aggregate melded unit cost of water for Basin Optimization Scenarios 1 and 2 are slightly more expensive than the aggregate melded unit cost of water for the Baseline Scenario. And the aggregate melded unit cost of water for Basin Optimization Scenario 3 averages about $150/af more than the aggregate melded unit cost of water for the Baseline Scenario and Basin Optimization Scenarios 1 and 2 from 2030-2059, and then declines to about $400/af less than these other scenarios after the loans for capital improvements are paid off. Basin Optimization Scenario 3 is less expensive in the long run because of the investment in facilities that produce a local, more reliable, and less expensive water supply as an alternative to imported water supplies.

Basin Optimization Scenario 3 is the recommended scenario for GSP implementation. It results in the highest Sustainable Yield for the Spadra Basin by recharging surplus recycled water from the Pomona WRP and increasing groundwater production by similar volumes. Through groundwater treatment, it increases local, reliable, potable water supplies as an alternative to the use of less reliable imported waters.

GSP IMPLEMENTATION

The implementation of the GSP for the Spadra Basin includes five main categories:

- ***Administration and legal support*** – The GSA will perform all administrative activities and legal services to implement the GSP.
- ***Monitoring*** – The GSA will conduct the monitoring program for the Spadra Basin GSP described in Section 4 Monitoring Program.
- ***Annual reporting*** – Annual reports for the Spadra Basin GSP are required to be prepared every year that is inclusive of all requirements in California Code of Regulations (CCR) §356.2 of the GSP Regulations. By April 1 of every year the GSA will prepared and submit the annual report and required electronic data deliverables to the DWR.

- ***Five-year evaluation reporting*** – Assessments of the Spadra Basin GSP will be prepared at least every five years and documented in a report. The five-year assessments shall describe whether the implementation of the GSP is meeting the Sustainability Goal and include all the information in CCR §356.4 of the GSP Regulations. These assessments could coincide with periodic updates and recalibration of the Spadra Basin Groundwater-flow Model (planned model updates occur at a minimum of every ten years) that will be used to evaluate sustainability of current and future conditions under GSP implementation.
- ***Planning and implementation of projects and management actions*** – The GSA will implement the projects and management actions in Basin Optimization Scenario 3 from the concepts described in this GSP to final design and then through construction and operation. These phases include: Phase 1 – Identify Project Alternatives; Phase 2 – Project Screening Assessment; Phase 3 – Feasibility Assessment; and Phase 4 – Project Implementation.

Conceptual cost estimates for implementation of the GSP were developed for the categories of Administrative, Monitoring/Reporting, and Project and Management Actions:

- ***Administrative*** - Costs are estimated to be about $53,000 annually.
- ***Monitoring/Reporting*** - Costs are estimated to range between $137,000 to $612,000. Cost for the first year of GSP implementation is $186,000, and subsequent years are $137,000. The costs for the years when a five-year evaluation of the GSP is performed is expected to be about $612,000.
- ***Projects and Management Actions*** - The annual cost for the planning and implementation of projects in preferred Basin Optimization Scenario 3 ranges from $5.3 to $ 5.8 million per year. This range is for the first 30 years when loans for capital improvements are being paid off.

The GSA will develop a funding structure to pay for the costs to implement the GSP upon adoption of the GSP. Additionally, the GSA may pursue other financing sources for capital projects, repayment of debt, operations and maintenance (O&M), and other ongoing expenses for the projects and management actions. Section 6 of the GSP includes an estimated schedule for the major categories of GSP implementation for the first 20 years.

SECTION 1
Introduction

1.1 PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

The Sustainable Groundwater Management Act (SGMA) was enacted in 2014 via a three-bill legislative package consisting of Assembly Bill 1739 (Dickinson), Senate Bill 1168 (Pavley), and Senate Bill 1319 (Pavley) (Part 2.74 of Division 6 of the California Water Code, beginning with § 10720). The SGMA and its associated regulations call for four main activities:

- Formation of one or more Groundwater Sustainability Agencies (GSA) to fully cover a basin
- Development of one or more Groundwater Sustainability Plans (GSP) for the basin
- Implement the GSP to achieve quantifiable objectives
- Periodic reporting to the California Department of Water Resources (DWR)

The Spadra Basin is a small, non-adjudicated subbasin of the San Gabriel Valley Basin (Basin No. 4-013) as defined by the California Department of Water Resources [DWR]. The DWR designated the San Gabriel Valley Basin as a "very low-priority" basin mainly because groundwater pumping rights across most of the basin have been adjudicated; and as such, the SGMA does not require that a GSP be prepared for the basin. However, the SGMA Legislation "encourages and authorizes" basins designated as very low priority to be managed under a GSP (Water Code § 10720.7(b)).

The Walnut Valley Water District (WVWD) and the City of Pomona (Pomona) collectively formed the Spadra Basin GSA in February 2017 and elected to prepare and adopt a GSP for the Spadra Basin. The main objectives for this decision were to encourage collaborative management of the Spadra Basin between all pumpers and make maximum beneficial use of the basin in a sustainable fashion. In 2018, the newly formed Spadra Basin GSA secured a Proposition 1 Sustainable Groundwater Planning Grant to support the preparation of the GSP (Appendix A).

1.2 AGENCY INFORMATION

The Spadra Basin GSA was formed on February 28, 2017 by the WVWD and Pomona under a Memorandum of Agreement (MOA) to establish the Spadra Basin GSA (Appendix B). The WVWD and Pomona are two of the public agencies the produce groundwater from the Spadra Basin. Pomona has land use responsibilities for most of the basin. On March 29, 2017, the Spadra Basin GSA completed its filing of the notice to the DWR of its formation and intent to prepare a GSP for the Spadra Basin. The Spadra Basin GSA was officially formed as the exclusive GSA for the Spadra Basin on June 27, 2017, 90 days after the filing.

The Spadra Basin GSA contact information is:

Spadra Basin Groundwater Sustainability Agency
c/o Walnut Valley Water District
Attention: Sherry Shaw
271 South Brea Canyon Road
Walnut, CA 91789

1.2.1 Organization and Management Structure of the GSA

The MOA between the WVWD and Pomona to form the Spadra Basin GSA established an Executive Committee, Implementation Team, and an Advisory Committee with roles to support the development and implementation of the Spadra Basin GSP:

- ***The Executive Committee*** is the governing body for the Spadra Basin GSA and is comprised of one member and one alternate from both the WVWD and Pomona. The Executive Committee is responsible for directing and providing guidance to the Implementation Team and consultants working with the Spadra Basin GSA on matters such as: a) developing a GSP that achieves the golds and objectives of SGMA; b) implementing actions undertaken pursuant to the MOA and resolving issues related to these actions; c) implementing measures in the event of insufficient or unsatisfactory progress is being made in development or implementation of the GSP; and d) establishing an Advisory Committee and developing a stakeholder participation plan. The Executive Committee appoints an Administrative Officer and Legal Counsel for the Spadra Basin GSA. Executive Committee meetings are required to be held annually. During the GSP development process, meetings were held bi-monthly.
- ***The Implementation Team*** is selected by the Executive Committee and is comprised of staff from WVWD and Pomona. The Implementation Team oversees and coordinates the activities to develop and implement the GSP. In coordination with the Executive Committee, the Implementation Team developed and implemented a stakeholder participation plan and related outreach.
- ***The Advisory Committee*** consists of representatives from interested Spadra Basin stakeholders. The Advisory Committee members include representatives from: California State Polytechnic University, Pomona (CPP) who is a groundwater producer in the Spadra Basin along with Pomona and WVWD; Rowland Water District; Three Valleys Municipal Water District (TVMWD); and Forest Lawn Memorial Park. An Advisory Committee chair and vice chair are appointed to assist with organizing the committee and leading the committee meetings. The Advisory Committee reviews and provides feedback on the technical memoranda prepared during the development of the GSP and provides input to the Implementation Team regarding issues addressed in the GSP, and the eventual actions to implement the GSP.

The MOA established the WVWD as the treasurer for the Spadra Basin GSA who shall hold all monies contributed by the parties to the MOA, and with approval of the Executive Committee, pay all invoices and bills relating to services rendered in connection with the MOA.

Bylaws for the Spadra Basin GSA organization and management structure are in Appendix C of this GSP.

The contact information for the Plan Manager for this GSP is:

Sherry Shaw
Director of Engineering, Walnut Valley Water District
271 S. Brea Canyon Road
Walnut, CA 91789
(909) 595-1268 x.234

1.2.2 Legal Authority of the GSA

The SGMA provides legal authority to local public agencies that have water supply, water management, or land uses responsibilities in a basin to become a GSA and develop and implement a GSP. Pomona and WVWD formed the Spadra Basin GSA through a February 27, 2017 MOU in accordance with Water Code § 10723.6(a) as the exclusive GSA for the entire Spadra Basin. In accordance with the SGMA, the Spadra Basin GSA has all the powers and authorities available to it outlined in Chapters 5, 8, and 9 of the SGMA legislation, which provide the necessary legal authority for the Spadra Basin GSA to carry out the preparation and implementation of the GSP. The following SGMA statutes provide the powers and authorities to the GSA:

- Chapter 5 (Water Code § 10725 et seq.) provides certain powers and authorities to the Spadra Basin GSA to perform duties, exercise powers, and accept responsibility for managing groundwater sustainability in the Spadra Basin. Some of these duties and powers are: adopting rules, regulations, ordinances, resolutions policies and procedures to support GSP implementation and sustainable groundwater management; conduct investigations to support sustainable groundwater management and implementation of the GSP; require the registration of groundwater extraction facilities; and require the measurement and reporting of groundwater extraction at every extraction facility except for *de minimis* extractors who pump two acre-feet per year (afy) or less for domestic purposes.
- Chapter 8 (Water Code § 10730 et seq.) provides the financial authorities to the Spadra Basin GSA to propose and collect fees on groundwater production to fund the costs of the GSP development, implementation and management.
- Chapter 9 (Water Code § 10732 et seq.) provides enforcement powers to the Spadra Basin GSA to impose penalties and bring actions in the Superior Court against persons who extract groundwater in excess of an authorized amount or who violate a rule, regulation, ordinance, or resolution of the GSA.

1.3 NOTICE AND COMMUNICATION WITH STAKEHOLDERS

The GSP Regulations Title 23 (23) California Code of Regulations (CCR) § 354.10, requires a summary of information related to the notification and communication with stakeholders by the GSA during the process to develop the GSP. This includes:

- Description of beneficial uses and users of groundwater in the basin, including land uses and property interest affected by the use, the persons or entities representing those interests, and the nature of consultation with those interests.
- Summary of public meetings at which the GSP was discussed or considered by the GSA.
- All comments regarding the GSP received by the GSA and a summary of responses.
- Description of communication including: the GSA decision making process; identification of opportunities for public engagement and how public input is used; and encouragement of active involvement of diverse social, cultural, and economic elements of the population within the basin.

1.3.1 Beneficial Uses and Users of Groundwater

The SGMA requires that a GSA consider the interest of all beneficial uses and users of groundwater in the development of the GSP. Pursuant to SGMA, in Water Code § 10723.2, the beneficial uses and users of groundwater to be considered in the GSP development include but are not limited to the following: holders of overlying groundwater rights (including agricultural users and domestic well owners); municipal well operators; public water systems; local land use planning agencies; environmental users of groundwater; surface water users; the federal government; Native American tribes; disadvantaged communities; and other local agencies that are monitoring and managing groundwater usage in the GSP area.

The beneficial uses in the Spadra Basin are potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply.

The Spadra Basin GSA prepared and submitted to the DWR a list of all beneficial uses and users of groundwater in the Spadra Basin (Appendix D). The beneficial users of the Spadra Basin include the following holders of overlying groundwater rights for agricultural users and domestic water well owners: WVWD, Pomona, CPP, and Walnut Hills Mobile Home Community. WVWD, Pomona, and CPP are municipal well operators for public water systems, and Walnut Hills Mobile Home Community is a private well operator for domestic use. Pomona and WVWD are parties to the MOA that formed the Spadra GSA. The Walnut Hills Mobile Home Community and CPP are not parties of the Spadra Basin GSA, but the GSA has engaged with these entities to encourage their participation in the preparation of the GSP. CPP is currently the largest groundwater producer in the Spadra Basin but is statutorily prohibited from becoming a member of the GSA. The CPP is a key stakeholder and member of the Spadra Basin Advisory Committee that provides input on the development of the GSP and its implementation (see Section 1.2.1).

Pomona is also the local land use planning agency. Portions of the Spadra Basin in the City of Pomona are considered Disadvantaged Communities by the DWR.

There are none of the following beneficial users in the Spadra Basin listed in Water Code § 10723.2: environmental users of groundwater, surface water users, federal government, and Native American tribes.

1.3.2 Notice

Prior to the official formation of the Spadra Basin GSA, public notices were published in local newspapers in February 2017 by the WVWD and Pomona to provide notice of a public hearing on the formation of the GSA. Copies of these notices are in Appendix E.

A Spadra Basin GSA website was established as the central repository for all information related to the Spadra Basin GSA and the GSP process. The Spadra Basin GSA website includes information on the Spadra Basin, the SGMA, the Spadra Basin, GSA organization structure, stakeholder engagement, and a calendar of meetings. All meeting agendas, meeting minutes, presentations, notices, press releases, project reports and other related information is made available on the website. In addition, the website provides options for contacting the Spadra Basin GSA and interested parties can sign-up to receive all GSA and GSP related notifications.

The Spadra Basin GSA compiled an initial list of stakeholders and interested persons for the development of the Spadra Basin GSP. The initial list is included in an appendix of the Stakeholder Engagement Plan described in Section 1.3.3.1 below. These interested persons were included in an email list of persons and

interested stakeholders as required in Water Code § 10723.4 to receive notices regarding plan preparation, meeting announcements, availability of draft plans and other relevant documents. Regular mail was used for any person(s) that did not have access to email.

Information about the Spadra Basin GSA and GSP development was distributed to the stakeholder list via email or mail, including notification of all meetings. The Spadra Basin GSA Executive Committee and Advisory Committee meetings are open to the public and were noticed at least 72 hours prior to each meeting.

1.3.3 Communication and Stakeholder Involvement

The Spadra Basin GSA is committed to an open, transparent, and inclusive public outreach and education process that supports the development and implementation of the GSP for the Spadra Basin. All interested parties or stakeholders are encouraged to participate.

1.3.3.1 Stakeholder Identification and Engagement

The Spadra Basin Implementation Team, with oversight from the Executive Committee prepared a Spadra Basin GSA Stakeholder Engagement Plan (Appendix F) to encourage engagement with the public and stakeholders of diverse social, cultural, and economic elements of the population within the basin, and describe the ways that the public and interested stakeholders can participate in the development and implementation of the Spadra Basin GSP. The Stakeholder Engagement Plan for the Spadra Basin GSA describes the GSA's program to:

- Identify stakeholder who have an interest in the Spadra Basin.
- Understand and involve stakeholders and their concerns in the decision-making process, including the anticipated schedule for providing information to the stakeholders and receiving feedback during the GSP development and its implementation.
- Evaluate the success of stakeholder engagement methods.

An initial list of the Spadra Basin stakeholders was developed and included as an appendix to the Spadra Basin GSA Stakeholder Engagement Plan in Appendix F of this GSP. The GSA maintained and modified this list through the GSP development process and will continue to do so during GSP implementation.

1.3.3.2 Opportunity for Public and Stakeholder Participation

The Spadra Basin GSA Advisory Committee was formed of representatives from interested Spadra Basin stakeholders to oversee and provide guidance on the GSP development and implementation. The Advisory Committee meetings are the forum to present all content used to prepare the GSP in an open and transparent process, and to receive feedback from all interested parties and stakeholders. All meetings of the Spadra Basin GSA Advisory Committee (and the Executive Committee) include an opportunity for public comments.

The schedule and process to develop the GSP was done in five phases:

- ***Phase I*** – Develop Hydrogeologic Conceptual Model and Groundwater Model for the Spadra Basin
- ***Phase II*** – Develop Sustainable Management Criteria for the Spadra Basin
- ***Phase III*** – Evaluate the Sustainability of Future Baseline Conditions

- ***Phase IV*** – Evaluate Basin Optimization Scenarios to Achieve Sustainability
- ***Phase V*** - Develop GSP

Five technical memoranda were prepared in sequence with input from interested stakeholders and the public along the way. Each technical memorandum (TM) represents an interim milestone in the development of the GSP and ultimately became sections in this GSP and were used to help prepare he GSP monitoring and implementation plans. The five technical memoranda were:

- ***Technical Memorandum 1 (TM 1)*** – Conceptual Model of the Spadra Basin
- ***Technical Memorandum 2 (TM 2)*** – Construction and Calibration of the Spadra Basin Groundwater Model
- ***Technical Memorandum 3 (TM 3)*** – Sustainable Management Criteria for the Spadra Basin
- ***Technical Memorandum 4 (TM 4)*** – Sustainability of Future Baseline Conditions
- ***Technical Memorandum 5 (TM 5)*** – Basin Optimization Scenarios to Achieve Sustainability

The contents of each draft TM were presented at one or more Advisory Committee meetings, and stakeholders and the public had a four-week review period to provide comments and suggested edits. All draft TMs were published on the GSA website documents page:

The comments received and the responses to comments were documented in an appendix to the final TM, along with edits based on the comments. Appendix G of this GSP includes all the comments and responses for each of the TMs. The final TMs were posted to the GSA website documents page.

The same review process applies to this GSP. All public and stakeholder comments received on the draft GSP and response to those comments is included in Appendix H.

1.3.3.3 Decision-making process

The Advisory Committee provides guidance, input, and advice in connection with the development and implementation of the GSP, and reviews and provides feedback on the draft technical memoranda and the GSP. The Executive Committee is responsible for the overall management of the GSA and if needed will implement measures if insufficient or unsatisfactory progress is being made in the development and implementation of the GSP. The Executive Committee approves all interim technical memoranda and other items related to the GSP development and implementation, including the final GSP.

1.3.4 Meetings

The Executive Committee and Advisory Committee meetings were held regularly. Executive Committee and Advisory Committee meetings were held bi-monthly (every two months) throughout the GSP development process. All meeting agendas and minutes are located on the Meetings/Agendas page on the Spadra Basin website. All meeting presentations are available on the Resources page on the Spadra Basin website.

Table 1-1 provides a complete list of all Executive Committee meetings held during the GSA formation and the GSP development process.

Table 1-1. Spadra Basin GSA Executive Committee Meetings

2018	2019	2020	2021
June 7, 2018	January 7, 2019	January 6, 2020	January 4, 2021
July 2, 2018	March 4, 2019	March 2, 2020	March 1, 2021
August 6, 2018	May 6, 2019	May 4, 2020	May 3, 2021
September 4, 2018	July 1, 2019	July 6, 2020	July 6, 2021
October 1, 2018	August 5, 2019	September 8, 2020	September 7, 2021
November 5, 2018	September 3, 2019	November 2, 2020	November 16, 2021
-	November 4, 2019	-	-

Table 1-2 provides a complete list of all Advisory Committee meetings held during the GSP development process.

Table 1-2. Spadra Basin GSA Advisory Committee Meetings

2019 and 2020	2021
November 19, 2019	February 4, 2021
February 3, 2020	April 1, 2021
June 1, 2020	June 3, 2021
August 3, 2020	July 6, 2021
October 5, 2020	August 7, 2021
December 7, 2020	September 15, 2021
-	November 10, 2021

1.3.5 Comments

The Executive Committee and Advisory Committee meetings included a scheduled time for public comments. There were no public comments offered during these designated comment periods.

As described in *Section 1.3.3.2 Opportunity for Public and Stakeholder Participation* above, the interested public and stakeholders of the Spadra Basin had the opportunity to provide comments on the draft technical memoranda prepared in the development of the GSP. All comments received and the responses to comments were documented in an appendix of each final TM. Appendix G of this GSP includes all Comments and Responses for each of the TMs. The five final TMs are available on the Resources page on the Spadra Basin website.

1.4 GSP ORGANIZATION

This GSP meets the minimum requirements of the DWR's GSP Regulations and statutory provisions of SGMA as described in *Article 5—Plan Contents* as described in 23 CCR, Title 23, Division 2, Chapter 1.5, Subchapter 2. The Spadra Basin GSP is organized based on the recommended outline in the DWR's guidance document *GSP Annotated Outline* (DWR, 2016). The *Preparation Checklist for the GSP* in Table 1-3 maps the GSP requirements in accordance with the DWR's GSP Regulations to the corresponding sections of this GSP. The GSP is organized as follows:

- **Section 1.0 Introduction.** This section summarizes the purpose of the GSP, information about the Spadra Basin GSA and its organizational structure, the beneficial uses and users of groundwater, the notice and communication with stakeholders, and the organization of the GSP.
- **Section 2.0 Plan Area and Basin Setting**. This section presents a description of the Plan Area and Basin Setting of the Spadra Basin. The Plan Area is a general description of the GSP area including jurisdictional boundaries, existing monitoring and management plans, and the overlying land uses, water uses and water disposal. The Basin Setting includes a detailed description of the hydrogeologic conceptual model of the Spadra Basin, its surface-water and groundwater hydrology over a long-term historical period to current conditions, the historical and current water budget, and the data gaps and levels of uncertainty in the description of the Basin Setting.
- **Section 3.0 Sustainable Management Criteria.** This section presents the conditions that constitute sustainable groundwater management in the Spadra Basin in accordance with the GSP Regulations, 23 CCR § 354.22 through § 354.30. This section defines the Sustainability Indicators relevant to the Spadra Basin, and a description of the Undesirable Results, Minimum Thresholds, Measurable Objectives, and Interim Milestones for each Sustainability Indicator. This section also includes a description of the Sustainability Goal for the Spadra Basin.
- **Section 4.0 Monitoring Network.** This section describes the monitoring network and monitoring procedures for GSP implementation designed to assess the conditions in the basin necessary to evaluate progress towards achieving Measurable Objectives and avoiding exceedance of Minimum Thresholds and Undesirable Results. This section also describes the process to fill data gaps that were identified during GSP preparation.
- **Section 5.0 Projects and Management Actions to Achieve Sustainability.** This section describes the development and evaluation of future projects and management actions necessary to achieve the Sustainability Goal. The section begins with a description and evaluation of a future Baseline Scenario that was used to guide the need for and the development of three Basin Optimization Scenarios. The Basin Optimization Scenarios are modifications of the Baseline Scenario that include projects and management actions to achieve sustainability and/or maximize the beneficial use of the basin. This section includes a recommendation for the preferred Basin Optimization Scenario for GSP implementation.
- **Section 6.0 Plan Implementation.** This section describes the plan to implement the GSP, including a schedule and cost estimates. This section also outlines the procedure for annual reporting and the periodic (5-year) evaluations of the GSP.
- **Section 7.0 References.** This section lists the references and publications used to prepare this GSP.

Table 1-3. Preparation Checklist for Spadra Basin GSP

GSP Regulations Section	Requirement	Description	Section Number, or other location in the GSP
Article 3. Technical and Reporting Standards			
352.2	Monitoring Protocols	Monitoring protocols adopted by the GSA for data collection and management	Section 4.1
		Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 4.1
Article 5. Plan Contents, Subarticle 1. Administrative Information			
354.4	General Information	Executive Summary	Executive Summary
		List of references and technical studies	Section 7
354.6	Agency Information	GSA mailing address	Section 1.2
		Organization and management structure	Section 1.2.1
		Contact information of Plan Manager	
		Legal authority of GSA	Section 1.2.2
		Estimate of implementation costs	Section 6.2
354.8(a)	Map(s)	Area covered by GSP	Section 2.1.1
		Adjudicated areas, other agencies within the basin, and areas covered by an Alternative	
		Jurisdictional boundaries of federal or State land	
		Existing land use designations	Section 2.1.3.1
		Density of wells per square mile	Section 2.1.2.3
354.8(b)	Description of the Plan Area	Summary of jurisdictional areas and other features	Section 2.1.1
354.8(c) 354.8(d) 354.8(e)	Water Resource Monitoring and Management Programs	Description of water resources monitoring and management programs	Section 2.1.2
		Description of how the monitoring networks of those plans will be incorporated into the GSP	Section 4.0
		Description of how those plans may limit operational flexibility in the basin	Not applicable
		Description of conjunctive use programs	
354.8(f)	Land Use Elements or Topic Categories of Applicable General Plans	Summary of general plans and other land use plans	Section 2.1.3
		Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects	
		Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans	
		Summary of the process for permitting new or replacement wells in the basin	Section 2.1.3.4
		Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Not applicable (optional)
354.8(g)	Additional GSP Contents **(optional items)**	Description of Actions related to: Control of saline water intrusion	Not applicable (optional)
		Wellhead protection	
		Migration of contaminated groundwater	Section 2.2.3.7
		Well abandonment and well destruction program	Section 2.1.3.4
		Replenishment of groundwater extractions	Not applicable (optional)
		Conjunctive use and underground storage	
		Well construction policies	
		Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects	Sections: 5.3, 5.4
		Efficient water management practices	Not applicable (optional)
		Relationships with State and federal regulatory agencies	
		Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity	
		Impacts on groundwater dependent ecosystems	
354.10	Notice and Communication	Description of beneficial uses and users	Section 1.3.1
		List of public meetings	Section 1.3.4
		GSP comments and responses	Section 1.3.5
		Decision-making process	Section 1.3.3.3
		Public engagement	Section 1.3.3.2
		Encouraging active involvement	Sections 1.3.3.2, 1.3.3.3
		Informing the public on GSP implementation progress	Section 1.3.2
Article 5. Plan Contents, Subarticle 2. Basin Setting			
354.14	Hydrogeological Conceptual Model	Description of the Hydrogeologic Conceptual Model	Section 2.2.2
		Two scaled cross-sections	Section 2.2.2.5 and Figures 2-15 a, b, c, d, e
		Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Figures 2-11, 2-12, and 5-15

Table 1-3. Preparation Checklist for Spadra Basin GSP

GSP Regulations Section	Requirement	Description	Section Number, or other location in the GSP
354.14(c)(4)	Map of Recharge Areas	Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Figures 2-8, and Figure 5-16
	Recharge Areas	Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 2.2.2.7
354.16	Current and Historical Groundwater Conditions	Groundwater elevation data	Section 2.2.2.11 and Figures 2-18 a, b, c, d
		Estimate of groundwater storage	Section 2.2.2.11
		Seawater intrusion conditions	Not applicable; this is described Section 3.2
		Groundwater quality issues	Section 2.2.3
		Land subsidence conditions	Section 2.2.4
		Identification of interconnected surface water systems	Not applicable; this is described Sections 2.2.5 and 3.2
		Identification of groundwater-dependent ecosystems	
354.18	Water Budget Information	Description of inflows, outflows, and change in storage	Section 2.2.6
		Quantification of overdraft	Sections 2.2.6.1.3 and 2.2.3.1.4
		Estimate of sustainable yield	Section 2.2.6.1.4
		Quantification of current, historical, and projected water budgets	Section 2.2.6
	Surface Water Supply	Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 2.1.3.3
354.20	Management Areas	Reason for creation of each management area	Not applicable
		Minimum thresholds and measurable objectives for each management area	
		Level of monitoring and analysis	
		Explanation of how management of management areas will not cause undesirable results outside the management area	
		Description of management areas	
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria			
354.24	Sustainability Goal	Description of the sustainability goal	Section 3.4
354.26	Undesirable Results	Description of undesirable results	Section 3.3
		Cause of groundwater conditions that would lead to undesirable results	
		Criteria used to define undesirable results for each sustainability indicator	
		Potential effects of undesirable results on beneficial uses and users of groundwater	
354.28	Minimum Thresholds	Description of each minimum threshold and how they were established for each sustainability indicator	Section 3.3
		Relationship for each sustainability indicator	
		Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater	
		Standards related to sustainability indicators	
		How each minimum threshold will be quantitatively measured	
354.30	Measurable Objectives	Description of establishment of the measurable objectives for each sustainability indicator	Section 3.3
		Description of how a reasonable margin of safety was established for each measurable objective	
		Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Section 3.5
Article 5. Plan Contents, Subarticle 4. Monitoring Networks			
354.34	Monitoring Networks	Description of monitoring network	Section 4.0
		Description of monitoring network objectives	Section 4.0
		Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions	Section 4.1
		Description of how the monitoring network provides adequate coverage of Sustainability Indicators	Section 4.1
		Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends	Section 4.1

Table 1-3. Preparation Checklist for Spadra Basin GSP

GSP Regulations Section	Requirement	Description	Section Number, or other location in the GSP
		Scientific rational (or reason) for site selection	Sections 4.1 and 3.3
		Consistency with data and reporting standards	Section 4.1
		Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone	Sections 4.1 and 3.3
		Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 4.1, Table 4-1, and Figure 4-1
354.36	Assessment and Improvement of Monitoring Network	Description of representative sites	Sections 4.1 and 3.3
		Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators	Sections 4.1.1.1.1, 3.3.2, and 3.3.4
		Adequate evidence demonstrating site reflects general conditions in the area	Sections 4.1, and 4.3
354.38		Review and evaluation of the monitoring network	Sections 4.3 and 6.1.4
		Identification and description of data gaps	Section 4.3
		Description of steps to fill data gaps	Section 4.3
		Description of monitoring frequency and density of sites	Sections 4.1 and 4.3
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions			
354.44	Projects and Management Actions	Description of projects and management actions that will help achieve the basin's sustainability goal	Sections 5.3 and 5.4
		Measurable objective that is expected to benefit from each project and management action	
		Circumstances for implementation	
		Public noticing	
		Permitting and regulatory process	
354.44(b)(2)		Timetable for initiation and completion, and the accrual of expected benefits	
		Expected benefits and how they will be evaluated	
		How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.	
		Legal authority required	
		Estimated costs and plans to meet those costs	Sections 5.4, 6.2, and 6.3
		Management of groundwater extractions and recharge	Section 5.3

SECTION 2
Plan Area and Basin Setting

2.1 PLAN AREA

The Plan Area is a description of the geographic area for the GSP and the interaction of the GSP with existing jurisdictions, monitoring and management plans, and land uses. The Plan Area description addresses the requirements of GSP Regulations 23 CCR § 354.8 of the GSP Regulations and includes the following descriptions:

- Jurisdictional areas and other features
- Existing monitoring and groundwater management programs
- Historical and current land use, water use, and water disposal

2.1.1 Jurisdictional Area and Other Features

The Spadra Basin is a relatively small groundwater basin, about seven square miles (4,200 acres), in eastern Los Angeles County in Southern California. It sits at the eastern end of the northeast-southwest trending San Jose Valley between the San Jose Hills and Puente Hills. Figure 2-1 shows the location of the Spadra Basin and nearby groundwater basins. The Spadra Basin boundary shown on Figure 2-1 is the Spadra Basin GSA boundary, which is defined as the unadjudicated portion of the San Gabriel Valley Groundwater Basin as defined in the DWR's *Bulletin 118 California's Groundwater Update 2003* (Basin No. 4-013) exclusive of the adjudicated boundaries of the Main San Gabriel and Puente Basins. The eastern boundary of the Spadra Basin is the western boundary of the Chino subbasin of the Upper Santa Ana Valley Groundwater Basin (Basin No. 8-002.01 as defined in Bulletin 118). The Spadra Basin is surrounded by four adjudicated groundwater basins: the Puente Basin to the southwest, the Main San Gabriel Basin to the northwest, the Six Basins to the north, and Chino Basin to the east.

Figure 2-2 shows the location of the Spadra Basin and the water purveyors in the area. Pomona, the WVWD, and CPP are the local water purveyors with service area boundaries overlying the Spadra Basin. The water purveyors obtain water supplies from multiple sources including groundwater, local surface water, treated imported water from the State Water Project and Colorado River, and recycled water. The water purveyors purchase imported water from the Three Valleys Municipal Water District (TVMWD), a sub-agency of the Metropolitan Water District of Southern California (Metropolitan). The Spadra Basin lies within the TVMWD's service area. Pomona's service area overlies the majority of the Spadra Basin. WVWD's service area overlies a smaller portion of the Spadra Basin to the west and CPP's service area overlies a small portion in the north. In the western portion of the Spadra Basin, there is an overlap of the Pomona and WVWD service areas where water is served by both purveyors.

Figure 2-2 also shows the location of cities within and immediately adjacent to the Spadra Basin. The City of Pomona boundary overlies the majority of the Spadra Basin and is the same boundary as the Pomona water service area boundary. The City of Diamond Bar overlies a very small corner of the Spadra Basin to the south, and the Cities of Walnut and Industry are located just west of the Spadra Basin; all three cities are served by the WVWD.

117°40'0"W

34°0'0"N

San Gabriel Mountains

Main San Gabriel Adjudicated Basin

Six Basins Adjudicated Basin

Cucamonga Adjudicated Basin

Spadra Basin

Chino Adjudicated Basin

Puente Adjudicated Basin

San Jose Hills

Puente Hills

Los Angeles County

San Bernardino County

210

57

10

60

71

83

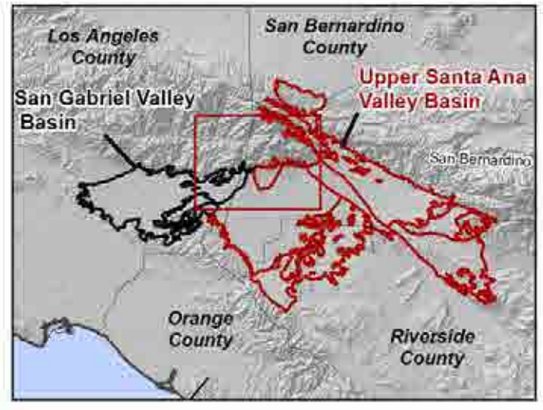
Spadra Basin (GSP Boundary)

DWR Bulletin 118 California Groundwater Basin Boundaries

San Gabriel Valley, 4-013

Upper Santa Ana Valley 8-002

Adjudicated Groundwater Basin
(Various Colors - Labeld in the Map)



Prepared by:

WEST YOST
Water. Engineered.

Updated By: VWarren
Date: 20191105

0 2 4 6 Miles

0 2 4 6 8 10 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN

The Spadra Basin and Nearby Groundwater Basins

Figure 2-1

117°40'0"W

34°0'0"N

San Gabriel Mountains

City of Glendora

City of La Verne

Golden State Water Company Claremont

San Antonio Water Company

Cucamonga Valley Water District

City of Upland

Golden State Water Company San Dimas

City of Covina

San Jose Hills

Valencia Heights Water Co

California State Polytechnic University Pomona

City of Pomona

Monte Vista Water District

Los Angeles County

San Bernardino County

City of Ontario

City of West Covina

Puente Hills

City of Chino

Walnut Valley Water District

Rowland Water District

CIM

Chino Airport

City of Chino Hills

Chino Hills

Spadra Basin (GSP Boundary)

Service Areas of Water Purveyors in the Spadra Basin Area (Various Colors - Labeled in map)

Area Mutually Served by City of Pomona and Walnut Valley Water District

Boundaries of Metropolitan Imported Water Contractors in the Spadra Basin Area

Three Valleys Municipal Water District

Inland Empire Utilities Agency Boundary

City Boundaries Within or Adjacent to the Spadra Basin

City of Pomona

City of Diamond Bar

City of Walnut

City of Industry

Prepared by:

WEST YOST
Water. Engineered.

Updated By: aponowlet

Date: 20191105

0 2 4 6 Miles

0 2 4 6 8 10 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN

Water Purveyors and Jurisdictional Boundaries in the Spadra Basin Area

Figure 2-2

2.1.2 Existing Water Resources Monitoring and Management Programs

The Spadra Basin is an unadjudicated portion of the San Gabriel Valley Basin (Basin No. 4-013). There is no formal basin management plan for the water resources in the Spadra Basin and there are no defined restrictions on groundwater pumping. The Spadra Basin GSA agencies are parties to the Judgments for the adjacent adjudicated groundwater basins: Six Basins, Puente Basin, and Chino Basin. Pomona is a party to the Six Basins Judgment (*Southern California Water Company vs. City of La Verne, et al.*) and Chino Basin Judgment (*Chino Basin Municipal Water District vs. City of Chino et al.*); the WVWD is a party to the Puente Basin Judgment (*Puente Basin Water Agency et al. vs. The City of Industry et al.*).

There are some regional water management plans that include Spadra Basin groundwater, including Urban Water Management Plans prepared by water purveyors in the Spadra Basin area and the *Water Quality Control Plan, Los Angeles Region* (LA Basin Plan) prepared by the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board). These water management plans are described in more detail below.

Monitoring of water resources in the Spadra Basin generally consists of uncoordinated efforts by water purveyors to measure and record groundwater pumping, groundwater quality, and groundwater levels. Surface-water monitoring is conducted by the Los Angeles County Sanitation Districts (LACSD) at the Pomona Water Reclamation Plant (Pomona WRP) for discharge and water quality.

2.1.2.1 Urban Water Management Plans

Urban Water Management Plans are prepared every five years pursuant to requirements in the California Water Code (§ 10610-10656 and § 10608), by urban water purveyors who serve more than 3,000 customers or supply more than 3,000 afy of water. These plans support the water purveyors' long-term resource planning to ensure that adequate water supplies are available to meet existing and future water needs. Spada Basin groundwater is described primarily as a non-potable water supply in several 2015 Urban Water Management Plans, including:

- **City of Pomona 2015 Urban Water Management Plan** (Pomona, 2016). Pomona pumps groundwater from three wells in the Spadra Basin primarily to supplement the City's non-potable water system. One of the wells can supply water to the City's potable water system on a limited basis.
- **Walnut Valley Water District 2015 Urban Water Management Plan** (Civiltec Engineering, 2016)**.** The WVWD pumps groundwater from one well in the Spadra Basin to supplement the District's non-potable water system.
- **Rowland Water District 2015 Urban Water Management Plan** (RMC Water and Environment, 2016). Spadra Basin groundwater pumped by the WVWD and used to supplement its non-potable water system can be delivered to Rowland Water District via an emergency recycled water connection.

2.1.2.2 LA Basin Plan

The responsibility for protecting water quality in California rests with the State Water Resources Control Board (State Water Board) and its nine Regional Water Quality Control Boards, who set policies and develop water quality control plans for their respective regions. The Spadra Basin is within the jurisdiction of the LA Regional Board who has developed the LA Basin Plan pursuant to state and federal water quality statutes and regulations to preserve and enhance water quality and protect beneficial uses of all regional waters in the Los Angeles Region (LA Regional Board, 2019). Specifically, the Basin Plan (i) designates beneficial uses for surface and groundwaters, (ii) sets objectives that must be attained or maintained to protect the designated beneficial uses and conform to the State's Antidegradation Policy, and (iii) describes implementation programs and other actions that are necessary to achieve the water quality objectives established in the Basin Plan. The Spadra Basin is part of the Bulletin 118 San Gabriel Valley Basin which has the following designated beneficial uses for groundwater indicated in Section 2, Table 2-2 of the Basin Plan:

- Municipal and Domestic Supply (MUN)
- Industrial Service Supply (IND)
- Industrial Process Supply (PROC)
- Agricultural Supply (AGR)

The State's policies and plans are based on the State Water Board's Antidegradation Policy (Resolution 68-16), which restricts the degradation of surface water or groundwater quality to protect their beneficial uses. Section 3 of the LA Basin Plan includes narrative water-quality objectives for regional groundwaters and specific numerical objectives for sub-basins in the region. The LA Basin Plan of the LA Regional Board contains numeric water-quality objectives for the Spadra Basin to maintain or protect the designated beneficial uses and conform to the State's Antidegradation Policy. When the existing water quality of a groundwater basin is better than its Basin Plan objective, then the water body has "assimilative capacity" for degradation. The Antidegradation Policy is implemented, in part, through Waste Discharge Requirements (WDRs) issued by the Regional Boards. In the Spadra Basin, this includes the reclamation requirements for discharges to groundwater from recycled water reuse from the LACSD's Pomona Water Reclamation Plant (Pomona WRP).

The LA Basin Plan also includes salt and nutrient management plans (SNMPs) for groundwater basins in the Los Angeles Region, that were developed pursuant to the State Water Board's 2009 *Policy for Water Quality Control for Recycled Water* (Recycled Water Policy). The Recycled Water Policy requires that a SNMP be prepared for all high priority[1] groundwater basins in the State to address: the potential for salt and nutrient degradation in groundwater from all sources, the potential impairment of beneficial uses, and to support recycled water reuse programs. Pursuant to this requirement, the Main San Gabriel Basin Watermaster in conjunction with other primary stakeholders[2] prepared *The San Gabriel Valley Basin SNMP* ([San Gabriel SNMP] Stetson Engineers Inc., 2016) to provide a framework for water management practices in the San Gabriel Valley Groundwater Basin to ensure beneficial uses and sustainability of groundwater resources, consistent with the LA Regional Board's water quality objectives. The San Gabriel SNMP was adopted by the LA Regional Board on December 8, 2016, the State Water Board on

[1] The basin priority designation for the Recycled Water Policy is different than that used by DWR for the SGMA.

[2] Upper San Gabriel Valley Municipal Water District, San Gabriel Valley Municipal Water District, Three Valleys Municipal Water District, County of Los Angeles Department of Public Works, Metropolitan Water District, and Los Angeles County Sanitation Districts.

May 16, 2017, and the Office of Administrative Law on December 19, 2018, and was subsequently included in Section 8 of the LA Basin Plan. The San Gabriel SNMP only incorporates the portions of the Bulletin 118 San Gabriel Valley Basin included in the Main San Gabriel Basin Judgment; the Spadra Basin was excluded from the San Gabriel SNMP. Consequently, there is no SNMP for the Spadra Basin.

2.1.2.3 Groundwater Monitoring

Figure 2-3 shows the locations of all known existing wells in the Spadra Basin. There are 10 known production wells: nine are municipal wells owned and operated by Pomona, WVWD, and CPP; one is owned by the Walnut Hills Mobil Home Park. Groundwater pumped from the municipal wells is primarily used as a supplemental supply source for non-potable uses by these water purveyors. Except for one production well owned by the WVWD, all wells are active (*i.e.,* they are currently used to pump groundwater). The production wells are generally located along the axis of the Spadra Basin, and their spatial density ranges from one to three wells per square mile. There may potentially be additional, privately owned production wells in the Spadra Basin that are yet to be identified.

There are 29 known monitoring wells in the Spadra Basin: 28 are associated with point-source contaminant sites at the Spadra Landfill, Teledyne Cast Parts, and Calsol Inc., one is a WVWD monitoring well located near WVWD's inactive "Valley" well.

Figure 2-4 characterizes the groundwater data that have been collected at wells in the Spadra Basin within the last 10 years, from 2010 to 2019. Currently, groundwater monitoring in the Spadra Basin occurs at the municipal production wells owned by water purveyors, and at wells installed for monitoring at the three point-source contaminant sites. Groundwater-quality samples are collected at most of the active production wells by the well owners for informational and operational purposes or to comply with State Water Resources Control Board Division of Drinking Water (DDW) monitoring schedules for water systems. Table 2-1 summarizes the groundwater monitoring that has occurred at Spadra Basin wells over the last 10 years.

Table 2-1. Summary of Groundwater Data Collected in the Last Ten Years (2010-2019) at Spadra Basin Wells

Well Type and Status	Total No. of Wells in Spadra Basin	No. of Wells with Production Data	No. of Wells with Groundwater Quality Data	No. of Wells with Groundwater Level Data
Active Municipal Production Well	8	8	5	5
Inactive Municipal Production Well	1	0	0	0
Active Private Production Well	1	0	0	0
Contaminate Site Monitoring Well	29	-	29	29
Other Monitoring Well	1	-	0	0
Total	**40**	**8**	**34**	**34**

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
San Jose Hills
Six Basins
Fuerte St
Via Verde
Via Verde
Orange Grove Ave
Mckinley Ave
10
57
San Jose Fault
Fairplex Dr
Dudley St
W. Orange Grove Ave
CPP-1
Kellogg Cir
Calsol Inc.
Holt Ave
P-19
P-31
P-28
Valley (Inactive)
Valley MW
Mission Blvd
Spadra Landfill
San Jose Ck
Valley Blvd
CPP-2
Chino Basin
Temple Ave
Pomona Blvd
South San Jose Ck
Grand Ave
Spadra Landfill Boundary
Walnut Hills
CPP-3
CPP-4
Phillips Blvd
71
White Ave
Garey Ave
Towne Ave
Teledyne Cast Parts
Temple Ave
57
Rio Rancho Rd
Industry
Puente Hills
Grand Ave
Valley Blvd
60
Chino Ck
Puente Basin

Wells in Spadra Basin

Existing Production Wells
Symbolized by Well Owner
- Cal Poly Pomona
- City of Pomona
- Walnut Valley Water District
- Walnut Hills Mobile Home Community

Existing Monitoring Wells
- Labeled by Well Name or Well Group

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology
Water-Bearing Sediments
- Quaternary Alluvium

Consolidated Bedrock
- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults
- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-3_Wells.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Wells in the Spadra Basin

Figure 2-3

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
Six Basins
San Jose Hills
Via Verde
Puente St
Via Verde
McKinley Ave
Orange Grove Ave
San Jose Fault
Fairplex Dr
Dudley St
W. Orange Grove Ave
Holt Ave
Kellogg Dr
CPP-1*
P-31**
P-19**
P-28**
Calsol Inc.
Valley (inactive)
Valley MW
Mission Blvd
Spadra Landfill
San Jose Ck
Valley Blvd
CPP-2*
Pomona Blvd
Chino Basin
Temple Ave
South San Jose Ck
Grand Ave
Spadra Landfill Boundary
Walnut Hills
CPP-3*
CPP-4*
Phillips Blvd
White Ave
Garey Ave
Towne Ave
Teledyne Cast Parts
Industry*
Rio Rancho Rd
Puente Hills
Grand Ave
Valley Blvd
Chino Ck
Puente Basin

Types of Monitoring Data Collected at Wells in the Last Ten Years (2010-2019)

Well Type (symbolized by shape)
- Monitoring Well
- Production Well

Data Type (symbolized by color)
- Groundwater Quality
- Groundwater Elevation
- Groundwater Production
- None

* indicates well in CASGEM program
\# indicates well that is part of the State Water Board GAMA Program

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments
- Quaternary Alluvium

Consolidated Bedrock
- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults
- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-4_WaterMonitoring.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Groundwater Monitoring in Spadra Basin

Figure 2-4

Production data is measured at eight of the active production wells (owned by water purveyors), and groundwater-quality and groundwater-level data are collected at some of these wells. No groundwater data have been collected from the active private production well (owned by Walnut Hills Mobile Home Park) or the inactive municipal production well.

At the 29 monitoring wells associated with the Spadra Landfill, Teledyne Cast Parts, and Calsol Inc. sites, groundwater-quality and groundwater-level data have been collected during the last ten years. There is one monitoring well where no groundwater data have been collected.

Four wells in the Spadra Basin are part of the DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program—these wells are annotated with a "*" symbol in Figure 2-4. The Puente Basin Watermaster is the designated CASGEM monitoring entity for the Puente Basin and the Spadra Basin subbasins of the San Gabriel Valley Basin and has been reporting groundwater elevations for the four wells semi-annually since 2011. Five wells in the Spadra Basin are part of the State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA) Program—these wells are annotated with a "#" symbol in Figure 2-4.

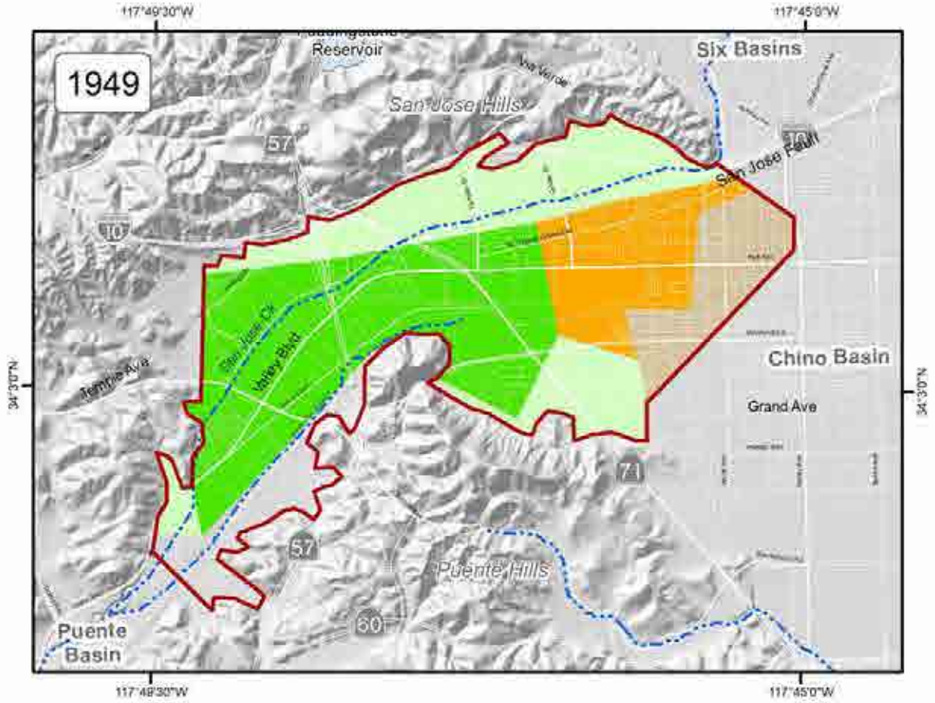
2.1.3 Land Use, Water Use, and Disposal in the Spadra Basin

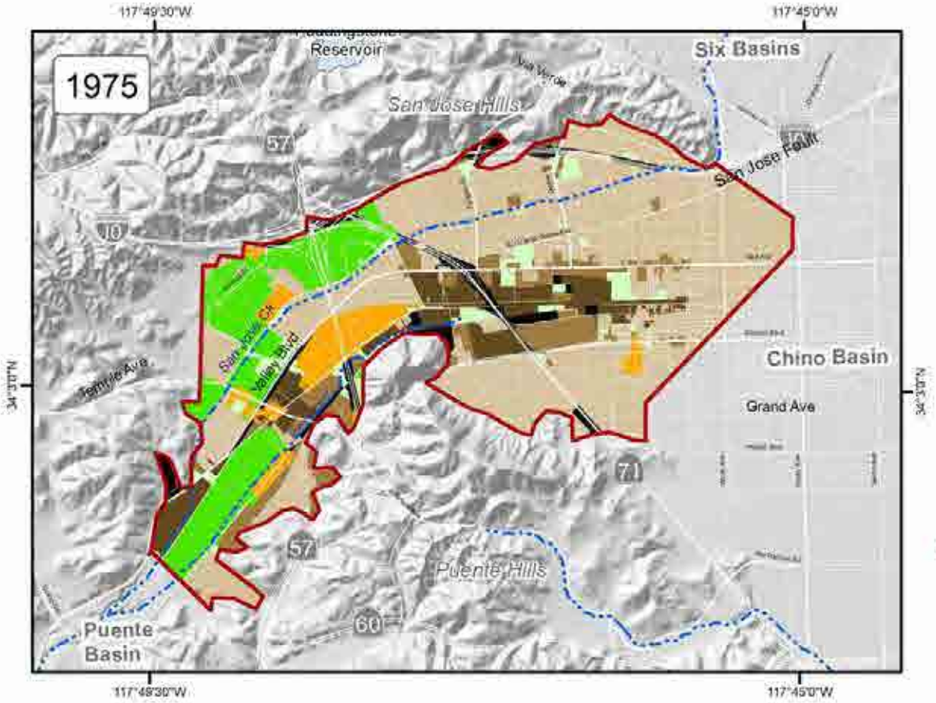
This section describes the historical and current land use, water use, and disposal of water in the Spadra Basin. The overlying land use impacts water demand and supply patterns. For example, outdoor water uses can result in return flows to the groundwater basin. Indoor water uses generate wastewaters that are conveyed to a treatment plant or to a septic system. It is important to understand overlying land use, water use, and disposal together because different land uses have different imperviousness, irrigation practices, and disposal practices that affect the volume of return flows to the groundwater basin. Furthermore, land use, water use, and disposal are an important influence on groundwater quality: the concentration of dissolved constituents in return flows is typically higher relative to groundwater, causing degradation of groundwater quality.

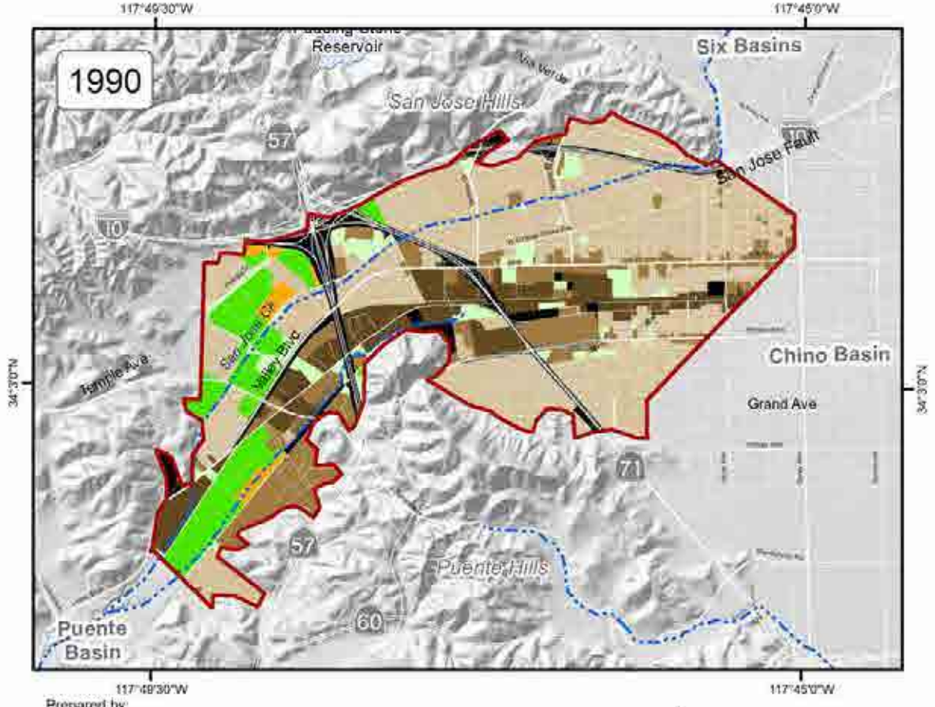
2.1.3.1 Land Use and Source Waters

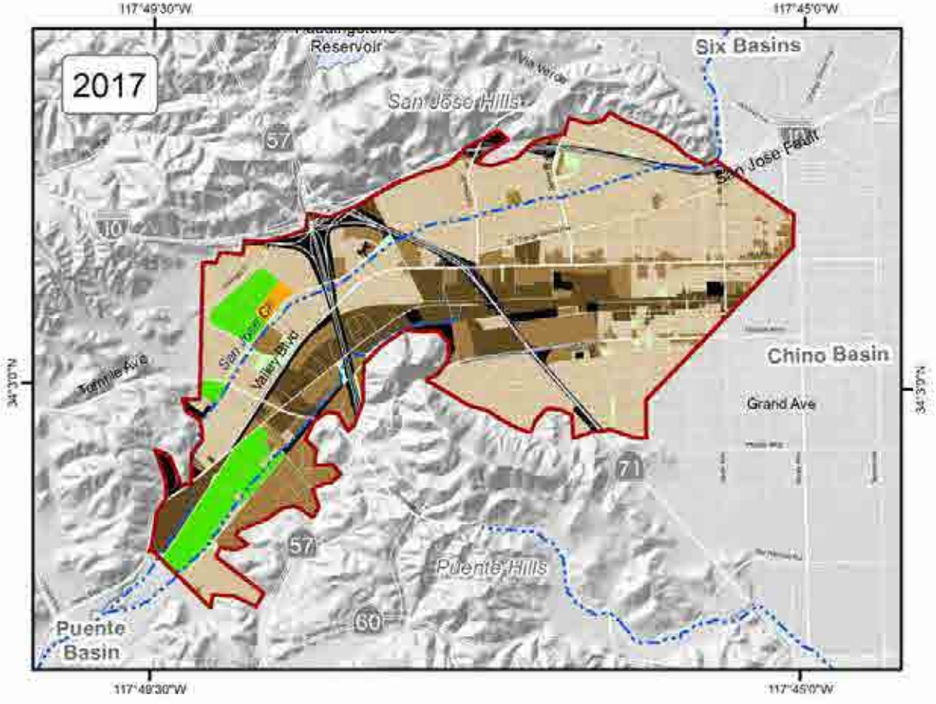
Figure 2-5 illustrates the overlying land use in the Spadra Basin in 1949, 1975, 1990, and 2017. Figure 2-6 shows the land-use changes in Figure 2-5 quantified by acreage. The land-use maps were developed from DWR land use surveys for 1949 and 1975, and from Southern California Association of Governments (SCAG) surveys for 1990 and 2017. The maps show a change in land use over time from primarily irrigated agriculture (crops, pastures, fruit, nuts, and citrus) and vacant lands in 1949 to urban (residential, commercial, and industrial) land uses by 2017. By 1975, about 78 percent of the overlying land use in the Spadra Basin was urban. By 2017, urban land uses accounted for about 93 percent of overlying land use, while irrigated agriculture accounted for six percent, associated with lands owned by the State of California and utilized by CPP for growing various crops for the university's horticultural program.

Pomona is the primary land use planning agency in the Spadra Basin. The urban and agricultural lands owned by CPP are not covered by Pomona and have a different land use planning process through the state. With the exception of a few vacant properties, the lands overlying the Spadra Basin are completely developed, and land and water use are not projected to change significantly in the future.









Land Use Type

- Native Vegetation/Vacant
- Irrigated Field Crops, Pasture, Fruit and Nuts
- Irrigated and Non-Irrigated Citrus
- Urban Residential
- Urban Commercial
- Urban Industrial
- Special Impervious

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 11/6/2019
File: Fig2-5_LandUse.mxd

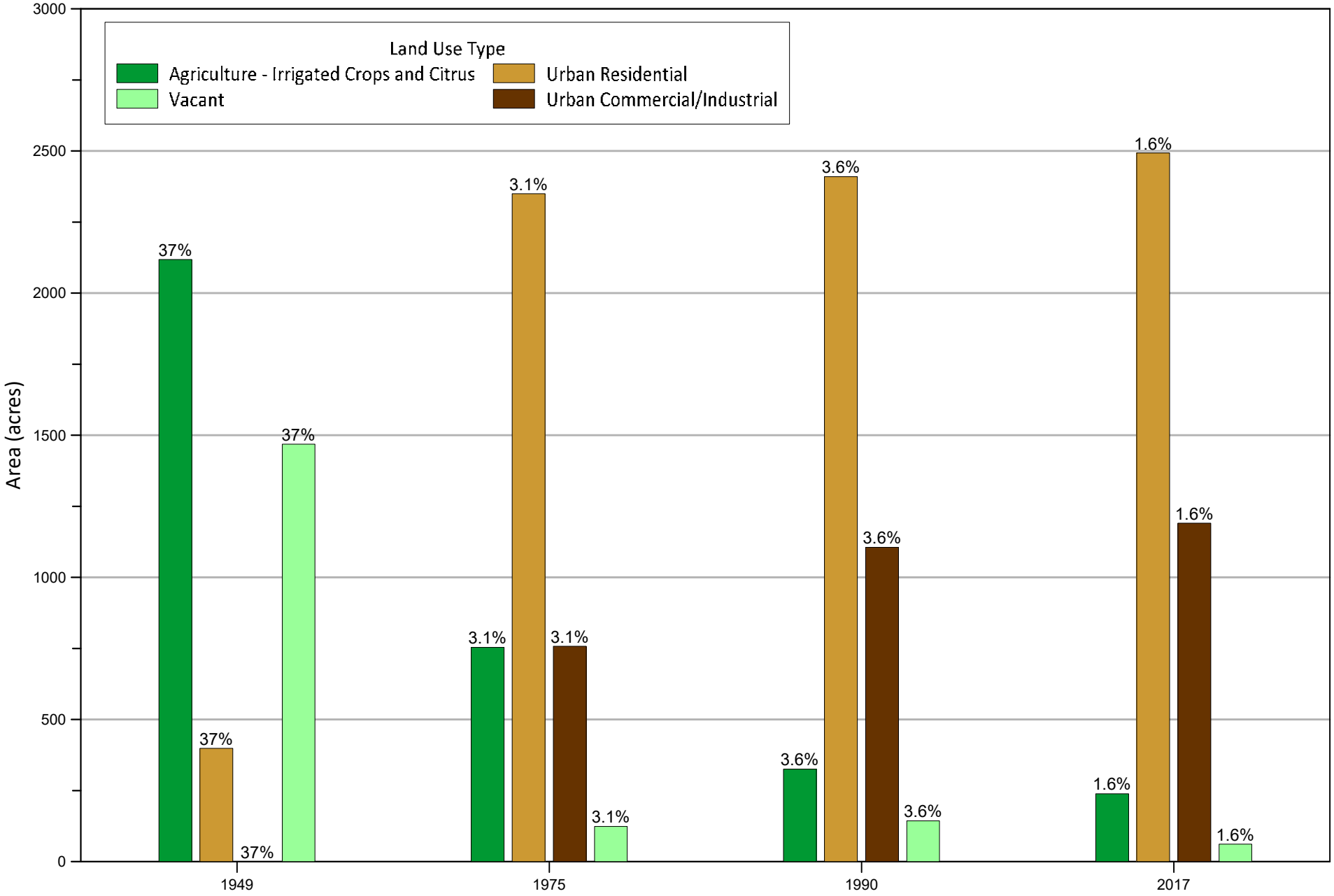
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Land Use in the Spadra Basin
1949, 1975, 1990, and 2017

Figure 2-5

Figure 2-6. Land Use Changes by Type - 1949 to 2017



WEST YOST

954-80-20-01 GRAPHER\GRF\TMs\TM5\Figure 2-6

The water purveyors with Urban Water Management Plans anticipate having sufficient water supplies from their various sources to serve the overlying land uses in the future. The development of the Spadra GSP is intended to maximize the beneficial use and reliability of Spadra Basin groundwater.

2.1.3.2 Outdoor Water Use and Return Flows

Irrigation return flows to groundwater are a function of land imperviousness and irrigation efficiency. When land was converted from vacant or agricultural to urban uses, the imperviousness of the Spadra Basin increased from near zero to between 20 and 100 percent, depending on the specific land use. The Los Angeles County Public Works Department (LACPWD) assumes a two percent impervious area for orchards and vineyards in their hydrology manual (LACPWD, 2006). By contrast, LACPWD assumes urbanized areas have a much higher fraction of imperviousness, typically ranging from about 20 percent for very low-density residential areas to about 90 percent or more for apartments, mobile home courts, and high-rise offices.

Irrigated agriculture and irrigated urban lands have different irrigation efficiencies.[3] The lower the efficiency, the more applied water will infiltrate past the root zone to the aquifer system. The typical efficiency of crop irrigation or flood-irrigated citrus groves is 60 percent or less. Modern irrigation methods, such as trickle irrigation, can achieve 90 percent efficiency (Pier, 2006). The combination of higher imperviousness and higher irrigation efficiency associated with urban land uses reduces the return flows of applied water. Thus, the change from agricultural to urban land uses in the Spadra Basin resulted in reduced irrigation return flows, and hence, reduced recharge to the basin.

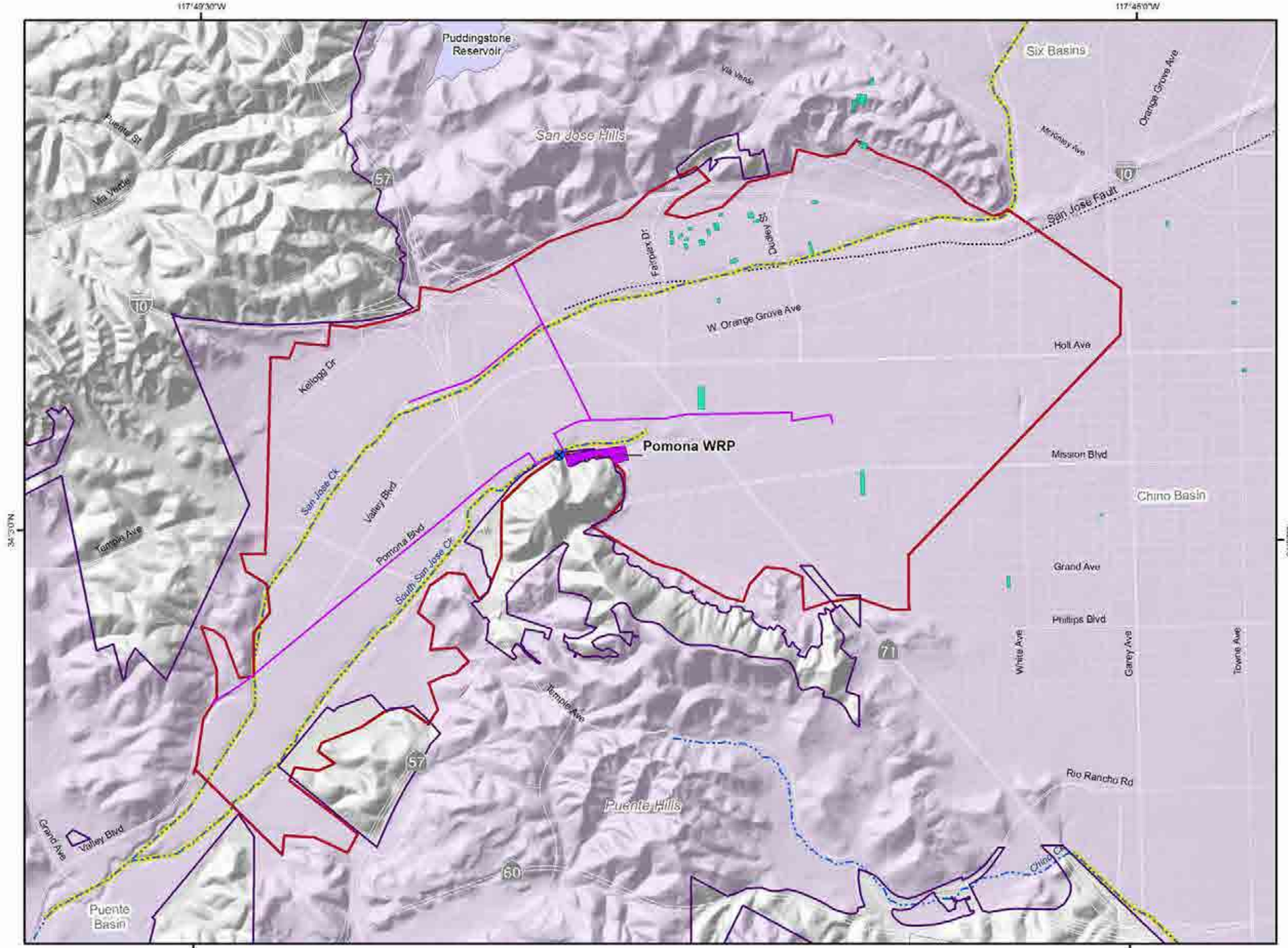
Additionally, irrigation return flows typically degrade groundwater quality. Agriculture, and to a lesser degree urban landscape irrigation, is associated with the application of fertilizers and pesticides that dissolve in the applied water. Plant uptake of the water concentrates the dissolved constituents within the return flows. The return flows are a non-point source of contaminant loading to the groundwater basin that has affected, and continues to affect, the groundwater quality of the Spadra Basin.

2.1.3.3 Disposal of Water

Surface-water runoff over lands that does not infiltrate, exits the Spadra Basin in concrete-lined storm-drain systems and flood-control channels. The two major concrete-lined channels exiting the Spadra Basin are the San Jose Creek and South San Jose Creek—their locations are shown in Figure 2-7. The surface-water runoff that exits the Spadra Basin in these channels is put to beneficial use by downstream entities mainly for groundwater recharge, is consumptively used by riparian vegetation in unlined stream reaches or flows to the ocean.

The land use agencies overlying the Spadra Basin are regulated by National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Order No. R4-2012-0175 (MS4 Permit). As part of the MS4 Permit, new development and redevelopment projects are required to control pollutants, pollutant loads, and runoff volumes from development sites.

[3] Irrigation efficiency is defined as the ratio of the use of the applied water by the plants to the total water applied (UCCE, 2000).



Pomona Water Reclamation Plant (WRP)

Pomona WRP Effluent Discharge to South San Jose Creek

Recycled Water Distribution Pipeline from the Pomona WRP

Pomona WRP Sewershed (82 square miles) in the Spadra Basin Region

*Full extent of the WRP is characterized in the inset map.

Onsite Waste Disposal Septic System

Unlined Streams & Flood Control Channels

Lined Streams & Flood Control Channels

Spadra Basin Boundary

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-7_Recycled-Wastewater.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN

Current Wastewater Disposal and Recycled Water Facilities

Figure 2-7

Figure 2-7 shows the current wastewater disposal and recycling facilities in the Spadra Basin. The Pomona WRP, located in the Spadra Basin, is a regional facility that receives and treats wastewater originating from indoor residential, commercial, and industrial uses within an 82 square-mile area in the eastern portion of Los Angeles County. It is owned and operated by the Joint Outfall System[4] of the LACSD. The tertiary-treated recycled water from the Pomona WRP is either discharged to South San Jose Creek, used for irrigation or commercial processes, or recharged outside the Spadra Basin, subject to the following permits:

- NPDES No. CA0053619 Order No. R4-2014-0212 and WDRs for the Joint Outfall System Pomona Water Reclamation Plant Discharge to the South Fork San Jose Creek Via Outfall 001
- Water Reclamation Requirements (WRRs) for County Sanitation Districts of Los Angeles County and others, 1981 Order No. 81-24; readopted in 1997 Order No. 97-072
- Monitoring and Reporting Program (M&RP) No. 6241, ordered July 27, 1981
- WRRs for Groundwater Recharge at the Montebello Forebay Order No. 91-100

Currently, recycled water from the Pomona WRP is reused by Pomona and the WVWD at approximately 211 sites over 2,393 acres in the Spadra Basin and Puente Basin (Hartling, E., personal communication, 2022). Recycled water that is not delivered for direct reuse is discharged to the concrete-lined South San Jose Creek where it flows into the San Gabriel River about 15 miles downstream and recharged at spreading grounds in the Montebello Forebay overlying the Central Basin. In 2020, approximately 50 percent of the recycled water from Pomona WRP was reused within the Spadra Basin and Puente Basin (3,124 af), and 50 percent was used for recharge at the Montebello Forebay (3,122 af) (Hartling, E., personal communication, 2022).

In 2019, the LACSD filed a wastewater change petition with the State Water Board to reduce the discharge of treated wastewater to South San Jose Creek from the Pomona WRP to zero during all months of the year based on recycled water demand. A notice of the wastewater change petition (WW0104) was published on October 15, 2019 by the State Water Board with a public protest period through November 14, 2019. This change petition was granted in October 2020 allowing for the potential utilization of this surplus recycled water in the Spadra Basin (State Water Board and California EPA, 2020).

Figure 2-7 also shows that some urbanized areas without sewer, and the disposal of wastewater occurs via on-site waste disposal (septic) systems. These areas are mainly located in northern portion of the Spadra Basin along the San Jose Hills. This wastewater has the potential for adverse impact on groundwater quality in downgradient areas—particularly regarding nitrate. Studies have indicated that return flows from septic systems have a nitrate-nitrogen concentration ranging from 30-40 milligrams per liter (mgl) (Environmental Protection Agency [EPA], 2002; Wildermuth Environmental [WEI], 2007; Kennedy/Jenks Consultants, 2013).

[4] Signatory parties to the amended Joint Outfall Agreement effective July 1, 1995 includes County Sanitation Districts of Los Angeles County Nos 1, 2, 3, 5, 8, 15, 16, 17, 18, 19, 22, 22, 23, 28, 29, and 34, and South Bay Cities Sanitation District of Los Angeles County.

2.1.3.4 Permitting of New Wells and Destruction of Wells

The well permitting agencies in the Spadra Basin include the California Department of Public Health (CDPH) and the Los Angeles County Department of Public Health (LADPH). The CDPH regulates production well construction for municipal water purveyors with service connections of 200 or more.

The LADPH is responsible for reviewing plans and approving private residential water wells and small water systems that serve fewer than 200 service connections and for production well construction for municipal water purveyors with service connections of 200 or more after approval from the CDPH. The LADPH requires an *Application for Well/Exploration Hole Permit*[5] be submitted for the construction, reconstruction, or destruction of a well. The LADPH is required to respond to an application within ten days after receiving it. For newly constructed or reconstructed wells, the LADPH requires site visits to evaluate the location and the installation of the well seal, the submittal of the well log, and the submittal of required water-quality testing results.

2.2 BASIN SETTING

The Basin Setting is a detailed description of the surface-water and groundwater hydrology of the Spadra Basin over a long-term historical period through current conditions, including the identification of data gaps and the level of uncertainty in the description. The Basin Setting addresses the requirements of Article 5, Sub article 2 of the GSP Regulations, and will serve as the basis for the construction and calibration of the numerical groundwater-flow model and the development of Sustainable Management Criteria for the Spadra Basin.

2.2.1 Surface-Water Hydrology

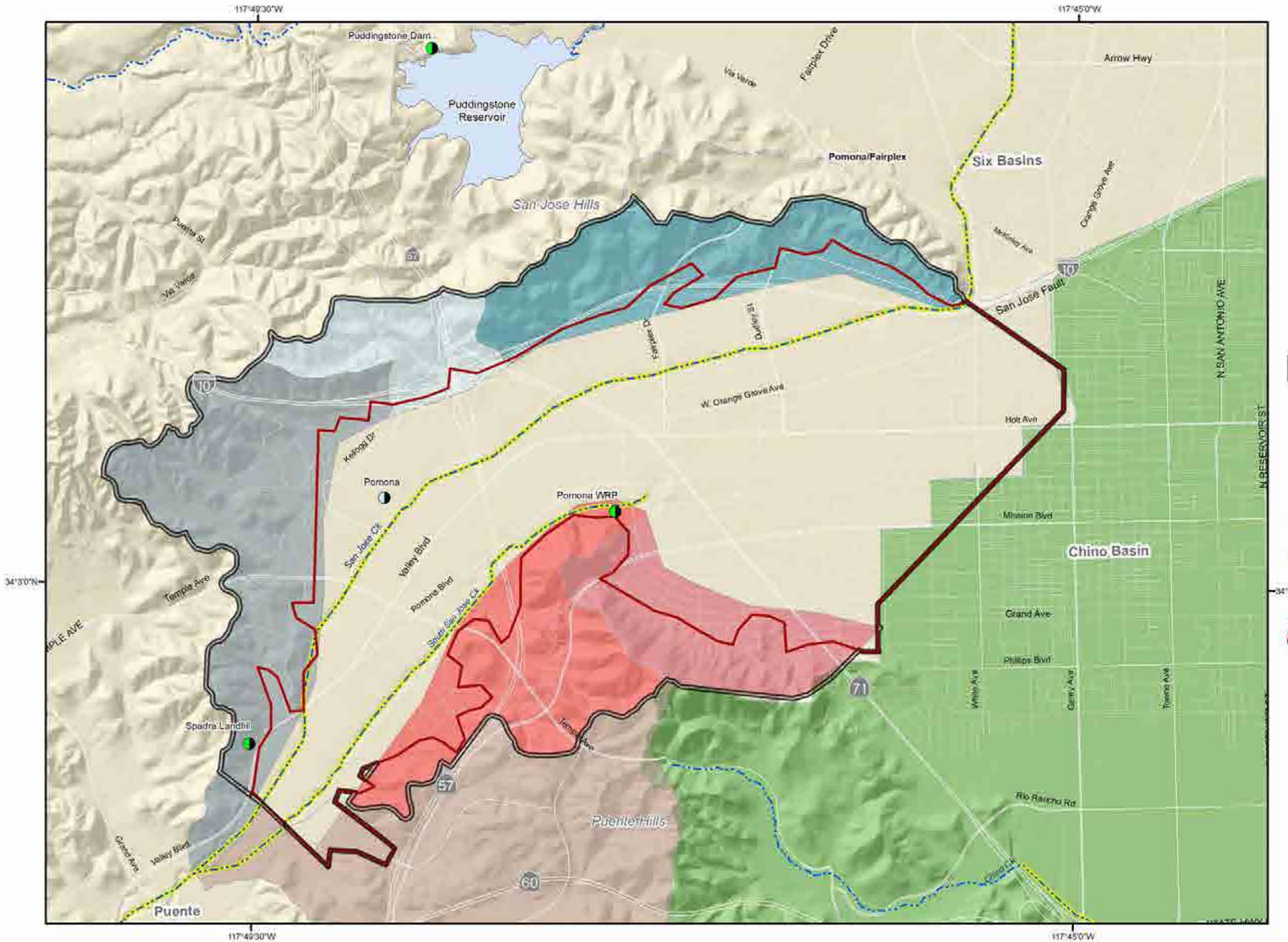
The following subsections describe the surface water resources tributary to the Spadra Basin.

2.2.1.1 Tributary Sub-watersheds

Figure 2-8 shows the primary watersheds and sub-watersheds that are tributary to the Spadra Basin. Along the northern margin of the basin, there are three sub-watersheds in the San Jose Hills (San Jose 1, 2, and 3) which generally flow from north to south. Along the northern margin of the basin, there are three sub- watersheds in the Puente Hills (South San Jose 1, 2, and 3) which generally flow from south to north. These six sub-watersheds in the surrounding hills are part of the San Gabriel River watershed.

Precipitation falling on pervious areas within the sub-watersheds in the hills can combine with any applied water in the soils, infiltrate past the root zone, and recharge the Spadra Basin as underflow from the San Jose Hills and Puente Hills. Precipitation falling on pervious areas overlying the basin can combine with any applied water in the soils, infiltrate past the root zone, and recharge the Spadra Basin directly. Stormwater and dry-weather runoff in the basin and from the sub-watersheds in the hills typically enter concrete-lined flood-control storm drains and channels that exit the Spadra Basin via the San Jose Creek and South San Jose Creek and flow about 13 miles downstream into the San Gabriel River. Currently, there are no artificial recharge facilities in the Spadra Basin that can divert and recharge surface-water runoff. A small area in the eastern portion of the Spadra Basin is part of the Santa Ana River watershed. Runoff generated in the Santa Ana River watershed flows south into the Prado Flood Control Basin in the southern portion of the Chino Basin.

[5] Public Health LA County



Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-8_Watersheds.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN

Watersheds Tributary to the Spadra Basin

Figure 2-8

2.2.1.2 Precipitation

The climate in the Spadra Basin area is characteristic of a semi-arid Mediterranean climate with generally dry summers and comparatively wet winters. Precipitation is a natural source of recharge to the Spadra Basin and can be characterized by looking at long-term records. Figure 2-8 shows the locations of active precipitation stations that have varying historical records dating as far back as the 1930s. Table 2-2 below summarizes the active stations, their owner/operator, elevation, and period of record.

Table 2-2. Active Daily-Precipitation Gages in the Spadra Basin

Station ID	Owner/Operator	Surface Elevation, ft-amsl	Period of Record	
			Date Range	Length of Record, years
Spadra Landfill (1260)	Los Angeles County Flood Control District	700	1988 - present	32
Pomona WRP	Los Angeles County Flood Control District	786	1981 - Present	39
Puddingstone Dam	Los Angeles County Flood Control District	1,030	1931 – Present	89
Pomona (78)	California Irrigation Management Information System (CIMIS)	730	1985 – present	35

Gridded data sets of precipitation data are also available including the National Oceanic and Atmospheric Administration (NOAA) Next-Generation Radar[6] (NEXRAD), and the PRISM Climate Group (PRISM).[7] Monthly precipitation estimates from the PRISM gridded data (an 800-meter by 800-meter grid) were computed as a spatial average across the hydrologic area of Spadra Basin shown in Figure 2-8 to characterize precipitation in the Spadra Basin. Figure 2-9 shows the annual precipitation time-history, the long-term average annual precipitation, and the cumulative departure from mean (CDFM) precipitation for this hydrologic area of Spadra Basin for the 124-year period from 1895 to 2018. The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods. When the slope of the CDFM plot trends downward from left to right, the annual precipitation is less than the average precipitation, and when the slope continues downward for more than one year, the CDFM indicates a dry period. When the slope of the CDFM plot trends upward from left to right, annual precipitation is greater than average precipitation, and when the slope continues upward for more than one year, the CDFM is indicates a wet period. Based on Figure 2-9, the precipitation trends in the region have been:

- 8-year dry period from 1896 through 1903
- 18-year wet period from 1904 through 1921
- 14-year dry period from 1922 through 1935
- 9-year wet period from 1936 through 1944

[6] NCDC NOAA Radar-Data Nexrad

[7] Prism Oregon State Education

- 32-year dry period from 1945 through 1976
- 9-year wet period from 1977 through 1982
- 8-year dry period from 1983 through 1990
- 7-year wet period from 1991 through 1997
- 21-year dry period from 1998 through 2018

Figure 2-9 shows that precipitation is highly variable, and that there are generally three to five years of consecutive, below-average precipitation before an average or above-average year occurs. The last 21 years constitute a long dry period.

The monthly variation in precipitation is also important to understand the availability of storm water throughout the year. Figure 2-10 is a statistical characterization of monthly precipitation in Spadra Basin in the form of a Box and Whisker Plot based on the monthly precipitation estimates from PRISM Climate Group. The Box and Whisker Plot shows the minimum, lower quartile, median, upper quartile, and maximum, precipitation values. Over the period of record, the median monthly precipitation ranges from 0 to 2.7 and the minimum monthly precipitation total was zero inches in every month of the year. The plot shows that most of the annual precipitation occurs during the period of November through March (the median greater than about two inches per month in these months), with the highest monthly precipitation occurring in January and February. A minor amount of precipitation (median less than one-half an inch per month) occurs during the period of May through October.

2.2.2 Hydrogeologic Conceptual Model

This section describes the evolution, structure, and composition of the Spadra Basin aquifer system and the occurrence and movement of groundwater. The section concludes with an initial estimate of the long-term yield that has been developed from the Spadra Basin and a discussion of data gaps.

The hydrogeology of the Spadra Basin area has been studied by various entities and authors in the past, including Mendenhall (1908), Eckis (1934), California DWR (1947, 1966, 1970), Ecological Systems Corporation (1975), Donald R. Howard Consulting Engineers (1999), Fox/Roberts (2001), and Worley Parsons Resources and Energy (2009). The hydrogeologic description below was prepared from a review of prior studies and from original work performed for this effort.

2.2.2.1 Geologic Setting

Figure 2-11 is a geologic map of the Spadra Basin and the surrounding area (Morton and Miller, 2006). The Spadra Basin is a relatively narrow, alluvial-filled valley located between the San Jose Hills and Puente Hills at the northern end of the Peninsular Ranges. The Spadra Basin was formed as tectonic compression and faulting uplifted the Tertiary and pre-Tertiary consolidated bedrock formations of the San Jose Hills and Puente Hills. An eastward-flowing ancestral stream carved a narrow canyon into the bedrock formations that deepens to the east. In Quaternary time, as the San Gabriel Mountains to the north were elevated, sediments were eroded and washed out of the mountains by San Antonio Creek, depositing a broad alluvial fan that emanates from the mouth of San Antonio Canyon. The progradation of the alluvial fan began to fill the valley between the San Jose Hills and Puente Hills with unconsolidated sediments, as San Antonio Creek may have flowed through this valley towards the west. Sediments were also eroded and deposited in the valley from local tributaries flowing out of the San Jose Hills and Puente Hills. The interconnected pore spaces within the Quaternary sediments are today's groundwater reservoirs of the Spadra Basin.

Figure 2-9. Annual Precipitation and CDFM - Spadra Basin and Tributary Watersheds - Water Year 1896 to 2019

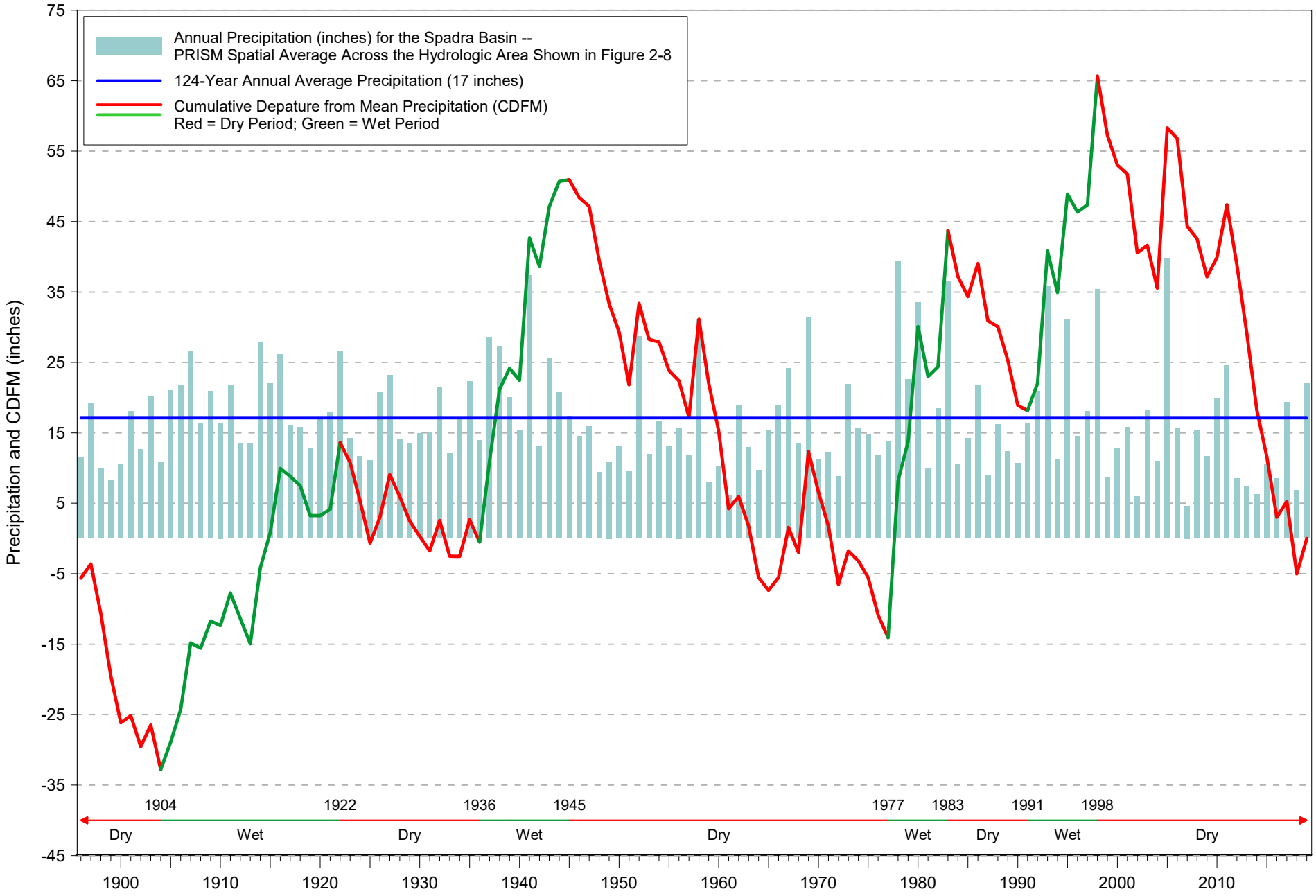
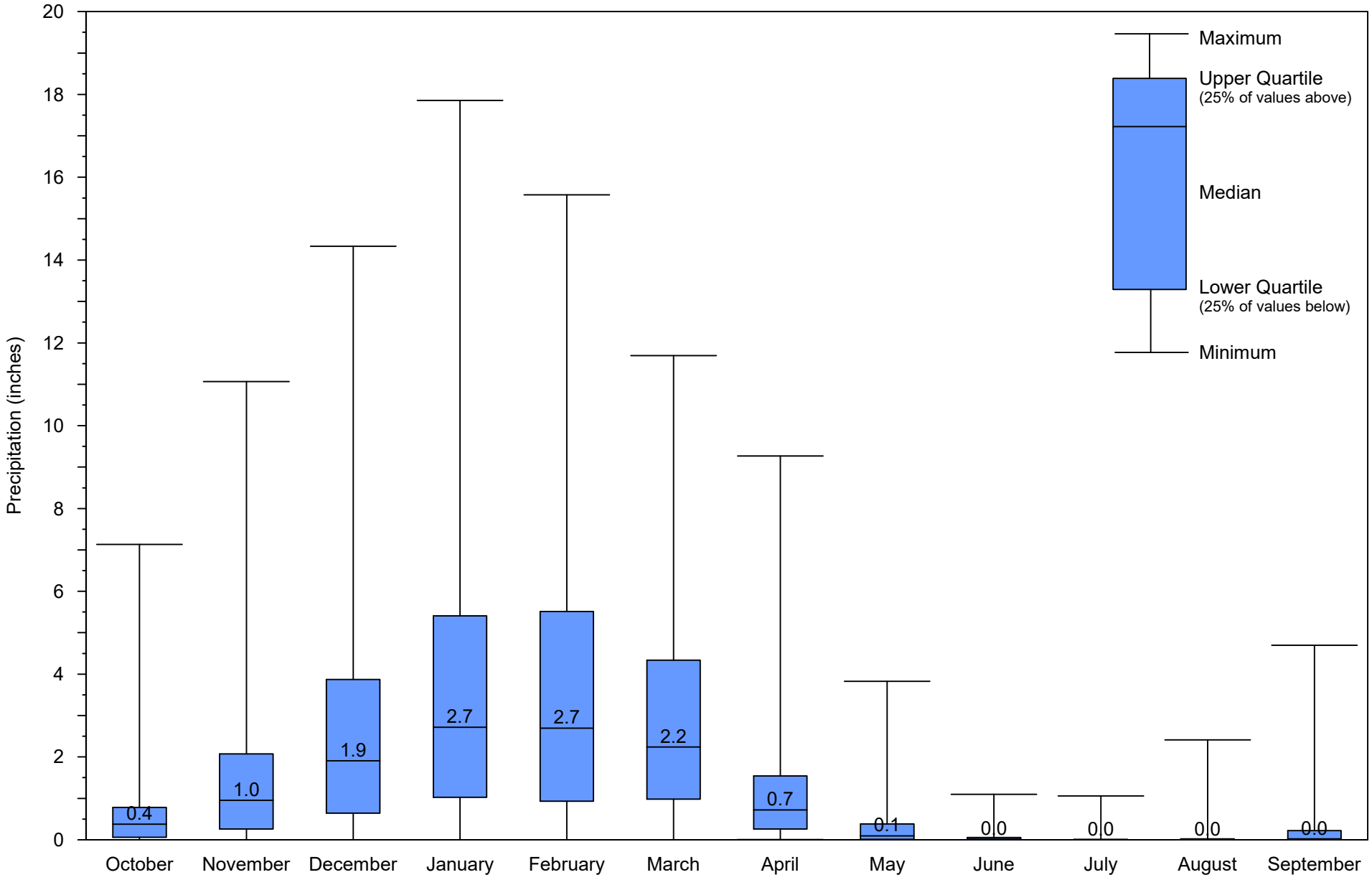


Figure 2-10. Box and Whisker Plot of Average Monthly Precipitation - Spadra Basin and Tributary Watersheds - Water Year 1896 to 2019



117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
San Jose Hills
Six Basins
Chino Basin
Puente Basin
Puente Hills
Via Verde
Puente St
Via Verba
Orange Grove Ave
McKinley Ave
San Jose Fault
Duncan Canyon Dr
Duffy St
W. Orange Grove Ave
Holt Ave
Kellogg Dr
San Jose Ck
Valley Blvd
Pomona Blvd
South San Jose Ck
Mission Blvd
Grand Ave
Phillips Blvd
White Ave
Garey Ave
Towne Ave
Temple Ave
Rio Rancho Rd
Chino Ck
1000
950
900
850
800
750
700
650
10
57
71
60

Surface Geology

Unconsolidated Sediments
(Source: CGS Special Report 217)

- Qyf — Undifferentiated Quaternary (younger) alluvial deposits
- Qoa — Undifferentiated Quaternary (older) alluvial deposits
- Qls — Landslide Deposits

Consolidated Bedrock Formations
(Source: CGS Special Report 217)

- Tss, Tsh, Tv — Puente Group: Tertiary sedimentary and volcanic rocks
- gr — Basement Complex: Cretaceous and Pre-Cretaceous igneous and metamorphic rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

- 800 — Topographic Elevation Contour
- Groundwater Divide (approximate hydrologic boundary between Spadra Basin and Chino Basin)
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Prepared by:
WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-11_Geology.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Geologic Map of the Spadra Basin Area

Figure 2-11

At present, San Antonio Creek flows south to the Santa Ana River. The main streams that drain the Spadra Basin are San Jose Creek and South San Jose Creek which flow to the west and merge, and ultimately discharge to the San Gabriel River.

2.2.2.2 Basin Boundaries

The physical boundaries of the Spadra Basin are described below and are shown in Figure 2-11. The physical boundaries do not coincide exactly with the SGMA boundaries as defined by the Spadra Basin GSA, which are also shown in Figure 2-11.

San Jose Hills. The northern boundary of the Spadra Basin is the contact with impermeable Basement Complex and the Puente Group that outcrops along the southern front of the San Jose Hills.

San Jose Fault. The northeastern boundary of the Spadra Basin is the San Jose Fault, which separates the upgradient Six Basins from the Spadra Basin. The San Jose Fault is a known barrier to groundwater flow from the Six Basins into the Spadra Basin and the Chino Basin. The barrier effect is demonstrated by groundwater elevations that are hundreds of ft higher in the Six Basins compared to the Spadra Basin and Chino Basin.

Groundwater Divide. The eastern boundary of the Spadra Basin is a natural groundwater divide that extends from the eastern tip of the San Jose Hills southward to the Puente Hills. The groundwater divide is evidenced by groundwater-elevations measured at wells in the Six Basins, Chino Basin and Spadra Basin (described in *Section 2.2.2.9 Groundwater Flow*). Eckis (1934) speculated that the origin of the groundwater divide is underflow from the Six Basins across the San Jose Fault. Groundwater flowing westward from the divide enters the Spadra Basin; groundwater flowing eastward from the mound enters the Chino Basin. The location of the groundwater divide is transient and can shift east or west depending on the rate of groundwater flow from the Six Basins and changes in groundwater levels in the Spadra Basin and/or Chino Basin.

Puente Hills. The southern boundary of the Spadra Basin is the contact with impermeable Basement Complex and the Puente Group that outcrops along the northern front of the Puente Hills.

Puente Basin. The western boundary of the Spadra Basin is a bedrock narrows that separates the Spadra Basin from the Puente Basin. Groundwater flows through the bedrock narrows as underflow from the Spadra Basin into the Puente Basin.

2.2.2.3 Stratigraphy

In this report, the stratigraphy of the Spadra Basin is divided into two generalized geologic formations: (i) the pervious formations that comprise the groundwater reservoir are termed *water-bearing sediments* and (ii) the impermeable formations that enclose the groundwater reservoirs are termed *consolidated bedrock*. Water-bearing sediments overlie the consolidated bedrock, with the bedrock formations coming to the surface in the surrounding hills and highlands. Below, these geologic formations are described in stratigraphic order, with the oldest formations first.

The terms used in this report to describe bedrock, such as “consolidated,” “non-water-bearing,” and “impermeable,” are used in a relative sense. The water content and permeability of these bedrock formations, in fact, is not zero. However, the primary point is that the permeability of the geologic formations in the areas flanking the groundwater basin is much less than the aquifer sediments within the basin.

2.2.2.3.1 Consolidated Bedrock

The consolidated bedrock formations that flank and underlie the Spadra Basin consist of very old crystalline rocks of the Basement Complex and younger sedimentary and volcanic rocks of the Puente Group.

The Basement Complex consists of deformed and recrystallized metamorphic rocks (e.g., banded gneisses) that have been intruded by masses of igneous rocks (e.g., granite). As shown in Figure 2-11, the Basement Complex outcrops in the eastern margins of the San Jose Hills and Puente Hills. Weathering and erosion of the Basement Complex in the San Gabriel Mountains is the major sediment source for the younger sedimentary formations—in particular, the water-bearing sediments of Spadra Basin.

The Puente Group, where present, overlies the Basement Complex and consists of interbedded shales, sandstones, conglomerates, lava flows, volcanic ash, and volcanic breccia (English, 1926). As shown in Figure 2-11, the Puente Group outcrops in the western San Jose Hills and Puente Hills.

2.2.2.3.2 Water-Bearing Sediments

During the Quaternary Period, sediments that eroded from the surrounding and distant mountains and hills were transported to the Spadra Basin by flooding and deposited atop the consolidated bedrock formations as interbedded, discontinuous layers of gravel, sand, silt, and clay to form the water-bearing sediments.

The water-bearing sediments are over 600 ft thick in places, but pinch-out to zero thickness along the northern and southern basin boundaries at the surface contact with the consolidated bedrock. Most water wells have their screens completed within the water-bearing sediments. Some of these wells in the Spadra Basin can pump over 400 gallons per minute (gpm).

The water-bearing sediments are typically composed of gneissic and granitic debris from the San Gabriel Mountains and can be differentiated into the Older Alluvium of Pleistocene age and Younger Alluvium of Holocene age. The general character of these formations is known from driller's logs and surface outcrops.

The Older Alluvium was deposited on top of the bedrock formations under conditions similar to today's depositional environments. The Older Alluvium is commonly distinguishable in surface outcrop by its red-brown or brick-red color. The red color comes from secondary clays that formed from the weathering and oxidation of sediments that were deposited in areas where the water table was deep and where sediments were not disturbed by stream erosion over long periods. The Older Alluvium contains many local unconformities because of the nature of the alluvial fan deposition process. The Older Alluvium is the main source of groundwater for today's wells.

The Younger Alluvium was deposited on top of the Older Alluvium after a period of weathering and erosion of the Older Alluvium. The Younger Alluvium is typically a fresh, un-weathered, grey or brown color, and exists in outcrop only along the recent streambed channels of San Jose Creek. The Younger Alluvium is absent in most places and is typically thin compared to the Older Alluvium. Where it exists, it is commonly unsaturated and lies above the regional water table. The Younger Alluvium is typically more permeable than the Older Alluvium.

Figure 2-12 is a map of the hydrologic soil types across the Spadra Basin area, as mapped by the Soil Conservation Service:

- ***Type A soils*** - have high infiltration rates, even when thoroughly wetted. Typically composed of sands and gravels.
- ***Type B soils*** - have moderate infiltration rates when thoroughly wetted. Typically composed of moderately fine to moderately coarse texture.
- ***Type C soils*** - have slow infiltration rates when thoroughly wetted. Typically include a layer that impedes downward movement of water and/or moderately fine to fine texture.
- ***Type D soils*** - have very slow infiltration rates when thoroughly wetted and a high runoff potential. Typically, are of fine texture and/or a thin soil over a nearly impervious material.

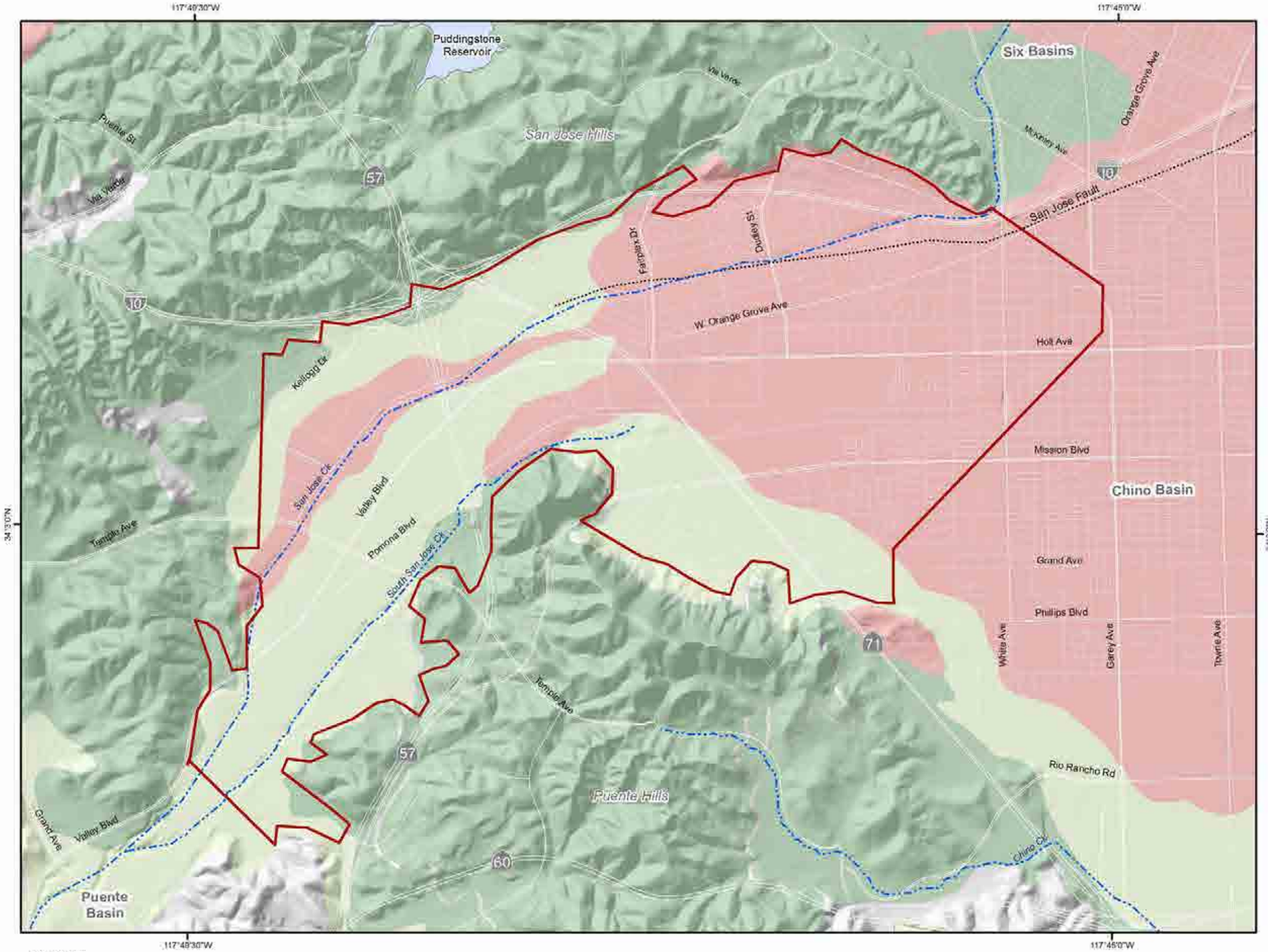
Note the absence of Type A soils across the Spadra Basin, which is consistent with the near absence of Younger Alluvium. Type B soils cover most of the eastern Spadra Basin and the older stream channels of San Jose Creek. Type C soils occur across most of the narrow western portion of the basin and along the basin fringes, likely representing the deposition of sediments eroded from the flanking San Jose Hills and Puente Hills. Type D soils occur across most of the San Jose Hills and Puente Hills, which are composed of the consolidated bedrock formations.

2.2.2.4 Bottom of the Aquifer

The consolidated bedrock formations underlying the water-bearing sediments of the Spadra Basin act as the effective base of the freshwater aquifer. Herein, the effective base of the freshwater aquifer is referred to as the "bottom of the aquifer."

Figure 2-13 is a contour map of equal depth to the bottom of the aquifer (i.e., the buried contact between the water-bearing sediments and consolidated bedrock). The units of depth are in feet below ground surface (ft-bgs). These contours were drawn from lithologic descriptions of borehole cuttings that were recorded on well driller's reports that were collected and reviewed for this study. Each well driller's report was reviewed, and best efforts were made to identify the driller's interpretation of depth to borehole penetration of the consolidated bedrock. The interpretations by the well drillers are often subjective and poorly described on the well driller's reports. The typical terminology used to describe bedrock on the reports were: "hill formation," "rock," or "decomposed granite," among others.

Depth to bedrock at each well-borehole location, which represents the bottom of the aquifer, were plotted on a map. Zero depth to bedrock was defined by the surface contact between the water-bearing sediments and the consolidate bedrock. Contours of the bottom of the aquifer were hand drawn and digitized in ArcGIS.



Hydrologic Soil Types

A Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or nearthe surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Source: Los Angeles County: United States Agriculture Dept Soils Bureau, 1917
San Bernardino County: National Cooperative Soil Survey

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Faults

Location Certain
Location Approximate
Location Concealed
Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 11/6/2019
File: Fig2-12_Soils.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN

Hydrologic Soil Types of the Soil Cosnervation Service

Figure 2-12

The contours on Figure 2-13 show that the bottom of the aquifer is a narrow trough aligned along the axis of the Spadra Basin. A bedrock "narrows" is located at the southwestern end of Spadra Basin (i.e., the boundary with the Puente Basin), where the bottom of the aquifer appears to be less than 200 ft-bgs. The bedrock trough deepens to the east, where at the eastern margins of the Spadra Basin (i.e., the boundary with the Chino Basin), the bottom of the aquifer is greatest at over 600 ft-bgs. The eastward-sloping bedrock trough appears to be related to erosion by ancestral streams that flowed from west to east as the San Jose Hills and Puente Hills were uplifted. Eckis (1934) speculated that the contact between the consolidated bedrock and the water-bearing sediments is unconformable, as indicated by an ever-present weathered zone in the consolidated bedrock directly underlying the contact with the water-bearing sediments. This observed relationship suggests that the consolidated bedrock in the Spadra Basin area was undergoing erosion prior to deposition of the water-bearing sediments. Eckis (1934) reported that the weathered zone is about 50 ft thick, and that beneath the weathered zone the bedrock is hard. Fractured and weathered zones in the bedrock formations may yield water to wells locally, but the storage capacity is typically inadequate for sustained production.

Like Figure 2-13, Figure 2-14 is a map of the bottom of the aquifer; however, depth of the bottom of the aquifer has been converted to elevation in feet above mean sea level (ft-amsl). The following steps were executed in ArcGIS Geostatistical Analyst to complete this conversion: (i) create a raster of the depth to the bottom of the aquifer from the contours and data shown on Figure 2-13; (ii) subtract the depth raster from the United State Geological Survey (USGS) 10-meter digital elevation model of the ground-surface elevation to create a raster of the elevation of the bottom of the aquifer; and (iii) create contours from the elevation raster.

2.2.2.5 Hydrostratigraphy and Aquifer Systems

As described above, the water-bearing sediments are composed of interbedded layers of gravel, sand, silt and clay, or layers that are a combination of one or more of these sediment types. The layers composed mainly of gravel and sand are permeable and groundwater flows through the interconnected pore space within these layers towards pumping wells. These layers of gravel and sand are referred to as "aquifers." The layers composed mainly of silt and clay are poorly permeable and impede groundwater flow to pumping wells. Layers of silt and clay are referred to as "aquitards." Aquitards store groundwater and can transmit appreciable amounts of groundwater to the adjacent aquifers through vertical drainage. Together, the aquifers and aquitards are herein referred to as the "aquifer system."

Groundwater can exist within an aquifer system under two different hydraulic conditions: unconfined and confined. Where the groundwater table is exposed to the atmosphere through the overlying unsaturated zone, the aquifer system is unconfined, and the groundwater table can rise and fall freely under the stresses of recharge and pumping. Where deeper groundwater is separated from the atmosphere by significant thicknesses of aquitards, the aquifer system is confined, and the groundwater can be under a pressure head that is higher than the top of the aquifer. Depending on the spatial distribution of the aquitards, and their effectiveness as "confining layers," a groundwater reservoir can be vertically stratified into multiple aquifer systems that have different physical and chemical characteristics.

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
Six Basins
San Jose Hills
Via Verde
Pueblo St
Orange Grove Ave
McKinley Ave
San Jose Fault
Fairplex Dr
Reservoir St
W. Orange Grove Ave
Kellogg Dr
Holt Ave
Mission Blvd
Chino Basin
Valley Blvd
Pomona Blvd
San Jose Ck
South San Jose Ck
Temple Ave
Grand Ave
Phillips Blvd
Garey Ave
Towne Ave
White Ave
Rio Rancho Rd
Puente Hills
Chino Ck
Puente Basin

10
57
71
60

0
50
100
150
200
250
300
400
500
600
700
800

185
368
218
255
275
330
600
71
180
186
150
153
170
105
107
152
132
85
170

250 Wells drilled to bedrock at the specified depth (ft-bgs)

Estimated Depth to Bedrock
600 ft-bgs
300
0

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments
Quaternary Alluvium

Consolidated Bedrock
Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults
Location Certain
Location Approximate
Location Concealed
Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-13_BOA_Depth.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Depth to the Bottom of the Aquifer

Figure 2-13

117°48'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
Six Basins
San Jose Hills
Puente Hills
Chino Basin
Puente Basin
San Jose Fault
Puente St
Via Verde
Orange Grove Ave
McKinley Ave
Fairway Dr
Dudley St
W. Orange Grove Ave
Kellogg Ck
San Jose Ck
Valley Blvd
Pomona Blvd
Temple Ave
Holt Ave
Mission Blvd
Grand Ave
Phillips Blvd
White Ave
Garey Ave
Towne Ave
Rio Rancho Rd
Chino Ck

A
A'
B
B'
C
C'
D
D'
E
E'

01S09W23R01
01S09W26A01
01S09W25E02
01S08W19N01
01S08W29C01
01S09W27Q01
01S09W27N02
01S09W27Q02
01S09W27R02
01S09W27R06
01S09W34Q01
01S09W34B05
01S09W34E01
01S09W34E02
01S09W34G01
01S09W34M01
01S09W34L03
01S09W34P01
P-07
P-19
P-31
P-28
WV-Valley
CPP-3
WV-Industry

650 700 750 800 850
500 550 600 650 700
450 500 550
400 450
350 400
300 350
250 300
500

10 57 71 60

Geologic Cross Section
(shown in profile on Figures 2-15a through 2-15e)

Well Used on Cross Section

100 Contours and Raster Surface

Surface Geology

Unconsolidated Sediments (Source: CGS Special Report 217)

- Qyf — Undifferentiated Quaternary (younger) alluvial deposits
- Qoa — Undifferentiated Quaternary (older) alluvial deposits
- Qls — Landslide Deposits

Consolidated Bedrock Formations
(Source: CGS Special Report 217)

- Tss, Tsh, Tv — Puente Group: Tertiary sedimentary and volcanic rocks
- gr — Basement Complex: Cretaceous and Pre-Cretaceous igneous and metamorphic rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Prepared by:
WEST YOST
Water. Engineered.

Author: AP
Date: 11/6/2019
File: Fig2-14_BOA_Elevation..mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Elevation of the Bottom of the Aquifer and Location of Hydrogeologic Cross Sections

Figure 2-14

The aquifer and aquitard layers and their geometries are numerous and complex in the Spadra Basin and must be simplified into a hydrogeologic conceptual model that represents the three-dimensional distribution of the water-bearing sediments and their hydrogeologic properties. This conceptual model is described below and will be used as input to a numerical groundwater-flow model (Spadra Basin Groundwater Model) to support the development of the Spadra Basin GSP.

In order to depict the hydrogeologic conceptual model, five hydrogeologic cross-sections were constructed across the Spadra Basin. The plan-view locations of these cross-sections are shown on Figure 2-14 and the profile-view cross-sections are shown in Figure 2-15a through Figure 2-15e. Plotted on these cross-sections are well and borehole data, including: borehole lithology, well casing perforations, recent estimates of groundwater elevation (Fall 2018), specific capacities of the wells, and estimates of horizontal hydraulic conductivity of the saturated sediments (see *Section 2.2.2.6 Initial Estimates of Aquifer Properties*).

The hydrogeologic cross-sections depict a narrow, channel-like aquifer system that consists of about 100-200 ft of saturated sediments along the axis of the basin that thicken to about 400 ft near the western boundary with the Chino Basin. Along the northern and southern edges of the basin, the depth to bedrock becomes shallow and the saturated sediments pinch out against the buried contact with bedrock.

The thickness of the unsaturated zone along the axis of the basin varies from about 40 ft at the western boundary of the basin to about 250 ft at the eastern boundary of the basin.

There are no data to support a multiple-layer aquifer system within Spadra Basin. The saturated sediments are a relatively thin unit (typically less than about 200 ft thick) of interbedded, discontinuous layers of gravel, sand, silt, and clay mixtures. There are no thick, regionally extensive, fine-grained layers (aquitards) that could create conditions for deeper confined aquifers. Flowing-artesian wells—an indication of confined aquifer conditions—have never been observed or mapped in the basin. The Spadra Basin is best characterized as a relatively thin, unconfined, alluvial aquifer system.

2.2.2.6 Initial Estimates of Aquifer Properties

The properties that characterize the ability of the water-bearing sediments of the Spadra Basin to store and transmit groundwater are specific yield (effective porosity) and hydraulic conductivity. The specific yield of the water-bearing sediments is a measure of its capacity to store water. Specific yield is the ratio of the volume of water that a given mass of saturated sediments will yield by gravity drainage to the volume of that mass. The ratio is typically stated as a percentage. The hydraulic conductivity of the water-bearing sediments is a measure of its capacity to transmit water. Hydraulic conductivity is the rate of flow of groundwater in gallons per day through a cross section of one square foot of sediment under a unit hydraulic gradient. The English units for hydraulic conductivity are feet per day (ft/d).

This section describes the initial estimation of specific yield and hydraulic conductivity for the saturated water-bearing sediments within the Spadra Basin. These estimates will be refined during the calibration of the Spadra Basin Groundwater Model.

A

Southwest

A′

East

B-B′

C-C′

Temple Avenue

D-D′

E-E′

State Highway 71

White Avenue

Puente Basin | *Spadra Basin*

Spadra Basin | *Chino Basin*

WV-Industry

6.7 gpm/ft
48 ft/d

01S09W34M01

54 ft/d

CPP-3

217 ft/d

01S09W34B05

169 ft/d

01S09W27Q02

227 ft/d

WV-Valley

5.6 gpm/ft
39 ft/d

P-28

20 gpm/ft
29 ft/d

CPP-1

P-19

27 gpm/ft
42 ft/d

P-31

01S08W19N01

119 ft/d

01S08W29C01

Unsaturated Sediments

Saturated Sediments

Non-waterbearing Sediments

Elevation (ft-msl)

1,000
900
800
700
600
500
400
300
200
100
0

0
5,000
10,000
15,000
20,000
25,000
30,000
35,000

Distance Along Baseline (ft)

Prepared by:

WEST YOST
Water. Engineered.

Vertical Scale: 1" = 120'
Horizontal Scale: 1" = 2310'
Vertical Exaggeration = 19:1

NR No Sample
Gravel
Clay
Crystaline Bedrock
Topsoil

Sand
Decomposed Granite
Sand with Gravel
Gravel with Clay
Clay with Gravel

Clay with Gravel and Sand
Sand with Gravel and Clay
Clay with Sand and Silt
Clay with Sand
Shale

Well Screen Interval
Groundwater Elevation (Fall 2018)

Vertical Scale: 1" = 120'
Horizontal Scale: 1" = 2310'
Vertical Exaggeration = 19:1

gpm/ft Specific Yield
ft/d Estimated Hydraulic Conductivity

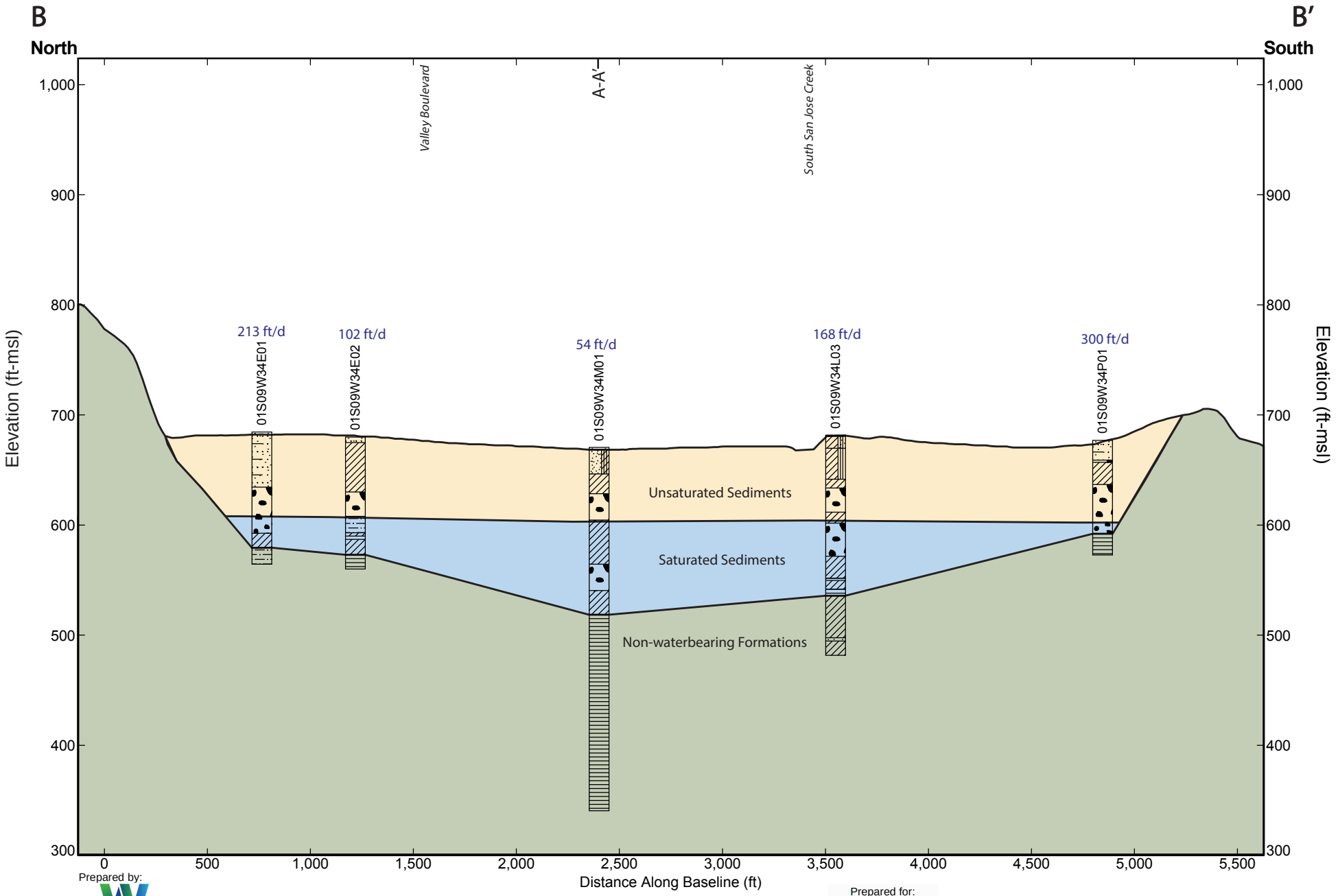
Prepared for:

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Hydrogeologic Cross Section

A-A'

Figure 2-15a



Prepared by:

WEST YOST
Water. Engineered.

Vertical Scale: 1" = 119'

Horizontal Scale: 1" = '667

Vertical Exaggeration = 5.6:1

Topsoil
Clay
Gravel
Sedimentary Bedrock
Shale
Clay with Sand and Silt
Clay with Silt
Sand
Sand with Silt and Clay
ft/d Estimated Hydraulic Conductivity

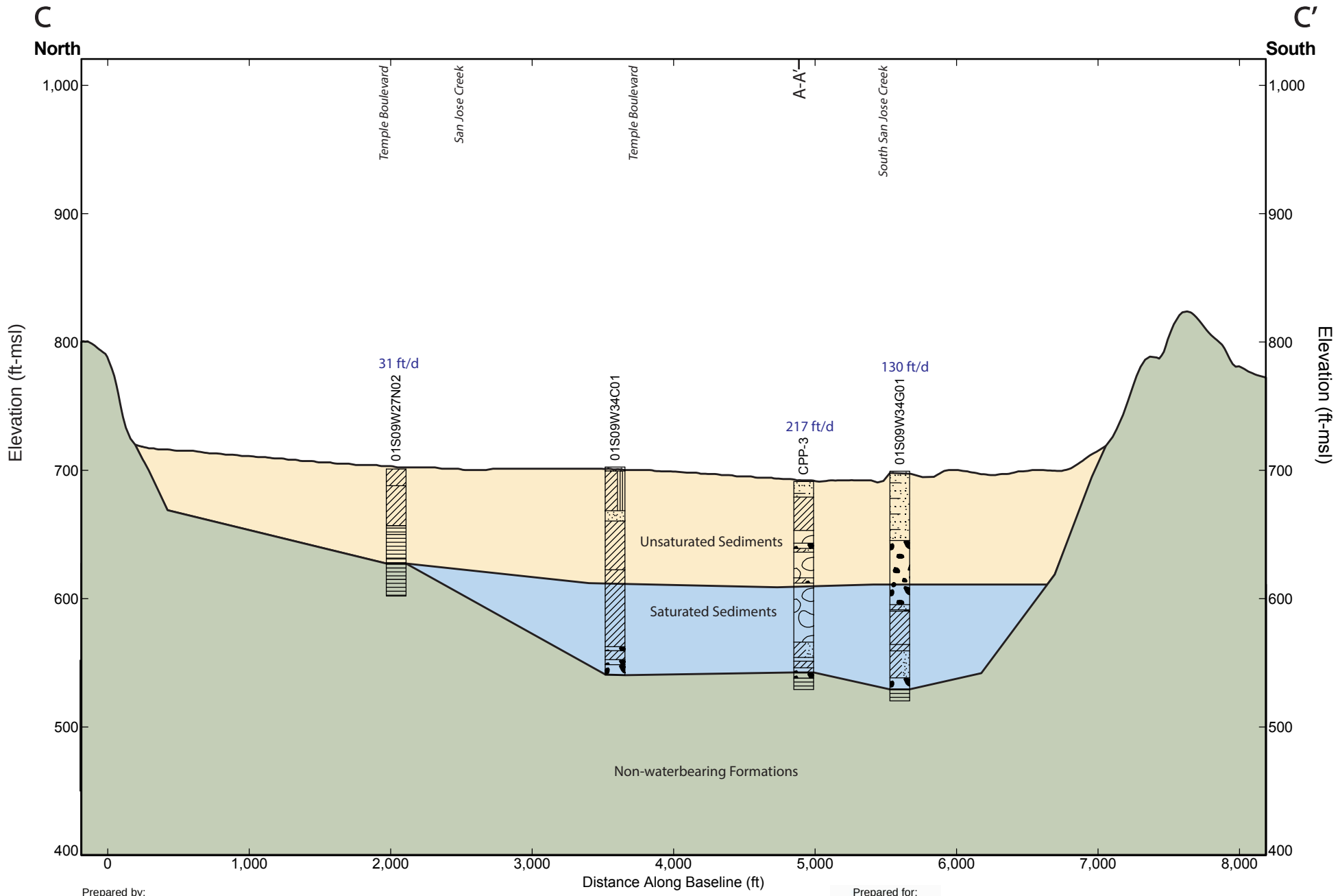
Prepared for:

SPADRA BASIN

Hydrogeologic Cross Section

B-B'

Figure 2-15b



Prepared by:

WEST YOST
Water. Engineered.

Vertical Scale: 1" = '102

Horizontal Scale: 1" = '929

Vertical Exaggeration = 9:1

Clay
Shale
Topsoil
Clay with Silt
Sand
Gravel
Clay with Sand
Cobbles and/or Boulders
Clay with Gravel
Gravel with Clay
ft/d Estimated Hydraulic Conductivity

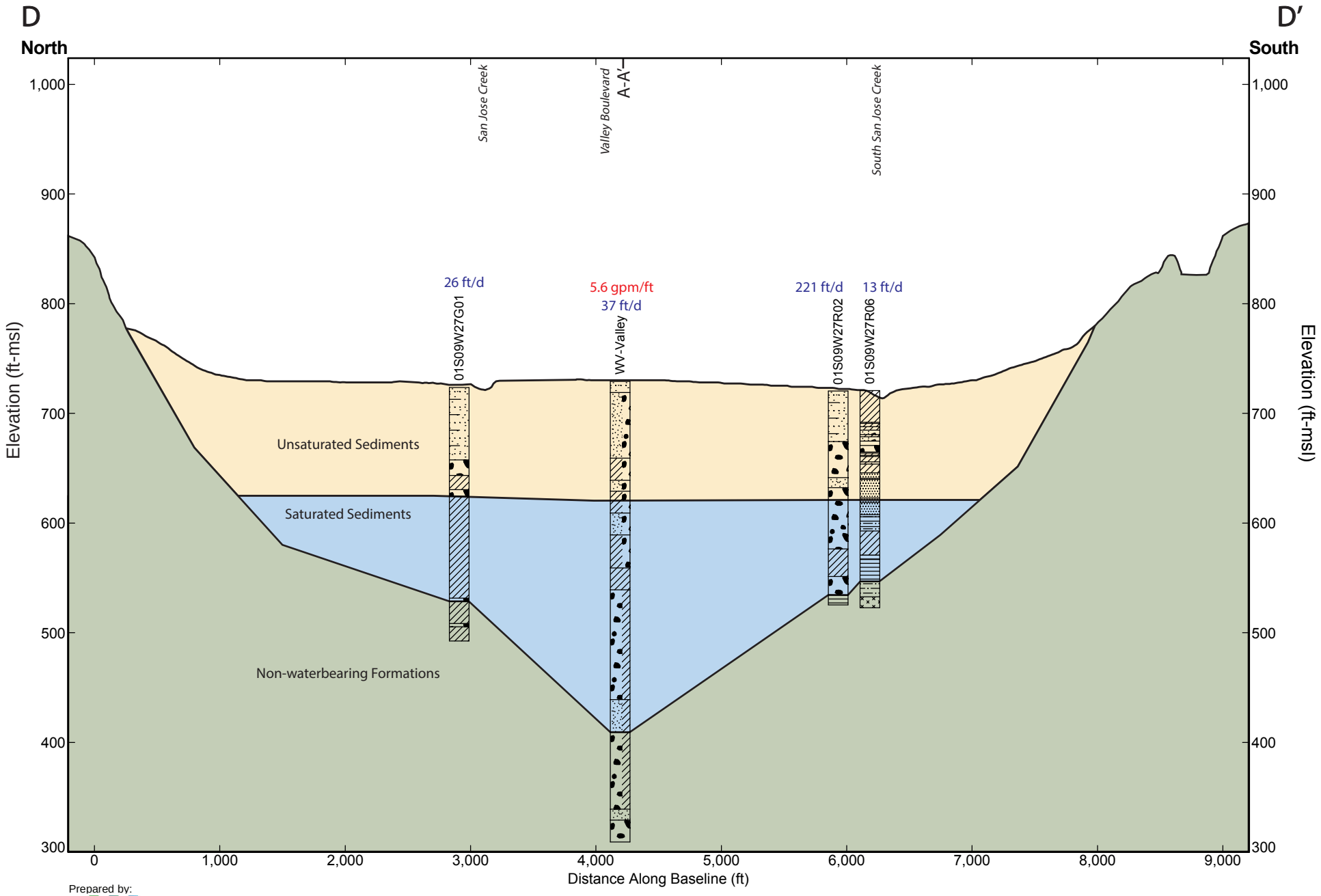
Prepared for:

SPADRA BASIN

Hydrogeologic Cross Section

C-C′

Figure 2-15c



Prepared by:
WEST YOST
Water. Engineered.

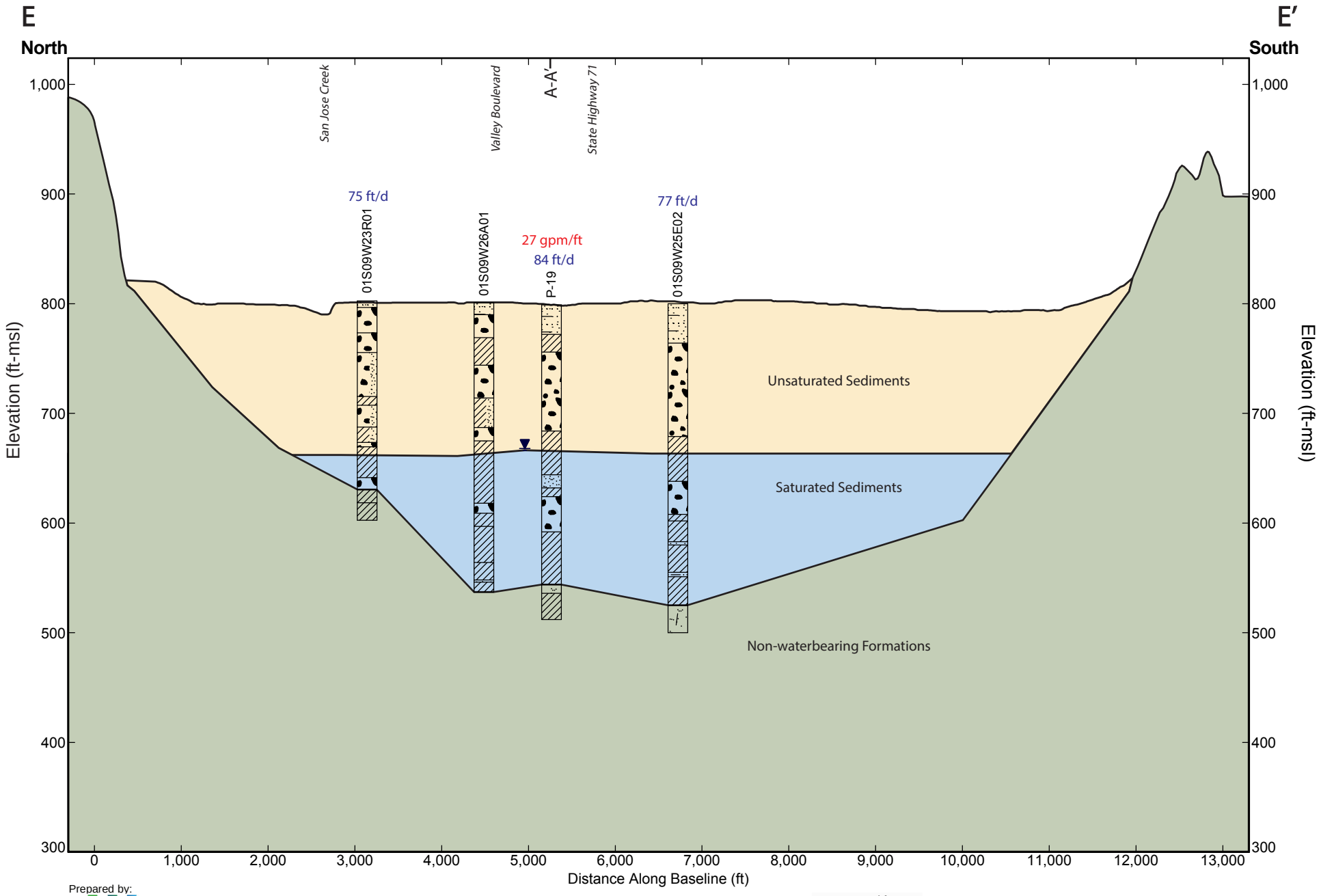
Vertical Scale: 1" = '118
Horizontal Scale: 1" = '1043
Vertical Exaggeration = 9:1

- Topsoil
- Gravel
- Sand
- Clay
- Shale
- Clay with Sand
- Sand with Gravel
- ft/d Estimated Hydraulic Conductivity
- Sedimentary Bedrock
- Clay with Gravel
- Sandstone
- gpm/ft Specific Yield
- Basalt
- Gravel with Clay
- Sand with Clay

Hydrogeologic Cross Section

D-D'

Figure 2-15d



Prepared by:

WEST YOST
Water. Engineered.

Vertical Scale: 1" = '120

Horizontal Scale: 1" = '1508

Vertical Exaggeration = 12.5:1

- Topsoil
- Gravel
- Clay
- Sand
- Sedimentary Bedrock
- Decomposed Granite
- Clay with Sand
- Gravel with Sand

gpm/ft Specific Yield

ft/d Estimated Hydraulic Conductivity

Prepared for:

SPADRA BASIN

Hydrogeologic Cross Section

E-E'

Figure 2-15e

Hydraulic conductivity and specific yield are closely related to the texture of the sediments (McCuen et al., 1981). For example, the values of hydraulic conductivity and specific yield are generally higher in sands and gravels as compared to silts and clays. Several databases and publications have estimated values of hydraulic conductivity and specific yield based on sediment texture (Rawls et al., 1982; Schaap and Leij, 1998; Carsel and Parrish, 1988; Bouwer, 1978; Prudic, 1991; Reese and Cunningham, 2000; Kuniansky and Hamrick, 1998; Domenico and Schwartz, 1990; Freeze and Cherry, 1979; and Johnson, 1967). These estimates were used to assign hydraulic conductivity and specific yield to each sediment description on every available well driller's report for boreholes drilled in the Spadra Basin. Using the following formulas, thickness-weighted estimates of horizontal hydraulic conductivity and specific yield were computed for each borehole across the saturated thickness based on 2008 water level conditions, a time of relatively high groundwater elevations:

$$K_h = \sum_{i=1}^{n} \frac{K_i b_i}{b}$$

$$S_y = \sum_{i=1}^{n} \frac{S_{yi} b_i}{b}$$

Where:

K_h is the average horizontal hydraulic conductivity of the saturated sediments

K_i is the hydraulic conductivity of *i* bed

b_i is the saturated thickness of bed *i*

b is the total thickness of the of the saturated sediments

S_y is average specific yield of the saturated sediments

S_{yi} is the specific yield for bed *i*

Figure 2-16 shows the thickness-weighted, initial estimates for specific yield at 16 boreholes that penetrated the entire thickness of the water-bearing sediments. The figure also shows interpolated estimates of specific yield between boreholes to depict its spatial distribution. The interpolated surface is clipped to the area of the saturated sediments (i.e., the water-bearing sediments are thin and unsaturated along the margins of the basin, hence, estimates of aquifer properties are not needed). Specific yield of the saturate sediments is relatively low across the basin and ranges from about 5 percent to 22 percent. Generally, specific yield is higher along the basin axis and lower along the edges of the basin. There is a localized area of higher specific yield in the western portion of the basin, and in the east, specific yield appears to increase toward the Chino Basin.

Figure 2-17 shows the thickness-weighted, initial estimates for horizontal hydraulic conductivity at boreholes that penetrate the entire thickness of the water-bearing sediments. The figure also shows interpolated estimates of horizontal hydraulic conductivity between boreholes to depict its spatial distribution. Horizontal hydraulic conductivity of the saturated sediments ranges from about 30 to 230 ft/d. As with specific yield, hydraulic conductivities are higher along the basin axis and lower along the edges of the basin. There is a localized area of higher hydraulic conductivities in the western portion of the basin, and in the east hydraulic conductivity appears to increase toward the Chino Basin.

The initial estimates of vertical hydraulic conductivity are assumed to be ten percent of the horizontal hydraulic conductivity.

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
San Jose Hills
Six Basins
Chino Basin
Puente Basin
Puente Hills
Fusilier St
Via Verde
Via Verde
Orange Grove Ave
Mckinley Ave
San Jose Fault
Eastbury Dr
Dudley St
W. Orange Grove Ave
Holt Ave
Kellogg Dr
Mission Blvd
San Jose Ck
Valley Blvd
Ramona Blvd
South San Jose Ck
Temple Ave
Grand Ave
Phillips Blvd
White Ave
Garvey Ave
Towne Ave
Rio Rancho Rd
Chino Ck
Grand Ave
Valley Blvd
Temple Ave
10
57
71
50

0.09
0.12
0.11
0.09
0.05
0.1
0.08
0.06
0.22
0.057
0.15
0.2
0.14
0.1
0.08
0.15
0.11

Initial Estimates of Specific Yield

.20

0

.1 Wells used to estimate specific yield labeled by specific yield of the saturated sediments

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain
Location Concealed
Location Approximate
Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

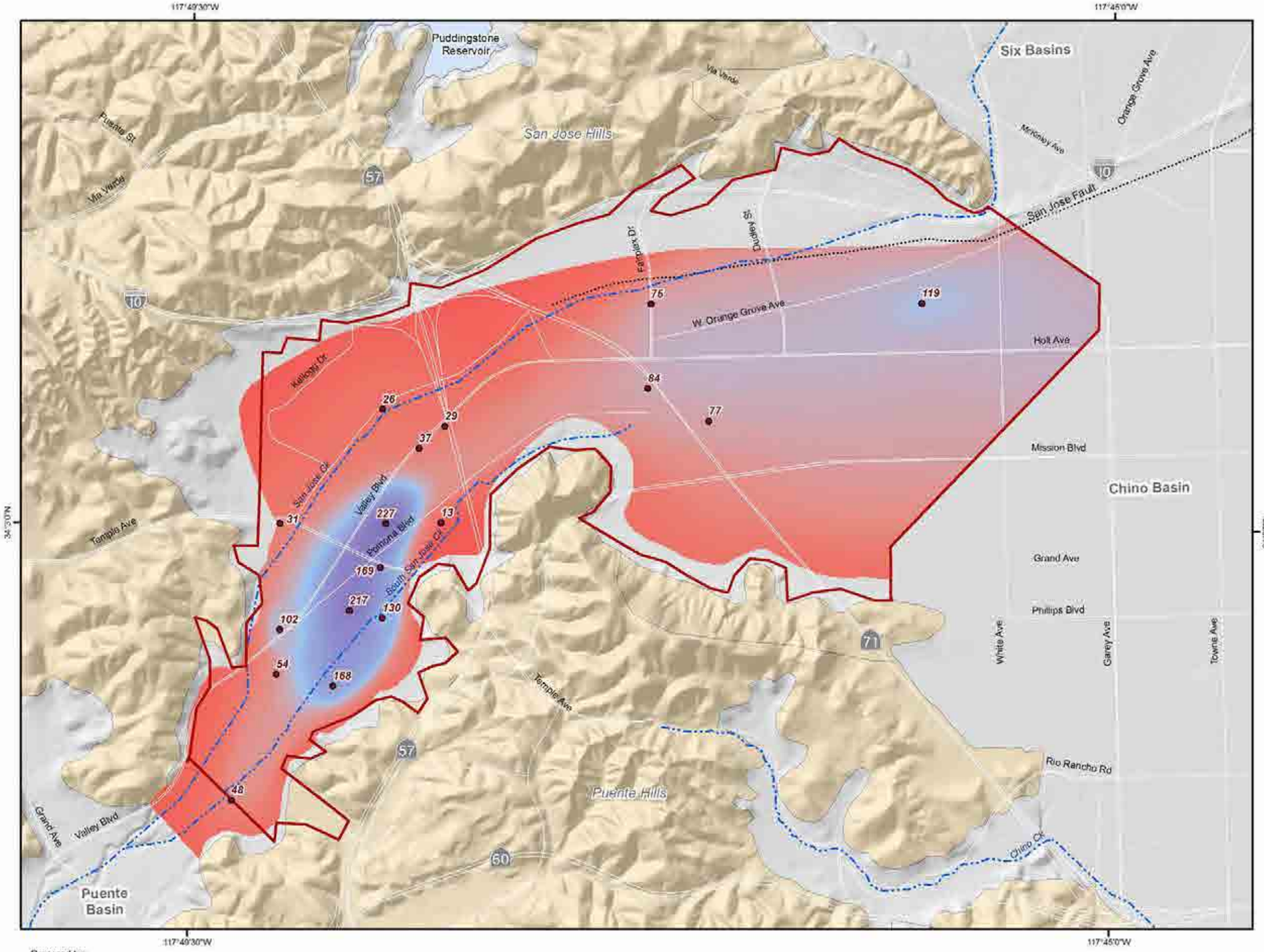
Author: AP
Date: 11/5/2019
File: Fig2-16_SpecificYield..mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Initial Estimates of Specific Yield of the Water Bearing Sediments

Figure 2-16



Initial Estimates of Horizontal Hydraulic Conductivity

250

0

122 Wells used to estimate hydraulic conductivity labeled by horizontal hydraulic conductivity of the saturated sediments

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate — Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-17_HorizontalHC.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Initial Estimates of Horizontal Hydraulic Conductivity

Figure 2-17

2.2.2.7 Groundwater Recharge

Groundwater recharge to the Spadra Basin primarily occurs by the following general mechanisms:

- **Subsurface inflow from the Six Basins across the San Jose Fault**. The San Jose Fault is a known barrier to groundwater flow from the Six Basins into the Spadra Basin; however, Eckis (1934) speculated that groundwater flows from the Six Basins into the Spadra Basin as underflow across the San Jose Fault near the eastern tip of the San Jose Hills.
- Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills).
- **Deep infiltration of precipitation and applied water (DIPAW).** DIPAW includes the combination of precipitation that falls directly on a pervious land surface, precipitation that falls on impermeable land surface that subsequently flows onto pervious surfaces, and irrigation water applied to the land surface; all of which when combined is surplus to the evapotranspiration (ET) demand and soil water storage capacity. DIPAW migrates through the root zone and subsequently reaches the underlying groundwater reservoir. DIPAW is an important source of recharge from a water quality standpoint because it is typically high in total dissolved solids (TDS) and nitrogen from land application of fertilizers and from consumptive use by vegetation.
- Deep infiltration of septic tank discharge and leakage from water mains.

2.2.2.8 Groundwater Discharge

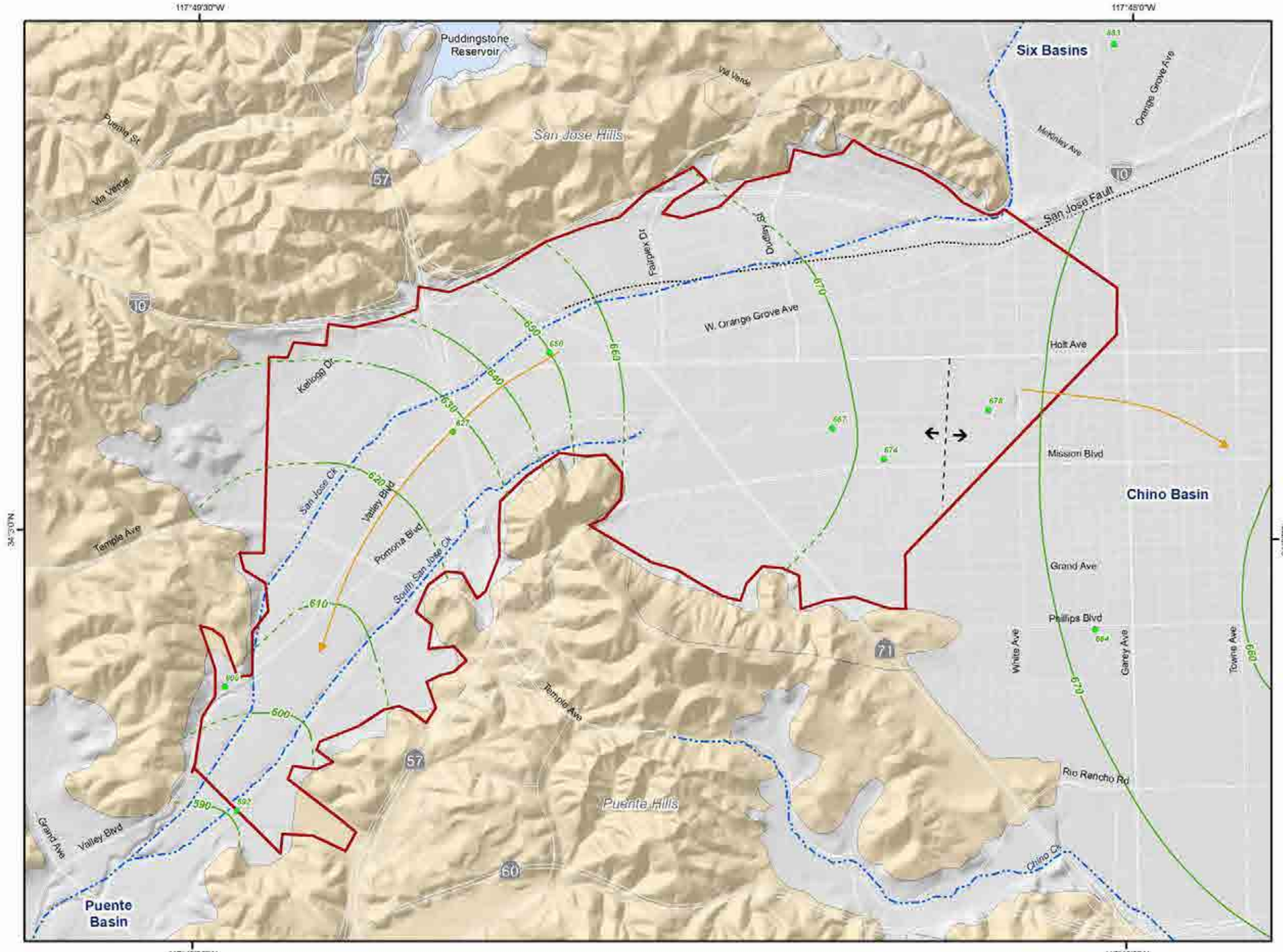
Groundwater discharge from the Spadra Basin occurs primarily as:

- Groundwater production from wells.
- **Sub-surface outflow to the Puente Basin.** This component of discharge occurs as underflow through the saturated sediments in the narrow bedrock gap that connects the Spadra Basin to the Puente Basin. The rate of underflow is dependent on the hydraulic gradient and the hydraulic conductivity of the saturated sediments.
- **Sub-surface outflow to the Chino Basin.** This component of discharge occurs as underflow through the saturated sediments when the groundwater divide is located west of the boundary with the Chino Basin. The rate of underflow is dependent on the hydraulic gradient and the hydraulic conductivity of the saturated sediments.

2.2.2.9 Groundwater Flow

Figure 2-18a is an equal groundwater-elevation contour map for fall 2018. Figures 2-18b, 2-18c, and 2-18d are groundwater-elevation contour maps for: fall 1977, which represents a period of low groundwater elevations; fall 2008, which represents a period of relatively high groundwater elevations; and fall 2015, which represents the start of SGMA implementation. The procedure for constructing groundwater elevation contour maps follows:

- **Collect historical groundwater-elevation data for wells within the basin**. Main data sources included files from the Pomona, WVWD, CPP, DWR, Chino Basin Watermaster (CBWM), and Six Basins Watermaster.
- **Prepare and analyze time-series charts of groundwater elevations for all wells**. The time-series charts can be used to distinguish between static and pumping groundwater levels. Groundwater-elevation data that were collected while the well was under the influence of pumping were not used in the preparation of the groundwater-elevation contour maps.
- **Extract groundwater-elevation data for specific time periods**. For example, for the Fall 2018 groundwater-elevation contour map, we extracted groundwater elevation data for wells with data between September 1 and December 31, 2018. After "pumping" data were discarded, we chose one groundwater-elevation data point for each well in the following order of priority: November, October, December, September.
- **Prepare maps of the groundwater-elevation data**. The maps included background hydrogeologic layers, such as surface geology, faults, and stream channels.
- **Prepare contours of equal groundwater elevation**. Groundwater elevation contours were hand drawn based on the plotted groundwater elevation point (well) data. The groundwater elevation contours were digitized and imported into the project GIS. The contours are dashed where groundwater-elevation data are sparse or absent, and hence, groundwater-elevations contours are uncertain.



—600— Groundwater-Elevation Contours (ft-amsl)

883 Wells Used to Draw Contours (labeled by static groundwater elevation in ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Surface Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate — Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

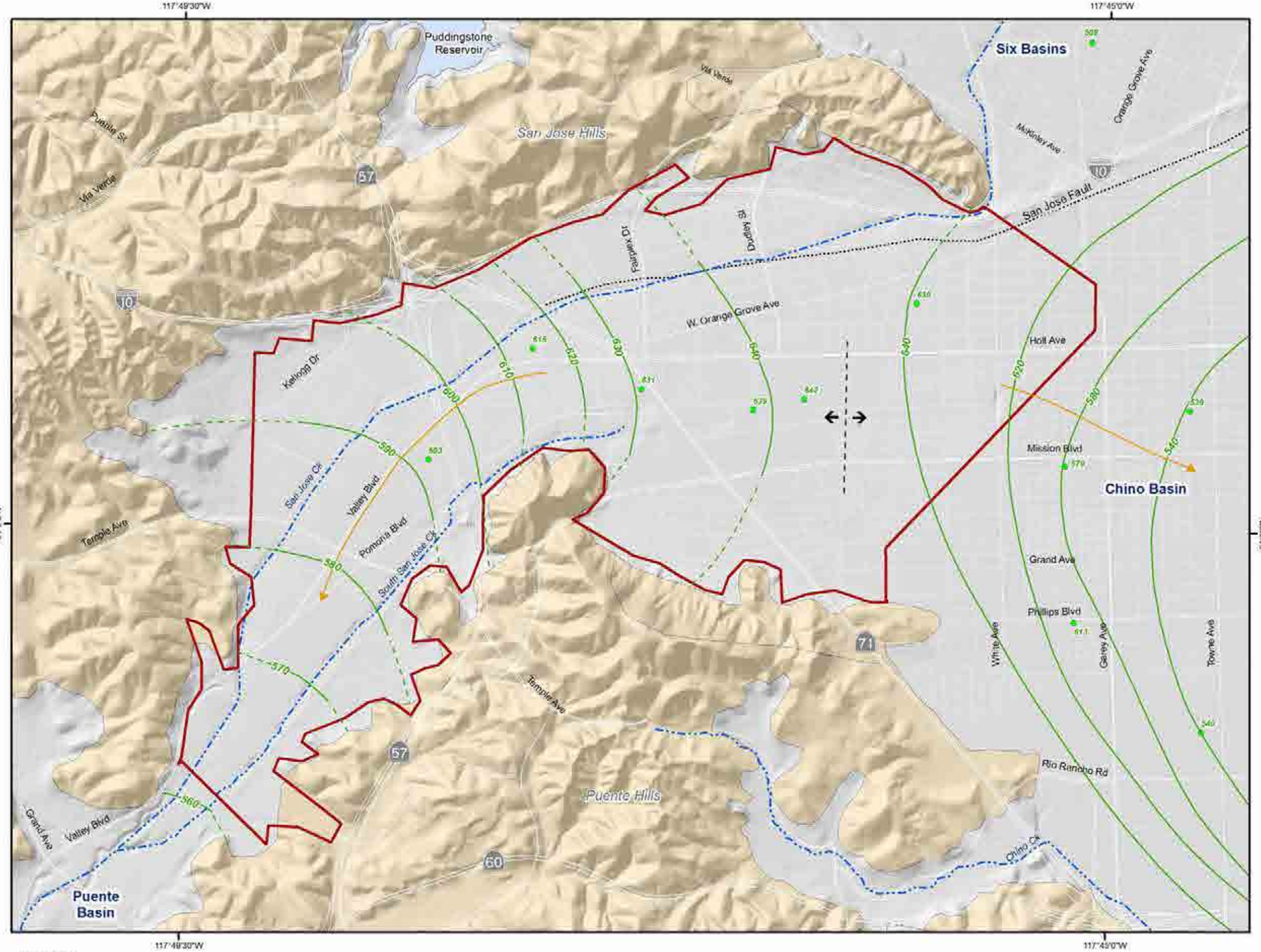
Author: AP
Date: 11/5/2019
File: Fig2-18a_GWE_2018.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Groundwater Elevation and Flow Directions
Fall 2018

Figure 2-18a



—600— Groundwater-Elevation Contours (ft-amsl)

883 Wells Used to Draw Contours (labeled by static groundwater elevation in ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Surface Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain
Location Concealed
Location Approximate
Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

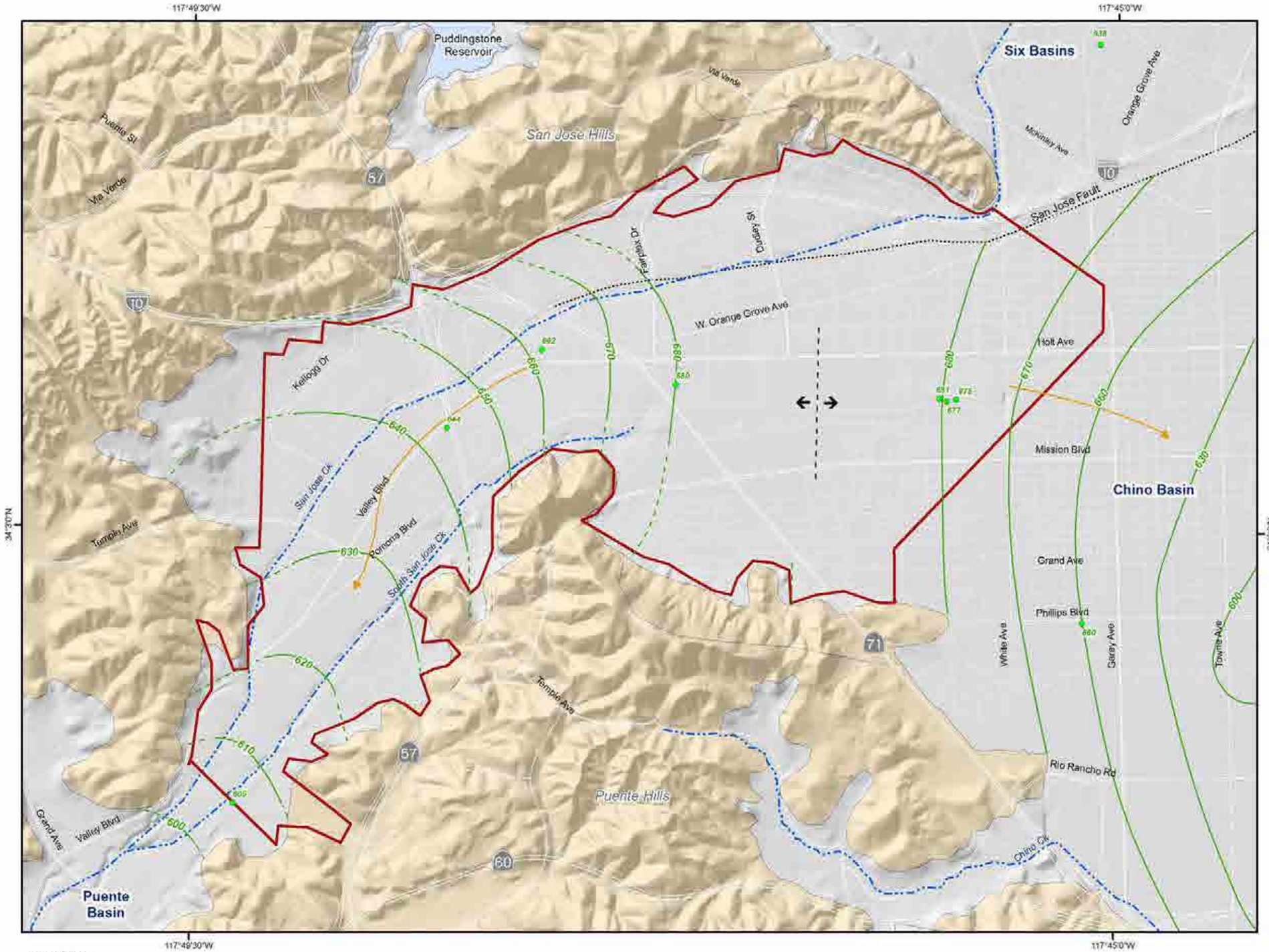
Author: LH
Date: 11/5/2019
File: Fig2-18b_GWE_1977.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Groundwater Elevation and Flow Directions
Fall 1977

Figure 2-18b



—600— Groundwater-Elevation Contours (ft-amsl)

883 Wells Used to Draw Contours (labeled by static groundwater elevation in ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Surface Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate — Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-18C_GWE_2008..mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Groundwater Elevation and Flow Directions

Fall 2008

Figure 2-18c

117°49'30"W

117°45'0"W

34°3'0"N

Puddingstone Reservoir

San Jose Hills

Six Basins

Via Verde

Puente St

Via Verde

Orange Grove Ave

McKinley Ave

10

57

San Jose Fault

Fairplex Dr

Dudley St

W. Orange Grove Ave

650

640

630

620

610

600

590

660

670

680

653

654

671

672

673

670

650

630

Holt Ave

Kellogg Dr

San Jose Ck

Valley Blvd

Pomona Blvd

South San Jose Ck

Temple Ave

Mission Blvd

Chino Basin

Grand Ave

Phillips Blvd

559

71

White Ave

Garey Ave

Towne Ave

Rio Rancho Rd

Puente Hills

Chino Ck

60

Puente Basin

Grand Ave

Valley Blvd

Surface Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

600 — Groundwater-Elevation Contours (ft-amsl)

883 — Wells Used to Draw Contours (labeled by static groundwater elevation in ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-18d_GWE_2015.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Groundwater Elevation and Flow Directions

Fall 2015

Figure 2-18d

The groundwater elevation contour maps were used to analyze and interpret groundwater flow directions (perpendicular to the groundwater elevation contours). Groundwater-flow directions are perpendicular to the contours from higher elevation to lower elevation. Although groundwater elevations are different on these maps, the shape and orientation of the contours are similar, demonstrating that the groundwater-flow patterns within the Spadra Basin have been generally consistent over time and under different hydrologic conditions. The maps and interpretations from this report were compared to maps and interpretations published in past literature. The main observations and interpretations from Figures 2-18a through 2-18d are:

- Groundwater elevations in the Six Basins may influence groundwater levels and groundwater-flow directions in the Spadra Basin. For example, when groundwater elevations in the Six Basins are higher than groundwater elevations in the Spadra Basin, the underflow across the San Jose Fault may help to create and maintain the groundwater divide that extends from the eastern tip of the San Jose Hills to the eastern Puente Hills. Note on the map figures the groundwater elevation at the P-3 well in the Six Basins, which helps to describe the head difference across the San Jose Fault. Consider the differences between Figure 2-18a and 2-18b which demonstrates the differences in groundwater levels and flow directions between 2018 and 1977:
  - Figure 2-18a is a map of groundwater elevations in 2018. The map shows that groundwater elevations were higher in the Six Basins compared to the Spadra Basin, which likely resulted in subsurface flow from the Six Basins across the San Jose Fault as a source of recharge to the Spadra Basin. Groundwater levels were relatively high in the Spadra Basin, and the groundwater divide was located just south of the eastern tip of the San Jose Hills (where the subsurface inflow from the Six Basins is most likely to occur).
  - Figure 2-18b is a map of groundwater elevations in 1977. The map shows that groundwater elevations were lower in the Six Basins compared to the Spadra Basin, which likely resulted in no subsurface flow from the Six Basins. Groundwater levels were relatively low in the Spadra Basin, and the groundwater divide was located further west of the tip of the San Jose Hills, likely because of the lack of subsurface flow from the Six Basins.
- From the groundwater divide, the main directions of groundwater flow within the Spadra Basin are: (i) eastward into the Chino Basin or (ii) westward and southwestward along the axis of the Spadra Basin toward the Puente Basin. The southwestward flowing groundwater that is not pumped ultimately migrates as underflow through the bedrock narrows into the Puente Basin.
- The hydraulic gradients shown by the groundwater-elevation contours on the figures are relatively constant in the eastward and westward directions, and hence, do not suggest the existence of internal barriers that interrupt or impede the flow of groundwater. The only mapped fault within the Spadra Basin is the extension of the San Jose Fault along the northern margin of the basin. There are no wells (or groundwater data) in the Spadra Basin that are located north of the San Jose Fault that would help determine if the San Jose Fault is a barrier to groundwater flow within the Spadra Basin.

2.2.2.10 Groundwater Pumping

Groundwater pumping is the extraction of groundwater from the aquifer system by a well. In 2018, there were approximately 10 active production wells in the Spadra Basin. Pumping capacities at these wells are relatively low ranging between 200 to 400 gpm. Specific capacities at the pumping wells are also typically low (<25 gpm/ft-drawdown). The low pumping capacities and specific capacities at wells are likely due to the saturated sediments in the Spadra Basin being relatively thin and of low hydraulic conductivity.

Annual groundwater pumping from 1977-2018 is listed by well in Table 2-3 and shown graphically in Figure 2-19. The maximum discharge by pumping occurred in 1986 at about 2,200 afy; the minimum pumping occurred in 1991 at about 700 afy. The average annual pumping over the entire 1977-2018 period was about 1,280 afy. Average annual pumping over the last 10 years was about 970 afy—about 310 afy less than the long-term average. The percentage of the total pumping in the Spadra Basin between the three water purveyors during 1977-2018 was 51 percent by Pomona, 46 percent by CPP, and 3 percent by the WVWD.

2.2.2.11 Groundwater Levels and Storage

This section describes how groundwater levels and storage have changed over time across the Spadra Basin, and why those changes occurred.

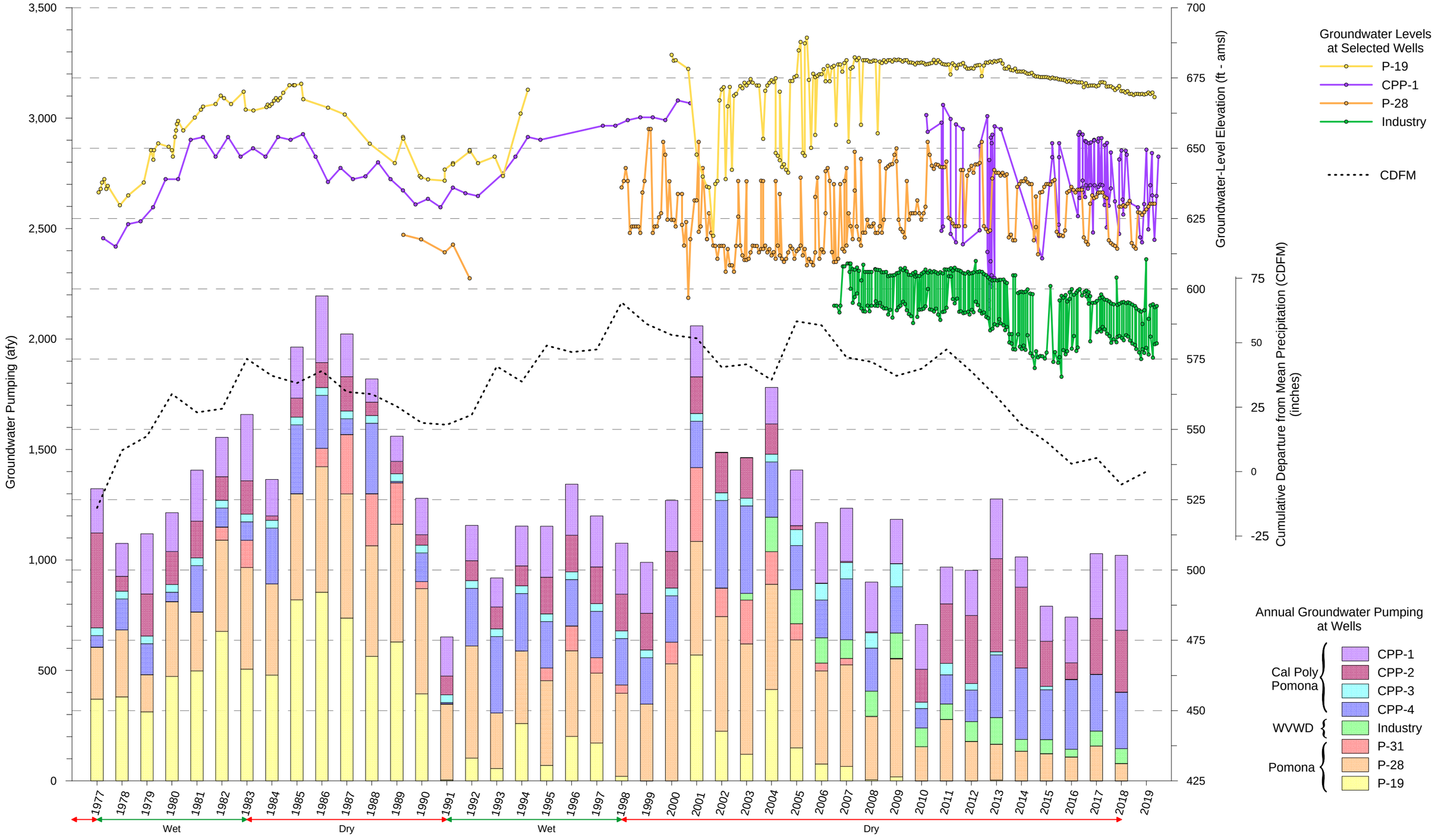
Figure 2-19 shows time-series charts of groundwater elevation at four wells located across the Spadra Basin. The time-series charts indicate:

- At some wells, the short-term groundwater-level fluctuations are caused by including pumping and non-pumping measurements on the time series charts.
- Seasonal changes in groundwater levels at all wells are minimal, and do not exceed a few ft of seasonal change.
- The long-term trends in groundwater levels appear to be consistent at all wells across the basin, suggesting that all wells are being influenced by the same regional stresses of recharge and pumping.

Table 2-3. Groundwater Pumping in the Spadra Basin 1977-2018 (afy)

	City of Pomona				Walnut Valley Water District			California State Polytechnic University of Pomona					Other	
Year	P-19	P-28	P-31	Total	Industry	Valley	Total	CPP-1	CPP-2	CPP-3	CPP-4	Total	Walnut Hills	Total
1977	370	235	1	605	0	0	0	201	430	*35*	52	718		1,323
1978	380	304	0	684	0	0	0	149	67	*35*	140	391		1,075
1979	312	168	0	480	0	0	0	273	190	*35*	140	638		1,119
1980	473	339	0	811	0	0	0	176	150	*35*	43	403		1,214
1981	498	267	0	764	0	0	0	231	166	*35*	210	642		1,407
1982	677	413	59	1,149	0	0	0	178	107	*35*	86	406		1,555
1983	506	460	123	1,089	0	0	0	300	151	*35*	83	569		1,658
1984	479	413	0	891	0	0	0	165	20	*35*	253	473		1,364
1985	820	480	0	1,300	0	0	0	231	86	*35*	312	664		1,964
1986	854	568	83	1,505	0	0	0	302	113	*35*	240	690		2,195
1987	737	562	269	1,568	0	0	0	193	155	*35*	2038	2422		3,989
1988	563	501	235	1,299	0	0	0	105	60	*35*	319	520		1,820
1989	629	533	188	1,349	0	0	0	114	56	*35*	6	211		1,560
1990	394	476	32	902	0	0	0	165	47	*35*	130	377		1,279
1991	4	343	2	348	0	0	0	177	85	*35*	6	303		651
1992	103	507	0	611	0	0	0	160	90	*35*	261	546		1,157
1993	56	251	0	307	0	0	0	132	99	*35*	346	611		919
1994	259	329	0	588	0	0	0	180	90	*35*	260	565		1,153
1995	70	383	57	511	0	0	0	*231*	*166*	*35*	*210*	642		1,153
1996	201	387	112	701	0	0	0	*231*	*166*	*35*	*210*	642		1,343
1997	171	316	70	557	0	0	0	*231*	*166*	*35*	*210*	642		1,199
1998	20	376	37	434	0	0	0	*231*	*166*	*35*	*210*	642		1,076
1999	0	347	0	347	0	0	0	*231*	*166*	*35*	*210*	642		989
2000	0	529	98	628	0	0	0	*231*	*166*	*35*	*210*	642	no data	1,270
2001	570	514	334	1,418	0	0	0	*231*	*166*	*35*	*210*	642		2,060
2002	225	519	129	873	0	0	0	0	182	*35*	396	614		1,487
2003	120	499	199	818	30	0	30	0	183	*35*	396	614		1,463
2004	414	476	148	1,038	156	0	156	165	137	*35*	250	587		1,781
2005	149	489	74	711	154	0	154	252	18	72	200	542		1,407
2006	76	422	35	533	115	0	115	274	2	75	171	521		1,169
2007	65	460		525	84	0	84	240	5	74	276	595		1,205
2008	5	286	2	293	114	0	114	225	5	69	195	494		900
2009	18	534	3	555	115	0	115	201	0	104	209	515		1,184
2010	0	155	0	155	85	0	85	203	149	29	88	468		708
2011	0	278	0	278	70	0	70	167	269	52	132	620		968
2012	0	178	0	178	90	0	90	204	308	30	143	685		953
2013	4	162	0	166	121	0	121	270	422	14	283	990		1,276
2014	0	134	0	134	53	0	53	137	366	0	323	826		1,013
2015	0	123	0	123	63	0	63	159	204	15	226	604		790
2016	0	108	0	108	35	0	35	207	74	2	314	598		741
2017	0	158	0	158	68	0	68	293	253	0	256	803		1,028
2018	0	78	0	78	67	0	67	339	280	0	256	875		1,021
Minimum	0	78	0	78	0	0	0	0	0	0	6	211		289
Average	243	359	56	657	34	0	34	200	147	36	250	633		1,323
Maximum	854	568	334	1568	156	0	156	339	430	104	2038	2422		4,145
Total	10,222	15,061	2,291	27,574	1,419	0	1,419	8,384	6,182	1,518	10,509	26,594		**55,587**
Percent of Total	-	-	-	**50%**	-	-	**3%**	-	-	-	-	**48%**		**100%**

* Numbers in *italics* are estimated volumes of pumping. These estimates were prepared based on confirmation that the well was active and were determined using the average of the measured and recorded annual pumping volumes.



Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 20191021
Filename: Fig2-23_Production_GWE

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Precipitation, Groundwater Pumping, and Groundwater Levels in the Spadra Basin

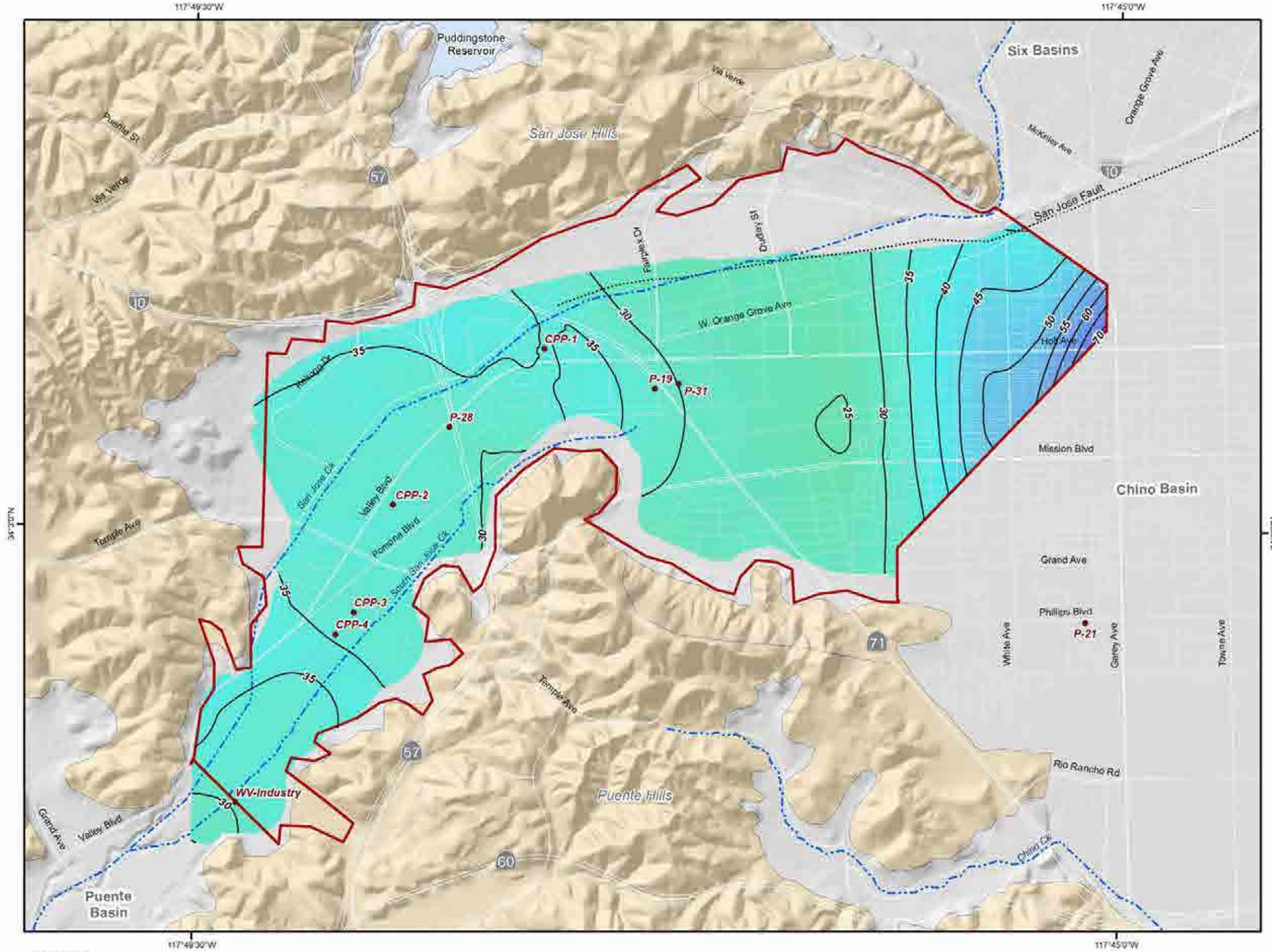
Figure 2-19

On Figure 2-19, the behavior of groundwater levels is compared to precipitation patterns and groundwater pumping to help describe why the changes in groundwater levels have occurred. Precipitation patterns are illustrated by the CDFM curve. The following describes the observations and interpretations from Figure 2-19 and Figures 2-18a through 2-18d:

- In 1977, groundwater elevations were relatively low in the Spadra Basin. This was true for two main reasons: (i) the period from 1945 through 1977 was a long-term drought and (ii) groundwater elevations in the Six Basins were near all-time lows (and in fact, lower than groundwater elevations in the Spadra Basin) (WEI, 2017) which likely resulted in cutting off subsurface inflow from the Six Basins.
- From 1978 to 1985, groundwater elevations increased in the Spadra Basin by 30-40 ft, even though groundwater pumping increased from about 1,200 afy to over 2,000 afy. This increase in groundwater levels was likely due to: (i) increased recharge from precipitation associated with the 1978-83 wet period and (ii) rapidly increasing groundwater levels in the Six Basins in the early 1980s (WEI, 2017) that likely resulted in increased recharge by subsurface flow across the San Jose Fault.
- From 1985 to 1992, groundwater elevations decreased by about 25-30 ft, even though groundwater pumping progressively decreased from over 2,000 afy in 1986 to about 700 afy in 1991. This decrease in groundwater levels was likely due to the 1984 to 1991 dry hydrologic period.
- From 1992 to 2008, groundwater elevations increased by about 40 ft. Groundwater pumping was variable over this period, but generally averaged about 1,200 afy. The increase was likely due to the 1991-98 wet hydrologic period which likely increased the recharge via DIPAW and subsurface inflow from the surrounding hills. Also, during this period, groundwater levels in the Six Basins had increased by at least 300 ft compared to the late 1970s which likely resulted in increased subsurface inflow to the Spadra Basin across the San Jose Fault.
- From 2009 to 2018, groundwater elevations in the Spadra Basin gradually decreased by about 10-20 ft even though groundwater pumping decreased to an average annual rate of about 970 afy for the period. The decrease in groundwater levels was likely due to the 1999- 2018 dry period from and a 50-ft decrease in groundwater levels in the Six Basins, both of which reduced the recharge to the Spadra Basin.

The changes in groundwater levels described above resulted in changes in groundwater storage. Figure 2-20 is a map that shows changes in groundwater levels from 1977 to 2018. Groundwater levels were about 25-35 ft higher in 2018 compared to 1977 across most of the Spadra Basin and were up to 70 ft higher near the boundary with the Chino Basin.

The data used to estimate groundwater in storage for a specific year included: bedrock elevation (shown on Figure 2-14); groundwater elevation (Figure 2-18b for 1977 and Figure 2-18a for 2018); and the thickness-weighted average specific yield of the saturated sediments (Figure 2-16). In ArcGIS, bedrock elevation, groundwater-level elevation, and specific yield were assigned to each cell of a 60 x 60-meter grid (196 x 196-ft) superimposed over the Spadra Basin. In Microsoft Excel, the volume of groundwater in storage within each grid cell was calculated and summed to estimate the total storage in acre-feet (af).



Groundwater Elevation Change

80 ft

40

0 ft

Active Production Wells

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 11/6/2019
File: Fig2-20_1977-2018_Change.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN

Change in Groundwater Levels

Fall 1977 - Fall 2018

Figure 2-20

Table 2-4 summarizes the estimated water in storage in 1977 and 2018, and the change in storage over this period.

Table 2-4. Groundwater in Storage and Change in Storage in the Spadra Basin (1977-2018)

Year	Storage, af
1977	23,678
2018	32,956
Storage 1977-2018	+9,278

2.2.2.12 Initial Estimate of Developed Yield: 1977-2018

As defined herein, the "developed yield" is the annual average yield that was pumped from the groundwater basin over a finite period of time but is corrected for the change in groundwater storage (described above) and the volume of supplemental-water recharge that occurred during the period of interest. The developed yield is reflective of the hydrology and water management practices of that period. It can be considered an estimate of the sustainable yield of a basin if: (i) it is computed over a long enough period to include both wet and dry hydrologic periods and (ii) there were no obvious undesirable results that occurred, such as chronic lowering of groundwater levels and reduction of storage.

Herein, the period of interest for computing an initial estimate of developed yield is 1977 to 2018. This period included wet periods (1978-83 and 1991-98) and dry periods (1984-90 and 1999-2018) and groundwater levels increased across the basin. No supplemental water recharge occurred in the Spadra Basin during 1977 to 2018.

The developed yield can be estimated using a pragmatic approach:

$$\text{Developed Yield} = (O_p - I_{ar} + \Delta S)/\Delta t$$

Where:

Δt is the time period over which the developed yield is being estimated

O_p is the total groundwater pumped from the basin(s) during Δt

I_{ar} is the total supplemental water recharged to the basin(s) during Δt

ΔS is the change in groundwater storage within the basin(s) during Δt

Developed Yield = (53,649 af – 0 af + 9,278 af)/42 yr = 1,498 afy

In *Section 2.2.6 Water Budget*, a more rigorous analysis of the water budget and the developed yield of the Spadra Basin over the 1977 to 2018 time period was performed through the development and calibration of the Spadra Basin Groundwater Model.

2.2.3 Groundwater Quality

Spadra Basin groundwater is used primarily for non-potable uses by the overlying water purveyors because of the general poor quality of groundwater. Groundwater from Spadra Basin that is used for potable supply often requires treatment or blending prior to use to comply with DDW drinking-water standards.

In the Spadra Basin, groundwater-quality data are available for production wells and monitoring wells. Groundwater-quality samples from production wells are sampled by well owners and are generally sampled for constituents required by the DDW monitoring schedules for municipal water systems. The frequency of water-quality sampling depends on the well use; some production wells in the Spadra Basin are rarely or never sampled because they are used for agricultural or other non-potable uses where water-quality monitoring is performed elsewhere in the distribution system. Groundwater-quality samples from monitoring wells in the Spadra Basin are collected by public entities, private companies and their consultants to characterize point-source contamination for which they are potentially responsible as determined by the LA Regional Board. The constituents and sampling frequency vary by contamination site.

All available groundwater-quality data from wells in the Spadra Basin over the last twenty years (2000-2019) was analyzed for exceedances of regulatory standards including: primary or secondary California maximum contaminant levels (MCLs)s) for drinking water; State notification levels (NLs) set by the DDW as advisory levels for potential negative health effects; and the numerical groundwater-quality objectives for the Spadra Basin as defined in the LA Basin Plan. There were 39 wells with available groundwater quality data during this period; the frequency of monitoring and constituents sampled for varies by well. Table 2-5 summarizes the number of wells in the Spadra Basin with constituent concentrations that exceed an MCL, NL, or a numerical Basin Plan objective. In one or more wells, there are 17 constituents that exceed a primary MCL, five constituents that exceed a secondary MCL, three constituents that exceed a NL, and four constituents that exceed a Basin Plan objective.

Table 2-5. Exceedances of Groundwater Quality Standards in the Spadra Basin 2000-2019

Analyte	Standard[a]	Number of Wells Sampled	Number of Wells with Exceedances	Percent of wells with Exceedance
Contaminant with Primary MCL				
1,1-Dichloroethene (1,1-DCE)	6 µgl	39	14	36%
1,2-Dibromo-3-chloropropane	0.2	27	1	4%
1,2-Dichloroethane	0.5 µgl	39	8	21%
Arsenic	0.01 µgl	17	4	24%
Benzene	1 µgl	36	4	11%
Cadmium	0.005 µgl	17	1	6%
Chromium	50 µgl	16	5	31%
cis-1,2-Dichloroethene (cis-1,2-DCE)	6 µgl	38	3	8%
Di(2-ethylhexyl)phthalate	4 µgl	14	1	7%
Methyl Tert-Butyl Ether (MTBE)	13 µgl	36	9	25%
Nickel	0.1 µgl	15	5	33%
Nitrate-Nitrogen	10 µgl	23	20	87%
Perchlorate	6 µgl	15	4	27%
Selenium	50 µgl	17	5	29%
Tetrachloroethene (PCE)	5 µgl	39	26	67%
Trichloroethene (TCE)	5 µgl	39	25	64%
Vinyl Chloride	0.5 µgl	29	2	7%
Contaminant with Secondary MCL				
Chloride	500 mgl	25	1	4%
Manganese	0.05 mgl	7	1	14%
Methyl Tert-Butyl Ether (MTBE)	5 µgl	36	16	44%
Sulfate	250 mgl	25	11	44%
TDS	500 mgl	25	24	96%
Contaminant with California NL				
1,4-Dioxane	1 µgl	12	2	17%
Tert-Butyl Alcohol	120 µgl	33	1	3%
Vanadium	50 µgl	12	6	50%
Contaminant with Basin Plan Objective[b]				
TDS	550 mgl	25	24	96%
Nitrate-Nitrogen	10 mgl	23	20	87%
Sulfate	200 mgl	25	15	60%
Chloride	120 mgl	25	12	48%

(a) All MCL standards used for this analysis are California Primary MCL standards; the Federal EPA MCL standards are either higher than, equivalent to, or non-existent for all the contaminants detected in Spadra Basin wells with a MCL exceedance.

(b) There are no wells in the Spadra Basin that exceed the Basin Plan objective of 1 mgl for Boron.

Understanding the spatial distribution of wells with concentrations greater than regulatory standards is important because it indicates areas in the basin where groundwater may be impaired from a beneficial use standpoint, and hence, poses current and future challenges that the pumpers may face in using the groundwater for certain end uses. A series of maps were prepared to depict the areal distribution of contaminants of concern in the Spadra Basin which are defined as follows:

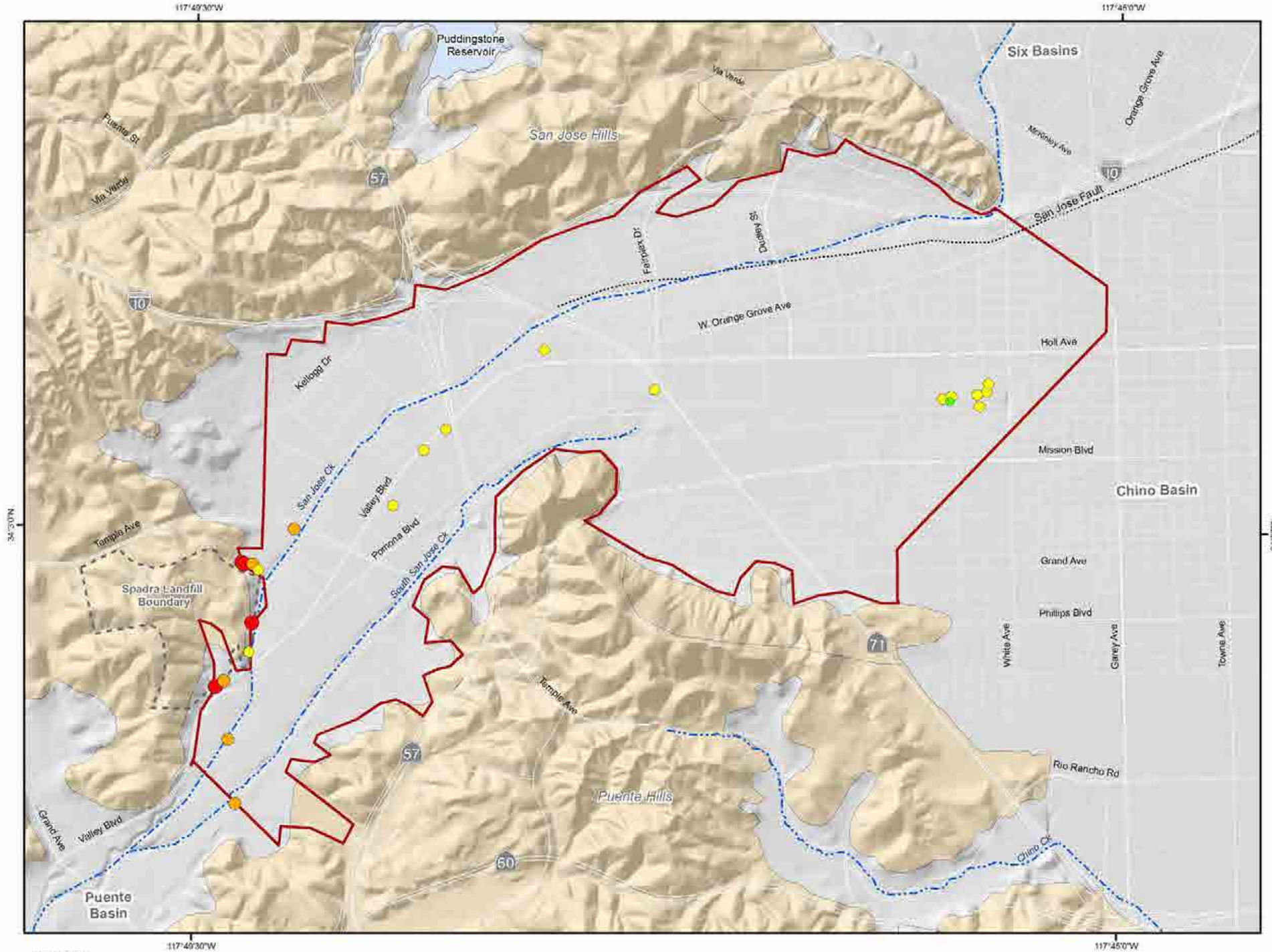
- Constituents that exceed primary MCLs in ten or more wells.
- Constituents that are associated with salt and nutrient management planning: total dissolved solids (TDS) and nitrate.
- Constituents associated with known point-source contamination sites and exceed a primary MCL in ten or more wells. These constituents are trichloroethene (TCE), tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE).
- Constituents for which the DDW is in the process of re-evaluating the current MCL that may impact the future beneficial use of groundwater and are found in several production wells. This constituent is perchlorate.

Figures 2-21 through 2-26 show the areal distribution of groundwater quality for the contaminants of concern listed above. The maximum concentration measured at each well from 2000 to 2019 is displayed using the following standardized class intervals based on the water-quality standard (WQS) for the constituent of concern:

Symbol	Class Interval
○	Not Detected
●	<0.5x WQS, but detected
●	0.5x WQS to WQS
●	WQS to 2x WQS
●	2x WQS to 4x WQS
●	> 4x WQS

2.2.3.1 TDS

TDS has a secondary MCL of 500 mgl. Figure 2-21 displays the areal distribution of the maximum TDS concentration at wells in the Spadra Basin from 2000 through 2019. During this period, 25 of the 39 wells with water-quality data were sampled for TDS, and TDS concentrations exceeded the secondary MCL at 24 (96 percent) of the wells sampled. The maximum TDS concentrations ranged from 424 to 2,380 mgl and averaged 1,265 mgl. The highest TDS concentrations are located along the western margin of the Spadra Basin adjacent to the Spadra Landfill. Higher TDS concentrations in groundwater can be related to the historical disposal operations at the landfill and the long history of agriculture in this area. Agricultural land uses impact TDS concentrations in the groundwater through the use of fertilizers on crops, and the concentrating effects on return flows from consumptive use by crops. All but one of the wells have maximum TDC concentrations that are above the Basin Plan objective of 550 mgl, indicating that the basin may not have assimilative capacity for TDS.



TDS (mgl)

- < 125
- 125 - 250
- 250 - 500
- 500 - 1,000
- 1,000 - 2,000
- > 2,000

California Secondary MCL = 500 mgl

Basin Plan Objective = 550 mgl

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate - - - Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-21_TDS.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

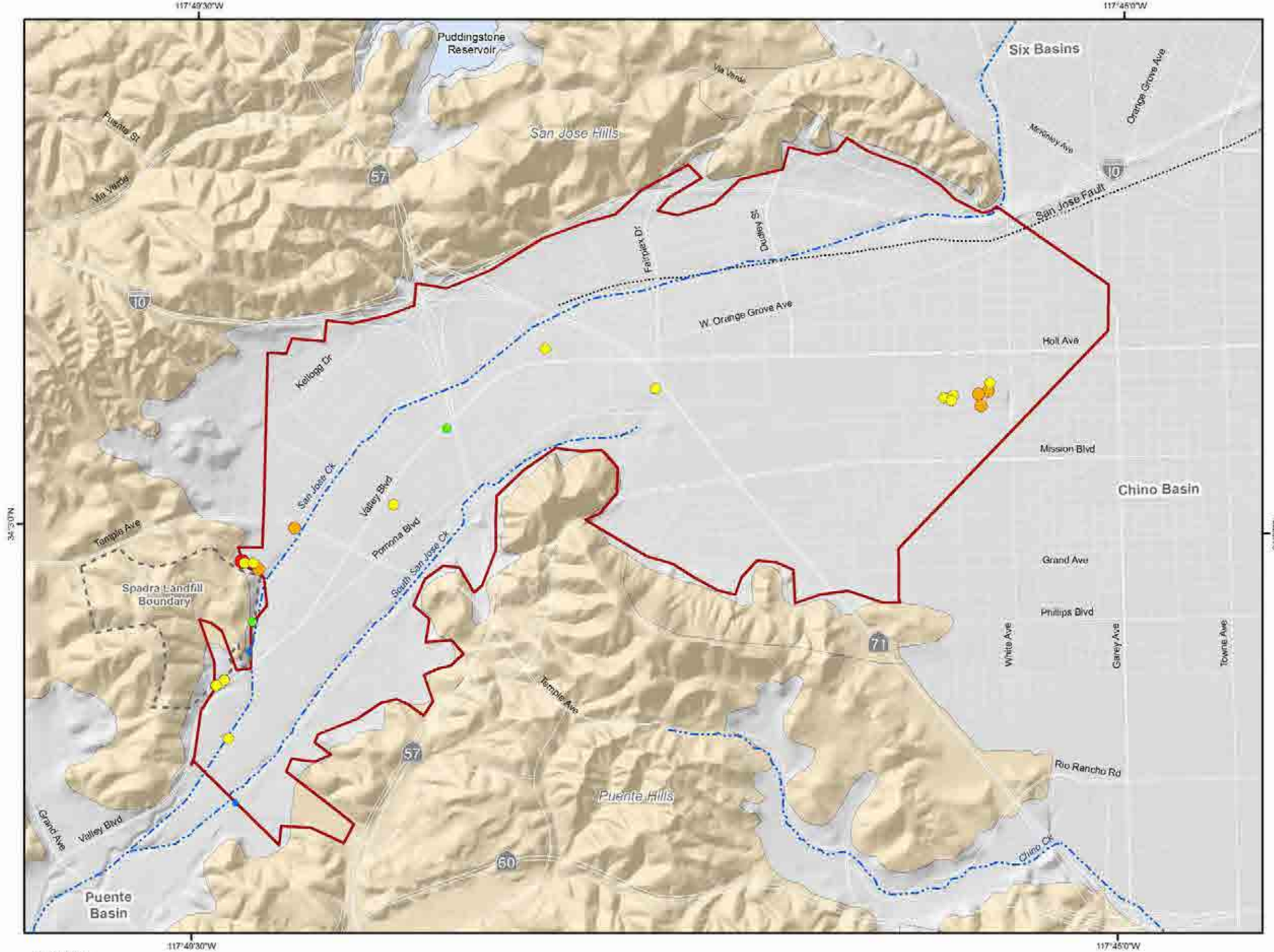
Groundwater Sustainability Plan

SPADRA BASIN

Total Dissolved Solids in Groundwater

Maximum Concentration (2000-2019)

Figure 2-21



Nitrate-Nitrogen (mg/l)

- ND
- < 5
- 5 - 10
- 10 - 20
- 20 - 40
- > 40

California Primary MCL = 10 mg/l

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate - - - Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-22_NO3.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

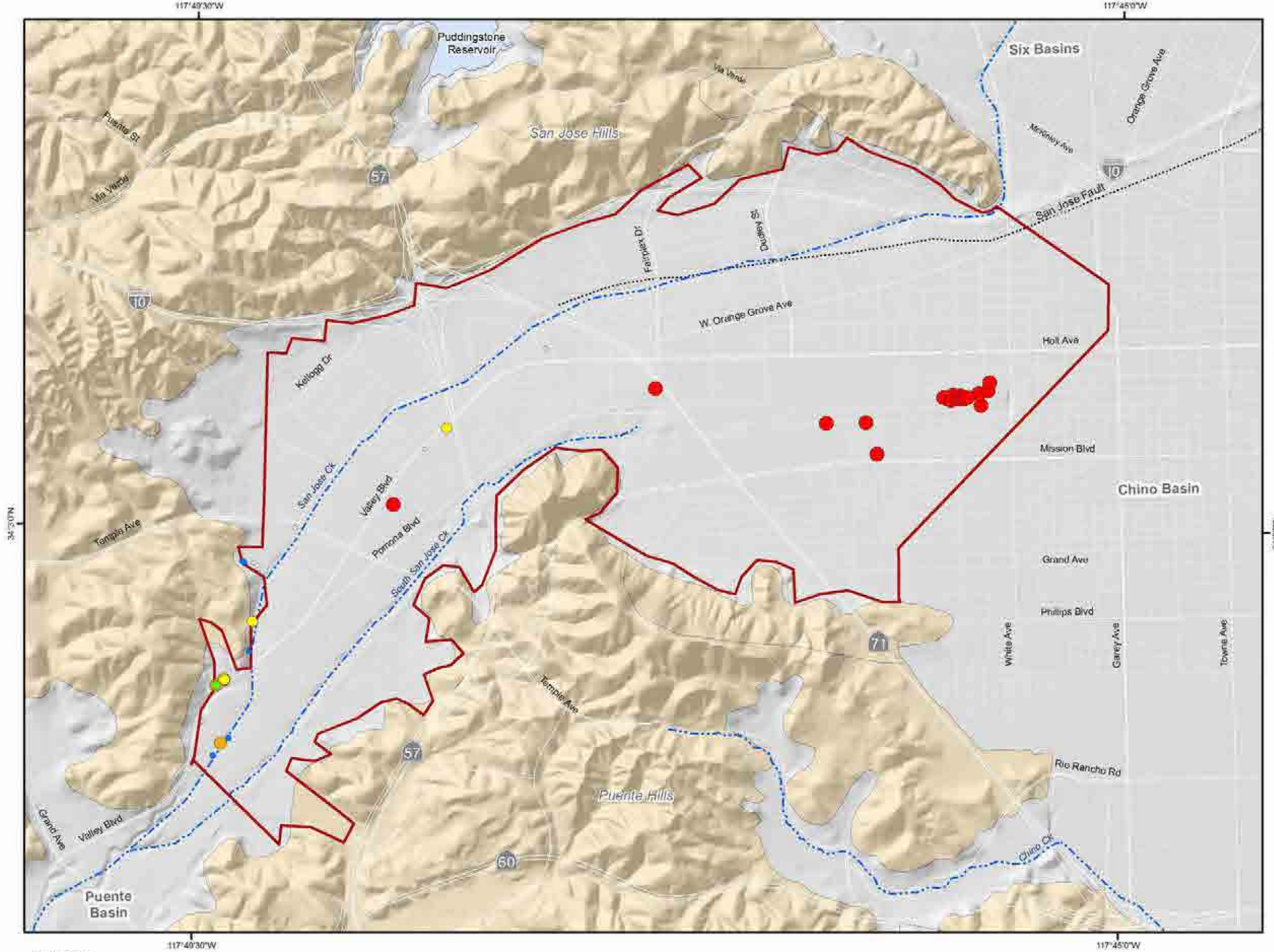
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Nitrate-Nitrogen in Groundwater

Maximum Concentration (2000-2019)

Figure 2-22



PCE (µgl)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

California Primary MCL = 5 µgl

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate - - - Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 11/5/2019
File: Fig2-23_PCE.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

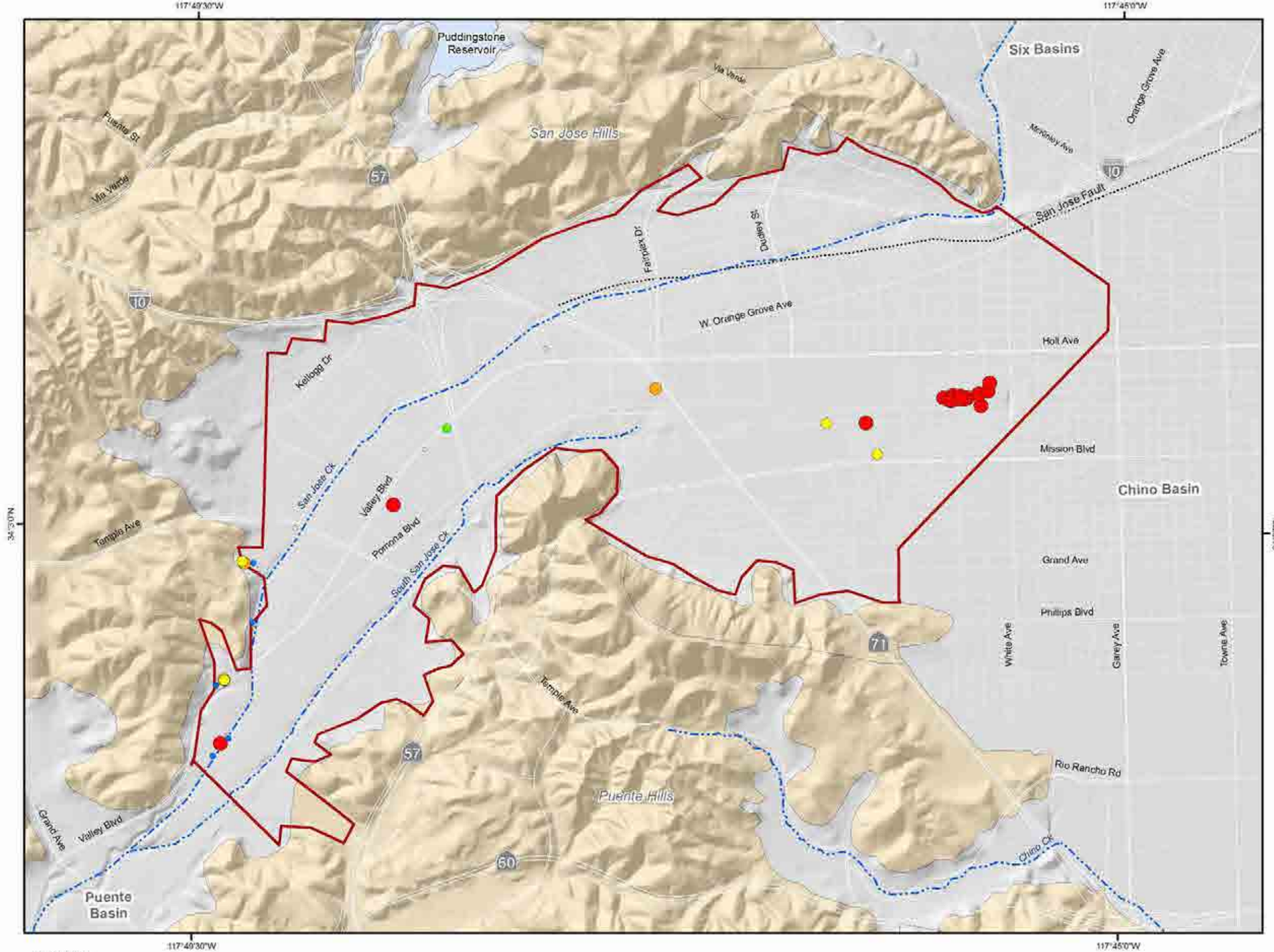
Groundwater Sustainability Plan

SPADRA BASIN

Tetrachloroethene (PCE) in Groundwater

Maximum Concentration (2000-2019)

Figure 2-23



TCE (µgl)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

California Primary MCL = 5 µgl

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate - - - Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-24_TCE.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

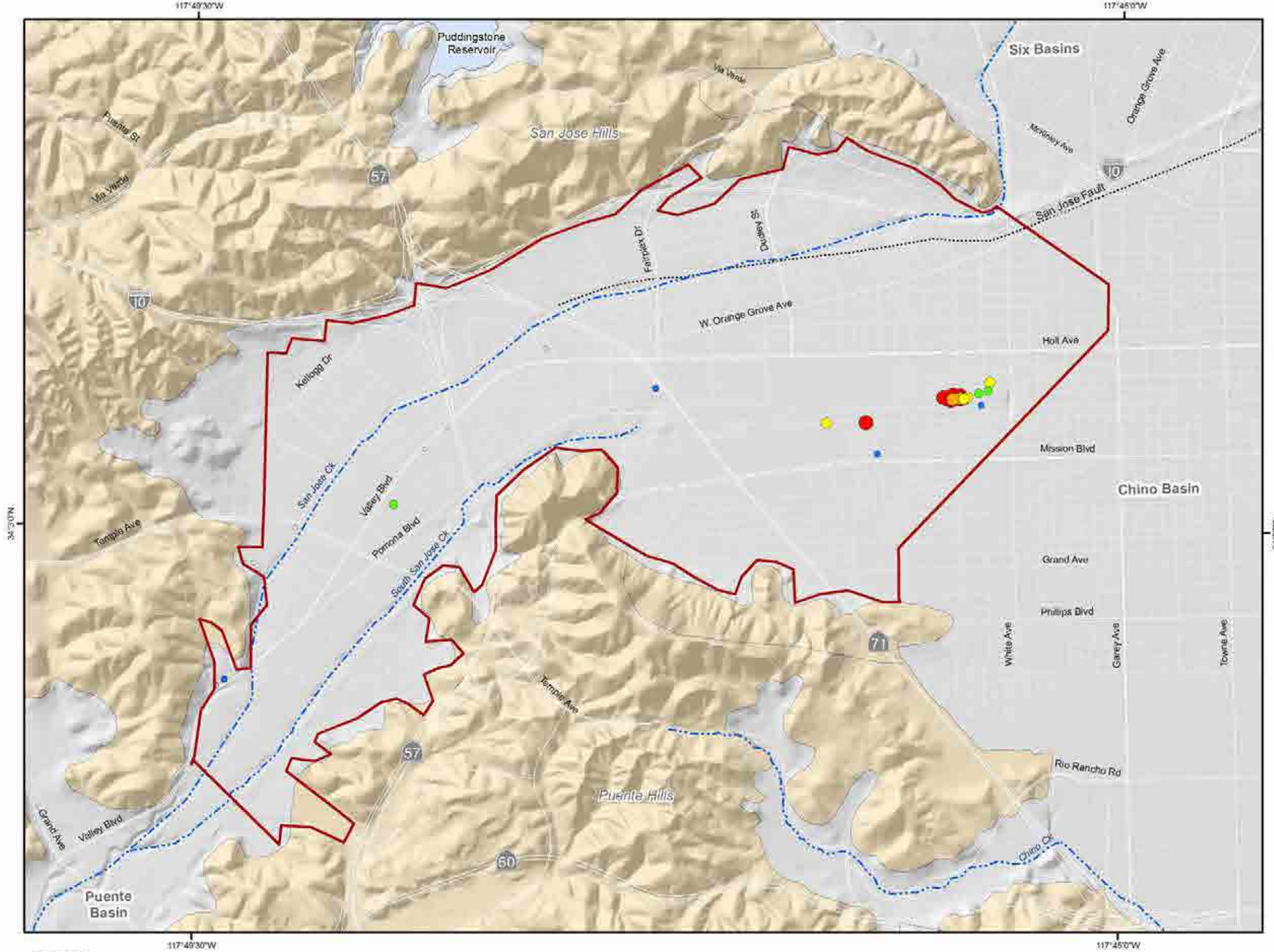
Groundwater Sustainability Plan

SPADRA BASIN

Trichloroethene (TCE) in Groundwater

Maximum Concentration (2000-2019)

Figure 2-24



1,1-DCE (µg/l)

- ND
- < 3
- 3 - 6
- 6 - 12
- 12 - 24
- > 24

California Primary MCL = 6 µg/l

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate - - - Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-25_1,1-DCE.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

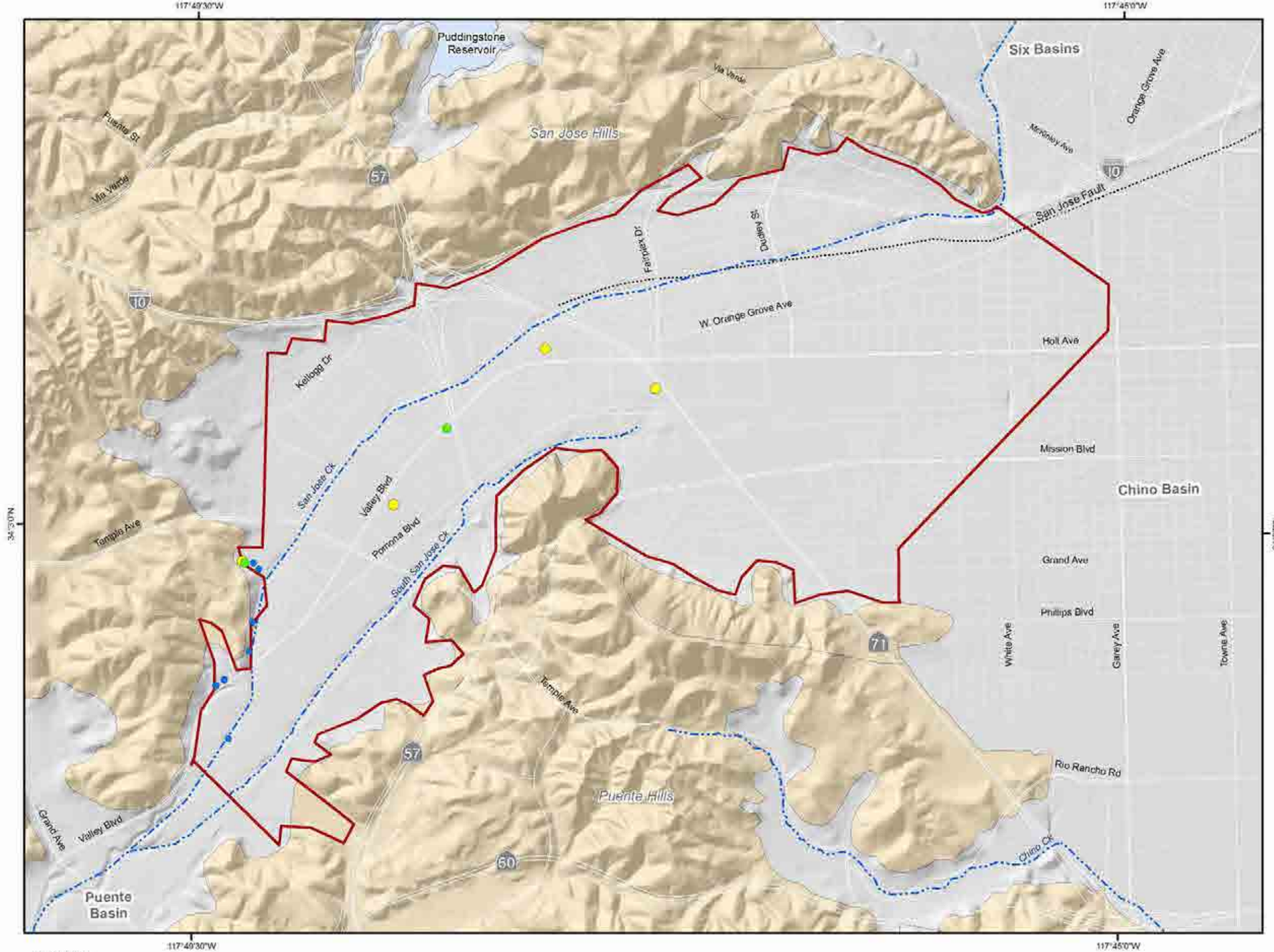
Groundwater Sustainability Plan

SPADRA BASIN

1,1-Dichloroethane (1,1-DCE) in Groundwater

Maximum Concentration (2000-2019)

Figure 2-25



Perchlorate (µgl)

- ND
- < 3
- 3 - 6
- 6 - 12
- 12 - 24
- > 24

California Primary MCL = 6 µgl

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain — Location Concealed

Location Approximate - - - Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-26_Perchlorate.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Perchlorate in Groundwater

Maximum Concentration (2000-2019)

Figure 2-26

2.2.3.2 Nitrate

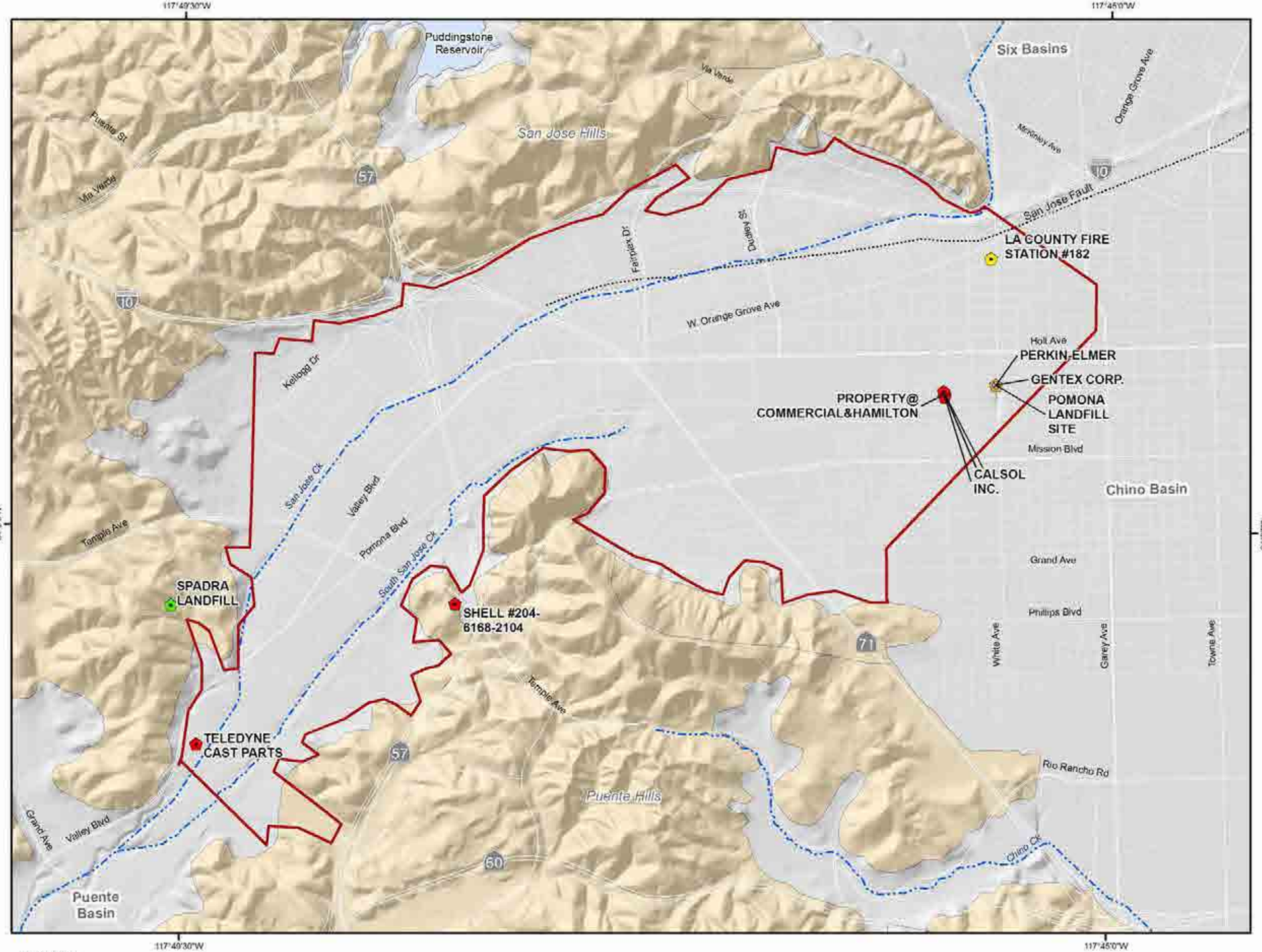
The California primary MCL for nitrate (as nitrogen) in drinking water is 10 mgl. By convention all nitrate values are expressed in this GSP as nitrate as nitrogen. The Basin Plan also has a nitrate objective of 10 mgl. Figure 2-22 displays the areal distribution of the maximum nitrate concentration at wells in the Spadra Basin from 2000 through 2019. During this period, 24 of the 39 wells with water-quality data were sampled for nitrate, and nitrate exceeded the primary MCL at 20 (87 percent) of the wells sampled. The maximum nitrate concentrations ranged from 0.8 to 43.4 mgl and averaged 17 mgl. The historical land use in the Spadra Basin included irrigated crops, pastures, and citrus where nitrate fertilizers were regularly applied to citrus and other crops. Furthermore, typical irrigation practices for citrus have low irrigation efficiencies, about 60 percent. The lower the irrigation efficiency of the practice, the more applied water percolates to groundwater. There are still portions of the Spadra Basin with irrigated citrus and other crops. These historical and current agricultural practices can result in high nitrate concentrations in groundwater.

2.2.3.3 PCE and TCE

PCE and TCE are regulated drinking water contaminants in California each with a primary MCL of 5 micrograms per liter (µgl). Figure 2-23 and Figure 2-24 display the areal distribution of the maximum PCE and TCE concentrations at wells in the Spadra Basin from 2000 to 2019, respectively. During this period, 39 out of 39 wells with water quality data were sampled for both PCE and TCE, and PCE concentrations exceeded the primary MCL at 26 (67 percent) of the wells sampled, and TCE concentrations exceeded the primary MCL at 25 (64 percent) of the wells sampled. PCE and TCE are common industrial solvents used as degreasers in metal-working industries. Wells with detectable levels of PCE and TCE occur predominantly in monitoring well clusters associated with known point-sources of contamination (see Figure 2-27) or in wells downgradient of these contamination sites. However, PCE and TCE are detected in some pumping wells in the Spadra Basin that are not located in proximity to these contamination sites and potential sources and responsible parties are yet to be identified. The known point-source contamination sites in the Spadra Basin will be discussed further in *Section 2.2.3.7*

2.2.3.4 1,1-DCE

1,1-DCE is a regulated drinking-water contaminant in California with a primary MCL of 6 µgl. Figure 2-25 displays the areal distribution of the maximum 1,1 DCE concentration at wells in the Spadra Basin from 2000 to 2019. During this period, 39 of the 39 wells with water quality were sampled for 1,1-DCE and, 1,1-DCE concentrations exceeded the primary MCL at 14 (39 percent) of the wells sampled. 1,1-DCE is a degradation by-product of TCE, PCE, and 1,1,1-trichloroethane (1,1,1-TCA) that is formed by reductive dehalogenation. Wells with detectable levels of 1,1-DCE occur predominantly in monitoring well clusters associated with the known point-sources of contamination (see Figure 2-27) or in wells downgradient of these contamination sites. However, 1,1-DCE is detected in a few wells that are not located in proximity to these contamination sites and potential sources and responsible parties are yet to be identified. The known point-source contamination sites in the Spadra Basin will be discussed further in *Section 2.2.3.7*.



Open Cleanup Sites Potentially Impactive Groundwater Supplies

Status

- Active Case - Remediation
- Active Case - Site Assessment
- Active Case - No Specified Action
- Active Case - Verification Monitoring
- Inactive Case**

*Inactive Cases: Cases where there is no funding or resources available to work on the case.
**Based on State Board's GeoTracker and EnviroStor website as of October 24, 2019

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain
Location Concealed
Location Approximate
Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-27_GeoTrackerEnviron.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Point Source Groundwater Contamination Sites

Open Cleanup Sites in the Spadra Basin

Figure 2-27

2.2.3.5 Perchlorate

Perchlorate is a regulated drinking-water contaminant in California with a primary MCL of 6 µgl. Figure 2-26 displays the areal distribution of the maximum perchlorate concentration at wells in the Spadra Basin from 2000 to 2019. During this period, 15 of the 39 wells with water-quality data were sampled for perchlorate, and perchlorate concentrations exceeded the primary MCL at 4 (27 percent) of the wells sampled. Perchlorate sources in groundwater can include: (i) synthetic perchlorate, such as ammonium perchlorate used in the manufacturing of solid propellants used for rockets, missiles, and fireworks and (ii) natural perchlorate, such as that derived from Chilean caliche that was used as a fertilizer. It is known that Chilean nitrate fertilizer was used in Southern California in the early 1900s for the citrus industry, which covered the eastern and western portions of the Spadra Basin as shown in Figure 2-5. While Chilean nitrate fertilizer is no longer used, and citrus farming is almost non-existent today in the Spadra Basin, like nitrate, the legacy of perchlorate contamination in groundwater still exists[8].

In 2015, the California Office of Environmental Health Hazard Assessment (OEHHA) lowered the public health goal (PHG) for perchlorate from 6 to 1 µgl, which prompted the DDW to initiate a process to evaluate the current MCL of 6 µgl. The State Water Board approved a July 2017 DDW recommendation to lower the detection limit for the purposes of reporting (DLR) to 1 µgl to gather state-wide occurrence data and use this to support a potential MCL revision. Perchlorate data has not been collected in every pumping well in Spadra Basin, and at the pumping wells that have been sampled the perchlorate concentrations are above the new PHG, and most are above the MCL. Because of the historical citrus farming in the Spadra Basin and a potential lowering of the MCL by the DDW, perchlorate is a contaminant of concern in the Spadra Basin that could impact the beneficial uses of groundwater.

2.2.3.6 1,2,3-Trichloropropane

1,2,3-Trichloropropane (1,2,3-TCP) is a newly regulated contaminant in California with a Primary MCL of 0.005 µgl, which was adopted and immediately effective in December 2017. 1,2,3-TCP was used historically as a solvent, an extractive agent, a paint remover, a cleaning and degreasing agent, and in the manufacturing of soil fumigants used for agriculture including citrus farming. During the period of 2000 to 2019, all of the 29 wells sampled for 1,2,3-TCP were non-detect for the contaminant, however all but two of the wells were sampled using laboratory methods with a DLR equivalent to, or lower than, the MCL of 0.005 µgl. The range in the DLR of the laboratory methods used to test for 1,2,3-TCP ranged from 0.5 to 100 µgl, equivalent to 100 to 20,000 µgl times the MCL – thus the occurrence of 1,23-TCP relative to the regulatory standard cannot be characterized. Because of the history of citrus and crop farming, and the existence of point-source contaminant sites related to solvent use, 1,2,3-TCP is a potential contaminant of concern in the Spadra Basin that could impact the beneficial uses of the groundwater.

2.2.3.7 Point-Source Contamination in the Spadra Basin

The State Water Board's GeoTracker databases and California Department of Toxic Substances Control (DTSC) EnviroStor database were queried to determine if there are any point-source contaminant sites with open cases for the monitoring and cleanup of groundwater within and adjacent to the Spadra Basin. Sites listed on GeoTracker and EnviroStor that contained no information about the contamination source, contaminants of concern, or contaminated media, were not further investigated, as well as sites where

8 The CBWM conducted a study analyzing the stable isotopes of oxygen and chlorine from perchlorate in samples from groundwater wells in west and central Chino Basin. This study concluded that Chilean fertilizer was the source of perchlorate in those portions of Chino Basin. The results of the study were not published by the CBWM.

the contaminated media is only soil. Figure 2-27 shows the general location of the point-source contaminant sites identified, categorized by investigation status. Three sites within the Spadra Basin were identified on GeoTracker and EnviroStor that have monitoring data and information indicating a potential impact to groundwater quality: the Teledyne Cast Parts, the Spadra Landfill, and Calsol Inc. These three sites are described below using the resources available on GeoTracker and EnviroStor for these sites.[9]

2.2.3.7.1 Teledyne Cast Parts

The Teledyne Cast Parts site (GeoTracker Case ID: SL0603791177), located at 4200 West Valley Boulevard in Pomona, is an approximately 12-acre facility operated by Consolidated Foundries Incorporated (CFI) for the manufacturing of aluminum and magnesium casting parts for the commercial and military aircraft industries. In 2000, CFI acquired the site from Teledyne Cast Parts who operated the facility since 1971. Teledyne Cast Parts documented the stockpiling of casting sands generated during casting processes. At the request of the LA Regional Board, the stockpiles were removed between 1994 and 1997 and initial site investigations began in 1990 with soil sampling. PCE and TCE were detected in soil samples at concentrations up to 630 to 11,000 micrograms per kilogram (µg/kg). In 1992, groundwater sampling was required in the investigation, including the installation of four on-site monitoring wells. Groundwater quality monitoring was conducted from 1994 to 2013. PCE and TCE were the primary volatile organic compound (VOC) contaminants detected in one of the four monitoring wells at concentrations up to 64.2 and 28.6 µgl, respectively. Additionally, cis-1,2 dichloroethene (cis-1,2 DCE) and vinyl chloride were detected in one of the four monitoring wells at concentrations up to 12 µgl and 6.4 µgl, respectively. A soil vapor extraction (SVE) system pilot study was conducted by PES Environmental in 2000 and by Environ in 2012. A full-scale SVE system was operated from December 2012 through September 2013.

In August 2014, CFI requested closure of the site by the LA Regional Board, and in 2017 submitted additional monitoring documentation as requested by the LA Regional Board to prepare for closure. According to the 2017 report, TCE and cis-1,2 DCE were detected at one of the four monitoring wells at concentrations of 3.8 and 3.5 µgl, respectively, both of which are below their respective MCLs. There have been no updates from the LA Regional Board or CFI regarding the potential site closure since 2017.

2.2.3.7.2 Spadra Landfill

The Spadra Landfill (GeoTracker Case ID: L10001382782) is about 300 acres in size and is located at 4125 West Valley Boulevard in Pomona adjacent to the Spadra Basin. The site is owned and operated by the LACSD. The landfill opened as a Class II municipal solid waste disposal facility in 1957 and was certified as closed in 2002. Post-closure monitoring includes collecting groundwater-quality samples from 17 monitoring wells constructed adjacent to and within the Spadra Basin.

Groundwater monitoring began in 1994. VOCs were detected at three of the monitoring wells, and in 2000 it was concluded that the VOCs entered the groundwater due to contact with gas from the landfill, and that groundwater outside of the landfill had not been impacted. VOCs detected included: benzene, chlorobenzene, chloroform, o-dichlorobenzene, p-dichlorobenzene, 1,1-dichloroethane (DCA), 1,2-dichloroethane, 1,1--dichloroethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,2-dichloropropane, ethylbenzene, Freon-11, methylene chloride, PCE, TCE, toluene, and vinyl chloride. To address these detections, in 2001 the LACSD began operating groundwater extraction wells to capture contaminated groundwater from

[9] Teledyne Cast Parts at Geotracker; Spadra Landfill at Geotracker; Calsol Inc. at Envirostor

beneath the site. Pumped groundwater is treated at an air-stripper treatment facility onsite and discharged to the sewer system under an industrial wastewater discharge permit.

Post-closure monitoring includes collecting groundwater-quality samples from 17 monitoring wells constructed adjacent to and within the Spadra Basin. During the May 2019 sampling event, the following VOCs were detected in monitoring wells: cis-1,2-dichloroethene, 1,4-dioxane, DCA, PCE, TCE, chloroform, and vinyl chloride.

In May 2019, the LACSD submitted a work plan for assessing per- and polyfluoroalkyl substances (PFAS) at the landfill. This sampling is planned to occur concurrently with the existing semi-annual sampling (May and November of each year).

2.2.3.7.3 Calsol Inc.

The former Calsol Inc. facility (Envirostor Site Code: 60000137) is a 1.2-acre lot located at the southwest corner of the intersection of Hamilton Boulevard and Commercial Street in Pomona. Calsol Inc. was a solvent distributor and hazardous waste generator of waste oil, mixed oil, and liquids with halogenated VOCs. In 1997, initial investigations identified that soil, soil vapor, and groundwater were impacted with VOCs, specifically PCE and TCE. This was attributed to an accident that occurred in 1976 between a city refuse truck and a train, that resulted in damage to an above-ground storage tank and subsequent release of up to 5,300 gallons of PCE. Secondary sources have also been identified on the site as a result of site operations, which included 23 fuel and solvent storage tanks (above- and below-ground).

A removal action workplan was submitted to and approved by the California Department of Toxic Substances (DTSC) in 2016. The workplan recommended the operation of an SVE system after the successful implementation of two SVE pilots from 2015-2016. At the time the workplan was submitted, groundwater sampling had been minimal and the workplan required quarterly monitoring for a year to better understand the impacts of VOCs in groundwater and the connection between a perched aquifer and a "basal" aquifer. The quarterly groundwater monitoring conducted from 2016-2017, and subsequent semi-annual sampling show elevated concentrations of PCE, TCE, and 1,1-DCE at onsite and offsite monitoring wells. During the latest sampling event in March 2019, the following constituents were detected (maximum concentration detected): PCE (1,400 µgl), TCE (1,900 µgl), 1,1-DCE (51 µgl), and methyl tert-butyl ether (MTBE) (21 µgl).

As of March 2019, the SVE system is still in operation and quarterly groundwater sampling continues. To date, an estimated total of 6,800 pounds of VOCs have been removed by the SVE system.

2.2.4 Ground Levels

Vertical ground motion, in the form of subsidence and rebound of the land surface, occurs in all groundwater basins as groundwater levels change within the underlying aquifer system. This process has occurred in the Spadra Basin, as well as in the adjacent groundwater basins, such as well-documented occurrences in the Chino Basin (WEI, 2019). It is important to understand and monitor vertical ground motion because land subsidence can cause damage to vulnerable infrastructure at the surface.

Although drawdown of groundwater levels is the driving force that causes land subsidence due to groundwater pumping, the geology of a groundwater basin also plays an important role in this process. Clay layers within the aquifer-system are relatively compressible materials. Therefore, aquifer-systems

that contain thick and/or numerous clay layers are most susceptible to land subsidence or rebound when groundwater is extracted or recharged.

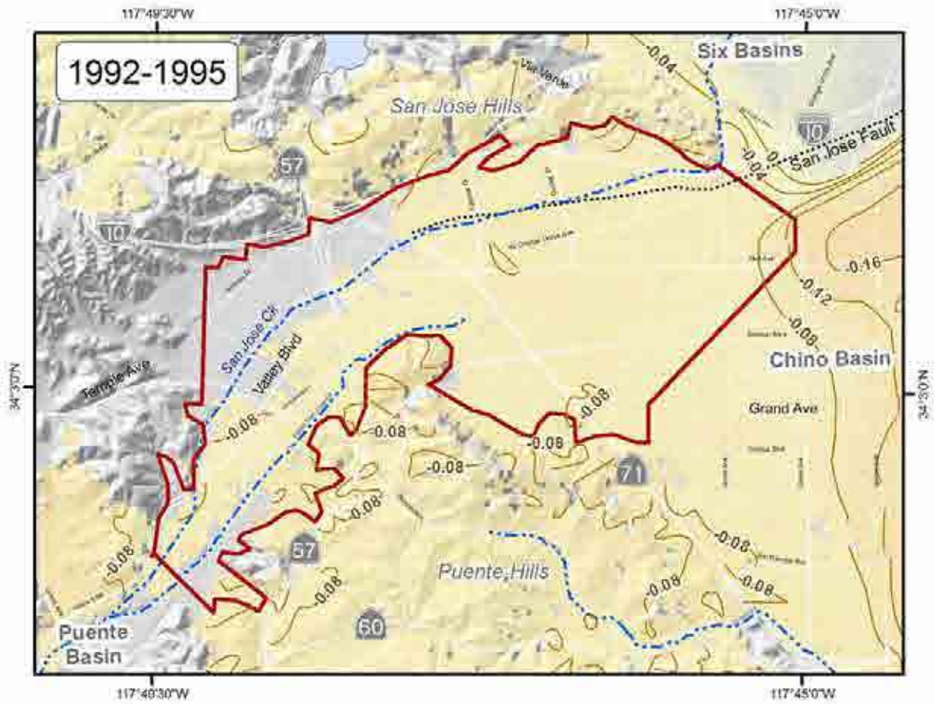
The process that describes pumping-induced land subsidence is termed the "aquitard-drainage model." Simply stated, an aquifer system consists of permeable sand and gravel layers interbedded with less-permeable silt and clay layers. The sand and gravel layers are the "aquifers" and groundwater flows through the aquifers toward pumping wells. The silt and clay layers are the "aquitards." Pumping wells cause groundwater-level drawdown in the aquifers which, in turn, cause the aquitards to slowly drain into the aquifers. The draining allows aquitard pore pressures to decay toward equilibrium with the reduced pore pressures in the adjacent aquifers. Since the pressure of the pore water provides some internal support for the sedimentary structure of the aquitards, this loss of internal support causes the aquitards to compress, resulting in subsidence at the land surface. When the pumping wells turn off, and groundwater levels recover in the aquifers, groundwater migrates back into the aquitards and they expand, resulting in rebound at the land surface. Over a limited range of seasonal groundwater-level fluctuations, this process can occur in a purely elastic fashion. That is, a recovery of groundwater levels to their original values causes the land surface to rebound to its original elevation. However, when drawdown falls below a certain "threshold" level, elastic compression transitions to a non-recoverable inelastic compaction of the aquitards, resulting in permanent land subsidence. The "threshold" level, referred to as the "preconsolidation stress," is taken to be the maximum past stress to which the sedimentary structure had previously equilibrated under the gradually increasing load of accumulating sediments.

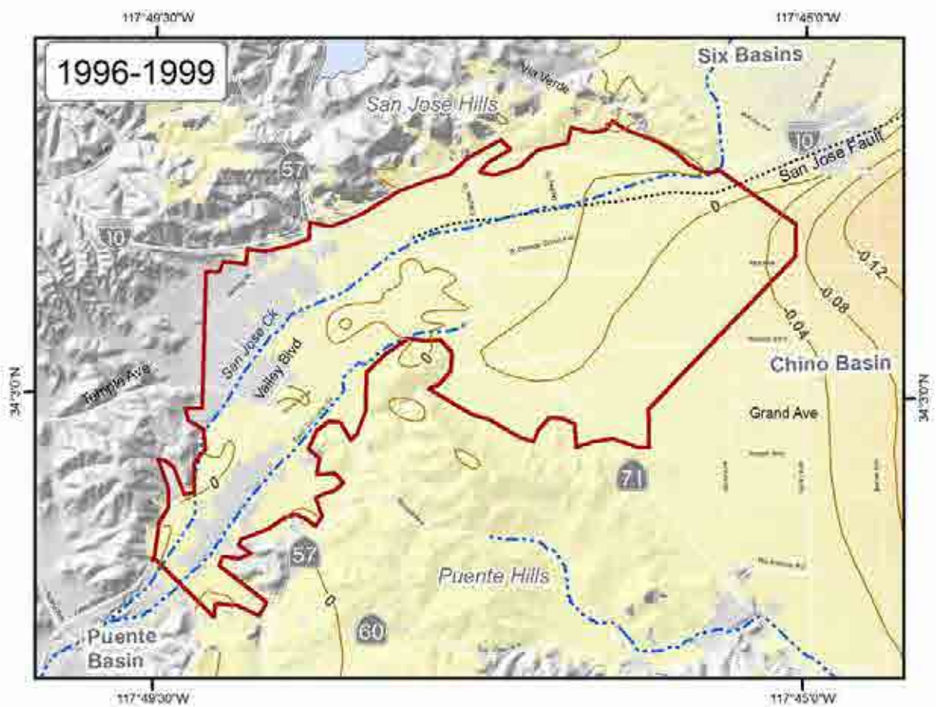
The hydrogeologic cross-sections in Figures 2-15a-e show that the aquifer system in Spadra Basin contains numerous aquitard lenses of varying thickness that could be susceptible to compaction via the aquitard-drainage model. However, the Spadra Basin is a relatively thin aquifer system which limits the potential magnitude of aquitard compaction and land subsidence that could occur.

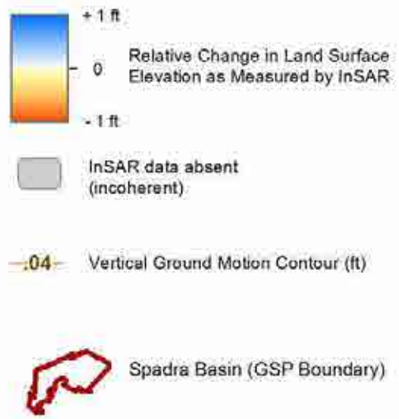
Aquitard drainage, and the resultant deformation of the ground surface, has been well documented in the Chino Basin where ground fissures damaged overlying infrastructure in the City of Chino in the early 1990s (WEI, 2006). The CBWM has conducted extensive studies of the process, and based on those studies, developed a subsidence management plan to minimize or abate the occurrence of subsidence and ground fissuring in the Chino Basin (CBWM, 2015). Currently, the CBWM's efforts are focused on developing a specific subsidence management plan for "Northwest MZ-1 Area", which is the area of the Chino Basin directly adjacent to the Spadra Basin.

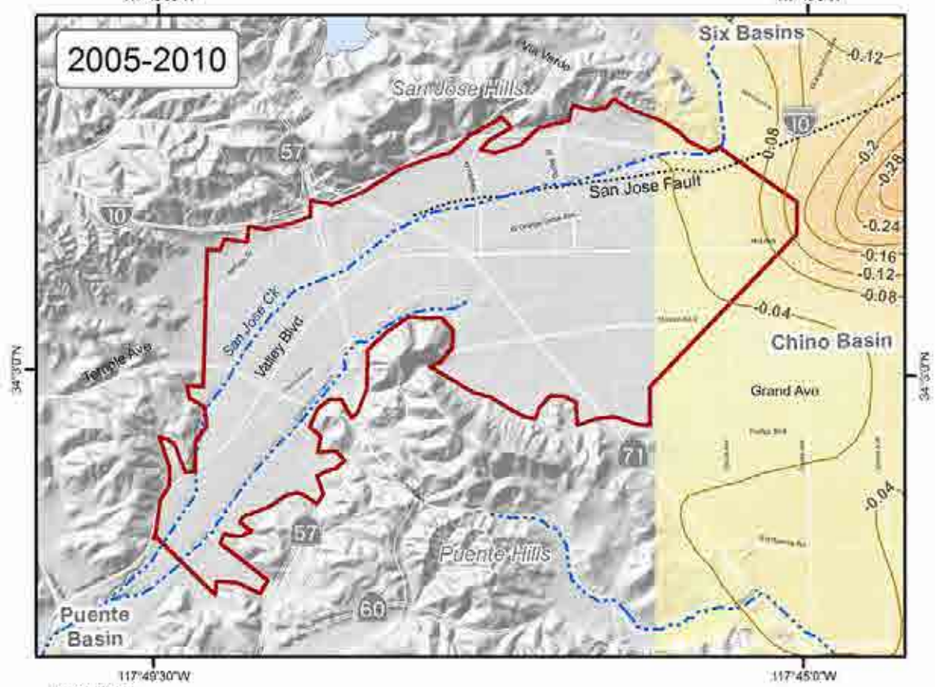
Part of the Chino Basin CBWM's subsidence management plan is to conduct ongoing monitoring of ground motion by Synthetic Aperture Radar Interferometry (InSAR), which is a method that utilizes radar imagery from an Earth-orbiting satellite to map ground motion over time. The CBWM determines the scope of its monitoring efforts annually. The InSAR data collected and utilized in the subsidence studies in Chino Basin cover portions of the Spadra Basin as well. These InSAR estimates are the most complete and accurate record of vertical ground motion available for the Spadra Basin.

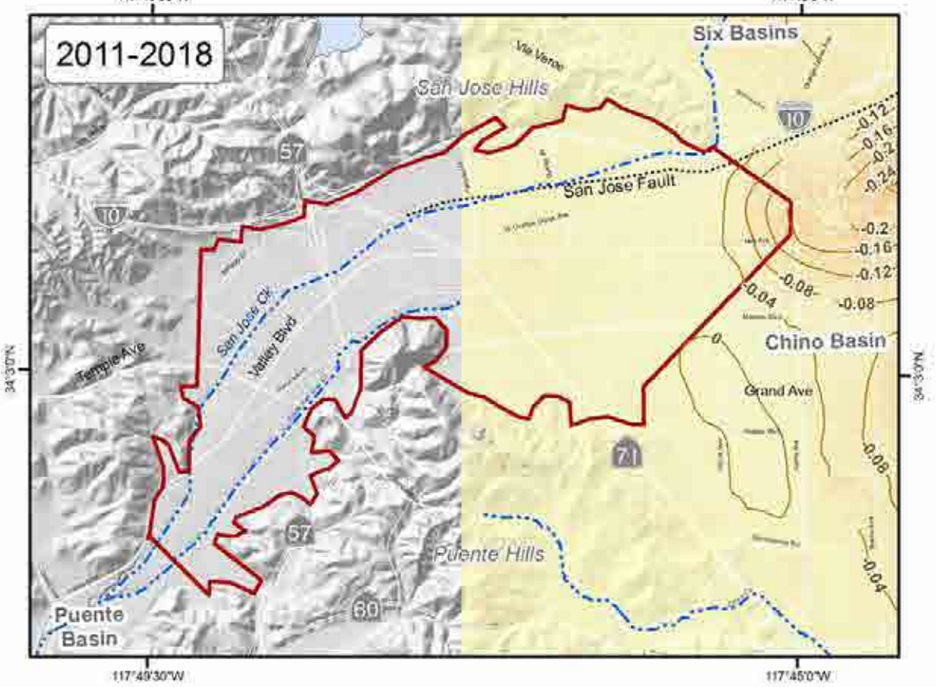
Figure 2-28 includes a series of maps that display the InSAR estimates of vertical ground motion across the Spadra Basin for the periods 1992-1995, 1996-1999, 2005-2010, and 2011-2018. The maps indicate that downward ground motion has occurred across the Spadra Basin over the period of record, even though groundwater levels have remained relatively stable over the same period (see Figure 2-19).











Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 11/5/2019
File: Fig2-28_Vertical_Ground_Motion.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN

Vertical Ground Motion
Various Years, 1992 - 2019

Figure 2-28

Figure 2-28 shows that the same gradual and persistent downward ground motion has occurred in the adjacent areas of the Chino Basin, although the magnitude of downward ground motion has been comparatively much less in the Spadra Basin. As in the Spadra Basin, groundwater levels in this part of the Chino Basin have been relatively stable or increasing during the 1992-2018 period. The CBWM (2019) states that a plausible explanation for the gradual and persistent downward ground motion is that thick, slow-draining aquitards are permanently compacting in response to the historical declines in groundwater levels that occurred between 1930 and 1978. This same process could explain the downward ground motion observed in the Spadra Basin from 1992 to 2018, but not enough data and information are available to confirm.

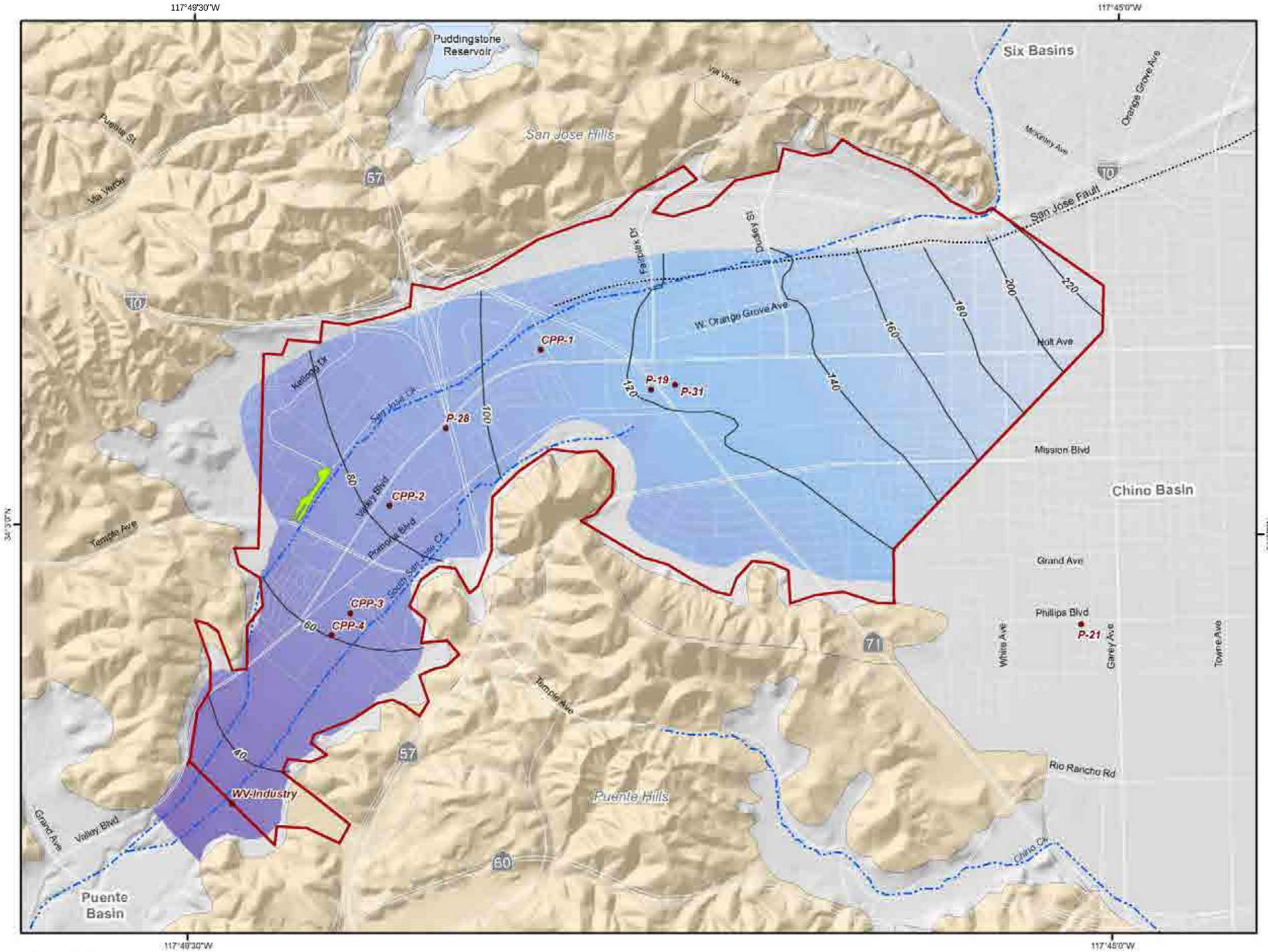
The aquifer systems of the Chino Basin and Spadra Basin are connected across their common boundary. Changes in groundwater levels within one basin could cause changes in groundwater levels in the other, which could lead to aquitard drainage and associated land subsidence. Therefore, land subsidence is a potential undesirable result of groundwater management practices in both basins and should be a factor of consideration in the development and implementation of groundwater management plans in both basins.

2.2.5 Surface Water and Groundwater Dependent Ecosystems

The GSP Regulations require that GSPs identify Groundwater Dependent Ecosystems (GDEs), and where appropriate, consider the potential impacts on GDEs. GDEs are defined in the GSP Regulations as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." Figure 2-29 is a map of depth-to-groundwater in the Spadra Basin in 2008, a period of highest recorded groundwater levels. Depth-to-groundwater in 2008 ranged from a maximum of about 220 ft-bgs in the eastern portion of the Spadra Basin to a minimum of about 40 ft-bgs at the western margin of the basin. Maximum rooting depths for vegetation in GDEs is typically less than 30 ft-bgs. Because depth-to-groundwater is greater than 40 ft-bgs, and because all stream channels in Spadra Basin are concrete-lined, there appears to be no areas of interconnected groundwater and surface-water or swallow groundwater in the Spadra Basin that are supporting GDEs in the Spadra Basin.

On the DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset map viewer of GDEs[10] there is one small area mapped as a vegetation type commonly associated with the sub-surface presence of groundwater (mapped vegetated area). The mapped vegetated area is shown on Figure 2-29 and includes the dominant species California Sycamore (*Platanus racemose*) The NCCAG data set is to be used as a starting point to identify GDEs with a groundwater basin and should be researched and verified using local knowledge.

[10] The NCCAG data set NC Dataset Viewer is a compilation of 48 publicly available State and federal agency datasets that map vegetation, wetlands, springs, and seeps in California, developed through a screening process by a working group comprised of DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy.



Estimated Depth to Groundwater

0 ft-bgs

120

240 ft-bgs

Active Production Wells

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Area identified in the NCAAG data set as a vegetation type commonly associated with the sub-surface presence of groundwater - dominant species California Sycamore

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: LH
Date: 1/8/2020
File: Fig2-29_GWDepth_2008_Raster.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN

Shallowest Depth to Groundwater

Fall 2008

Figure 2-29

The Sycamore trees in mapped vegetated area are located on the northern side of the concrete-lined San Jose Creek and appear to be part of the irrigated urban landscaping along both sides of Campus Drive between Temple Avenue and Kellogg Drive. The estimated depth to groundwater in this mapped vegetated area is greater than 40 ft-bgs, which is likely too deep to support the Sycamores that typically have rooting depths of less than 10 ft-bgs. Additionally, San Jose Creek is concrete lined along its entire reach within the Spadra Basin and therefore cannot provide recharge to support riparian vegetation. These observations indicate that the mapped vegetative area is not a GDE.

Notwithstanding the above observations, the Spadra GSA will continue to refer to additional resources and local knowledge to identify potential GDEs in the Spadra Basin, and if appropriate, consider the impacts to GDEs in the final GSP

2.2.6 Water Budget

23 CCR § 354.18 of the GSP Regulations requires that each GSP include a water budget for the basin, reported in tabular and graphical form, for historical, current, and projected conditions. The water budget is the annual accounting of specific components of recharge to and discharge from the groundwater system and the resultant changes of groundwater in storage. When total recharge is equal to total discharge, there is no change in groundwater storage, indicating that the aquifer system is at equilibrium or steady state. When total recharge does not equal the total discharge, there is either an increase in storage or a decrease in storage, which results in a change in groundwater levels. The water budget is transient over time, and can be affected by short-term weather events, long-term climatic trends, overlying land uses, outdoor water uses, water disposal practices, groundwater pumping, groundwater management activities in adjacent basins, and artificial recharge activities. Understanding of the water budget for a groundwater basin is key to the development of sustainable management criteria and management practices.

Water budgets for the Spadra Basin were estimated using the numerical Spadra Basin Groundwater Model that was developed from the hydrogeologic information described in this *Basin Setting* section of this GSP and then calibrated to refine the aquifer-system properties. The construction and calibration of the Spadra Basin Groundwater Model is described in a technical memorandum that went through the stakeholder review process and is included as Appendix I of this GSP. The historical and current water budget spans the model calibration period of 1978-2018. The "current" water budget conditions are considered to be 2018 conditions. Future water budgets were estimated from subsequent model- simulations over the 60-year planning horizon of 2019-2079 for baseline conditions and for the three planning scenarios that were evaluated in the development of this GSP. (see *Section 5 Projects and Management Actions to Achieve Sustainability).*

2.2.6.1 Historical and Current Water Budget

This section describes the historical water budget for the Spadra Basin for the period of 1978-2018, prepared or the calibration period for the Spadra Basin Groundwater Model (see Appendix I). Table 2-6 lists the various methods that were used to estimate the historical water budget for the Spadra Basin, which include measured data, model estimates, information from prior investigations, or a combination of these methods. Table 2-7 lists the annual volumes of each water-budget component and the annual change in groundwater storage. The measured data that were used to estimate certain water-budget components, such as groundwater pumping, are described in previous sections of the Basin Setting. The models used to estimate other water-budget components are described in Appendix I.

Table 2-6. Methods, Data, and Information Used to Estimate the Water Budget for the Spadra Basin

	Method Used to Estimate Water Budget Component (Measurement, Model, or Both)	Data/Information Used in the Development of Recharge and Discharge Components							
		Land use	Hydrologic Soil Type	Surface Water Drainage System	Measured Surface Water Discharge	Measured Precipitation	Measured ET and Evaporation	Metered Groundwater Pumping	Measured Water Level at Wells
Recharge Component									
Subsurface inflow from adjacent hills and mountains	Model	◆	◆	◆	◆	◆	◆		
Deep infiltration of precipitation and applied water	Model	◆	◆	◆	◆	◆	◆		
Discharge Component									
Subsurface outflow to adjacent groundwater basins	Both, and prior information[(a)]								◆
Groundwater pumping	Measurement							◆	
Evapotranspiration (ET)	Both	◆	◆			◆	◆		

(a) Prior information is derived from prior investigations.

Table 2-7. Water Budget for the Spadra Basin -- Fiscal Year 1978-2018

Fiscal Year	Recharge			Discharge				Change in Storage (Recharge - Discharge)		Annual Developed Yield
	DIPAW[(a)]	Subsurface Inflow from San Jose and Puente Hills	Total Recharge	Pumping	Outflow to Puente Basin	Outflow to Chino Basin	Total Discharge	Annual	Cumulative	
				a				*b*		*a + b*
1978	2,961	1,504	4,465	1,402	1,336	950	3,689	777	777	2,179
1979	3,076	1,527	4,604	937	1,769	446	3,151	1,452	2,229	2,389
1980	3,161	1,636	4,797	1,188	1,819	293	3,300	1,497	3,726	2,685
1981	3,114	1,665	4,779	1,544	1,786	384	3,714	1,066	4,792	2,610
1982	3,107	1,657	4,764	1,344	1,871	434	3,649	1,115	5,907	2,460
1983	3,430	1,621	5,051	1,752	2,019	482	4,253	798	6,706	2,550
1984	3,353	1,545	4,898	1,189	2,000	529	3,718	1,179	7,885	2,369
1985	2,984	1,367	4,351	1,805	1,899	648	4,352	0	7,884	1,804
1986	2,992	1,451	4,442	2,133	1,827	699	4,658	-216	7,668	1,917
1987	2,722	1,337	4,059	2,159	1,774	685	4,617	-559	7,110	1,600
1988	2,827	1,142	3,969	1,934	1,746	655	4,335	-366	6,744	1,568
1989	2,791	1,140	3,931	1,615	1,768	677	4,060	-129	6,615	1,486
1990	2,412	1,085	3,496	1,388	1,785	639	3,812	-316	6,299	1,073
1991	2,315	955	3,270	999	1,721	520	3,240	31	6,330	1,029
1992	2,386	1,078	3,464	910	1,740	449	3,099	365	6,694	1,274
1993	2,429	1,126	3,555	1,129	1,578	434	3,141	414	7,108	1,543
1994	2,374	1,048	3,422	872	1,599	483	2,953	469	7,578	1,341
1995	2,323	1,163	3,485	1,175	1,491	504	3,171	314	7,892	1,490
1996	2,272	1,195	3,467	1,266	1,499	661	3,426	41	7,933	1,307
1997	2,375	1,151	3,527	1,351	1,481	684	3,516	11	7,944	1,362
1998	2,602	1,178	3,780	1,101	1,584	699	3,384	396	8,340	1,497
1999	2,445	1,172	3,617	1,025	1,560	600	3,185	432	8,772	1,457
2000	2,292	1,114	3,406	1,106	1,483	727	3,316	90	8,862	1,196
2001	2,366	1,127	3,493	2,096	1,431	730	4,257	-765	8,097	1,332
2002	2,201	996	3,197	1,735	1,202	633	3,569	-372	7,725	1,362
2003	2,204	823	3,027	1,409	1,062	616	3,086	-59	7,665	1,350
2004	2,087	842	2,929	1,552	1,065	616	3,233	-304	7,361	1,248
2005	2,096	997	3,093	1,496	1,124	554	3,174	-82	7,280	1,415
2006	2,113	950	3,063	1,039	1,271	481	2,791	272	7,551	1,311
2007	1,974	940		1,177	1,159	238	2,573	341	7,892	1,517
2008	1,938	935	2,873	1,082	1,182	398	2,662	211	8,103	1,293
2009	1,974	940	2,914	834	1,335	558	2,726	188	8,291	1,021
2010	1,977	802	2,779	887	1,272	630	2,789	-10	8,281	877
2011	2,073	884	2,958	788	1,457	561	2,806	151	8,432	939
2012	1,789	891	2,680	764	1,368	459	2,591	90	8,522	854
2013	1,712	819	2,531	1,001	1,253	496	2,750	-218	8,303	783
2014	1,721	766	2,487	1,180	1,060	590	2,829	-342	7,961	838
2015	1,663	669	2,332	865	1,100	609	2,574	-242	7,719	623
2016	1,613	549	2,163	602	1,215	560	2,377	-214	7,505	387
2017	1,625	659	2,284	809	1,208	425	2,442	-158	7,347	651
2018	1,475	653	2,128	986	1,065	335	2,386	-258	7,089	728
Statistics for the Calibration Period 1978 through 2018										
Minimum	1,475	549	2,128	602	1,060	238	2,377	-765		387
Average	2,374	1,100	3,474	1,259	1,487	555	3,301	173		1,432
Maximum	3,430	1,665	5,051	2,159	2,019	950	4,658	1,497		2,685
Total	97,345	45,100	142,445	51,624	60,959	22,774	135,356	7,089		58,713

2.2.6.1.1 Recharge Components

The recharge components for the Spadra Basin are listed in Table 2-7 for the calibration period and are characterized below:

Deep infiltration of precipitation and applied water (DIPAW). The Hydrological Simulation Program-FORTRAN (HSPF) and R4 watershed models were used to estimate surface water discharge from precipitation throughout the Spadra Basin watershed and the DIPAW from the soil (root) zone. The data requirements of these models include the following: land use and associated properties (imperviousness, irrigation practices), hydrologic soil type, topography, surface water drainage system (channel alignment, hydraulic properties and operating schemes), surface water discharge measurements (boundary inflows), precipitation, and evapotranspiration (ET) and evaporation. Recharge from DIPAW ranged from about 1,475 to 3,430 afy and averaged about 2,374 afy over the calibration period.

Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose and Puente Hills). The model estimated DIPAW for watersheds that are tributary to and not overlying the groundwater basin was assumed to be the subsurface inflow from these areas to the Spadra Basin proximate to the discharge point of the watershed to the groundwater basin. Surface water discharges estimated by these models were routed through the stream systems that overlie the active Spadra Basin domain. Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills ranged from about 549 to 1,665 afy and averaged about 1,100 afy over the calibration period.

Subsurface inflow from the Six Basins across the San Jose Fault. Subsurface inflow from the Six Basins across the San Jose Fault is a possible source of recharge to the Spadra Basin. Eckis (1933) speculated that this inflow could be, at least in part, responsible for the existence of the groundwater divide that separates the Spadra Basin from the Chino Basin. However, the gap between the San Jose Fault and San Jose Hills, where such subsurface inflow could occur, is small, and there is a paucity of hydrogeologic data in this area to characterize how such inflow occurs. For these reasons, subsurface inflow from the Six Basins was assumed to be negligible in this modeling effort.

Deep infiltration of septic tank discharge. Wastewaters generated within the Spadra Basin are almost entirely conveyed to the Pomona Water Reclamation Plant for treatment. Therefore, the deep infiltration of septic tank discharge was assumed to be negligible in this modeling effort.

Table 2-7 shows that average recharge to the Spadra Basin was estimated to be about 3,474 afy over the period of 1978-2018.

2.2.6.1.2 Discharge Components

The discharge components for the Spadra Basin are listed in Table 2-7 for the calibration period and are characterized below:

- **Groundwater pumping from wells**. This discharge component was estimated based on the records of major groundwater producers in the Spadra Basin (Pomona, WVWD, and the CPP). Groundwater pumping ranged from about 602 to 2,159 afy and averaged about 1,259 afy over the calibration period.

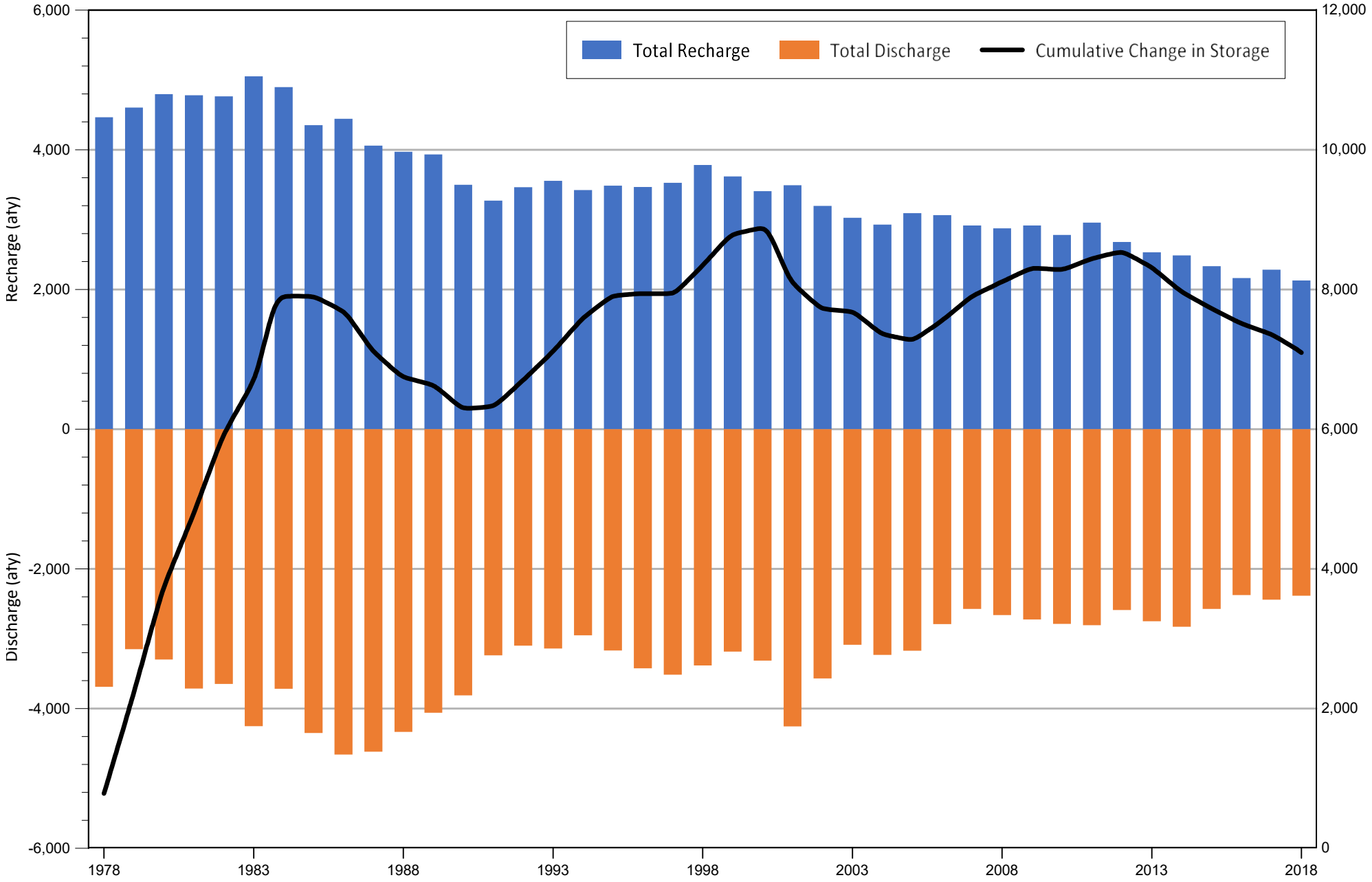
- **Subsurface outflow to the Puente Basin**. Subsurface outflow to the Puente Basin occurs through the saturated sediments in the bedrock narrows at the southwestern boundary of the Spadra Basin. The outflows were estimated by the Spadra Basin Groundwater Model based on a historical time series of groundwater elevations at a well located near the boundary and the calibrated hydraulic conductivities in the Spadra Basin adjacent to the boundary as described in Appendix I. The boundary was treated as a variable-head boundary during model calibration. Subsurface outflow to the Puente Basin ranged from about 1,060 to 2,019 afy and averaged about 1,487 afy over the calibration period.
- **Subsurface outflow to the Chino Basin**. Subsurface outflow to the Chino Basin occurs within the saturated sediments across the eastern boundary of the Spadra Basin, which is the adjudicated Chino Basin boundary. The outflows were estimated by the Spadra Basin Groundwater Model during model calibration. Subsurface outflow to the Chino Basin ranged from about 238 to 950 afy and averaged about 555 afy over the calibration period.
- **Rising Groundwater Outflow and Evapotranspiration**. Measured groundwater levels and model-simulated groundwater levels during model calibration never rise to closer than 30 ft from the ground surface in the Spadra Basin, so there is no discharge due to rising groundwater outflow. In addition, there are no Groundwater Dependent Ecosystems (GDEs) within the Spadra Basin, so there is no discharge due to evapotranspiration.

Table 2-7 shows that average discharge from the Spadra Basin was estimated to be about 3,300 afy over the calibration period 1978-2018.

2.2.6.1.3 Change in Groundwater Storage

Table 2-7 lists the annual and cumulative change in groundwater storage over the calibration period as estimated from the water budget. Figure 2-30 is a time-history chart that shows annual recharge, annual discharge, and the cumulative change in storage for 1978-2018. The cumulative change in storage over this period was +7,089 af. This table and figure indicate that the water budget, and hence the changes in storage, were primarily driven by climatic conditions and changes in groundwater production. For example, groundwater storage increased by about 8,000 af during the 1978-83 wet period, primarily because recharge (DIPAW and subsurface inflow from the surrounding mountains and hills) was higher than discharge (pumping and subsurface outflow). From 1984 to 2018, recharge was approximately equal to discharge, annual changes in storage were relatively small, and total groundwater in storage remained relatively stable. This relative balance persisted even during the long-term dry period from 1999-2018, primarily because of reduced groundwater pumping. These model-estimated changes in storage are consistent with the measured changes in groundwater elevations across the Spadra Basin as described in *Section 2.2.2.11 Groundwater Level and Storage* (see Figure 2-19 and 2-20).

Figure 2-30. Total Recharge, Discharge, and Change in Storage in the Spadra Basin During the Calibration Period (1978-2018)



WEST YOST

954-80-20-01 GRAPHER\GRF\TMs\TM5\Figure 2-30

2.2.6.1.4 Sustainable Yield

The term Sustainable Yield is central to SGMA and is defined as the maximum quantity of water that can be withdrawn annually from a groundwater supply without causing Undesirable Results. The water budget in Table 2-7 shows the annual "developed yield" of the Spadra Basin. Developed yield is equal to groundwater production plus the change in storage. Developed yield is an estimate of net inflow to a basin. Over a representative hydrologic period and under similar conditions of overlying land and water uses, developed yield is an estimate of the Sustainable Yield from the groundwater basin. The average developed yield over the calibration period was about 1,430 afy. This estimate of developed yield is about 170 afy greater than the average pumping from the Spadra Basin over the same period, suggesting that higher Sustainable Yield (sustainable pumping rates) equivalent to the calculated developed yield are possible within the Spadra Basin without causing a decrease in storage or other Undesirable Results that are described in *Section 3 Sustainable Management Criteria*.

2.2.6.2 Future Water Budget

Potential future water budgets over the 60-year planning horizon of 2019-2079 were developed for a Baseline Scenario of future conditions in the Spadra Basin and for three Basin Optimization Scenarios (planning scenarios with combinations of conceptual projects and management plans to achieve long-term sustainability in the Spadra Basin and maximize the beneficial use). The model-evaluation of these future scenarios and the resulting water budgets are described in *Section 5 Projects and Management Actions to Achieve Sustainability.*

2.2.7 Data Gaps

Section §354.12 of the GSP Regulations requires the identification of "data gaps" and levels of uncertainty in the description of the Basin Setting. A "data gap" refers to a lack of information that significantly affects the understanding of the basin setting or the future evaluation of the efficacy of GSP implementation to sustainably manage the basin.

The Basin Setting description above has revealed potential data gaps that may need to be filled as part of GSP implementation to improve the monitoring network. A preliminary list and description of the data gaps is listed below.

- There is a lack of hydrogeologic data and information to describe the groundwater interactions between the Spadra Basin, Six Basins, and Chino Basin. The Basin Setting describes: (i) the important role of the Six Basins as a potential source of recharge to the Spadra Basin just south of the eastern tip of the San Jose Hills and (ii) the transient groundwater divide that separates the Spadra Basin from the Chino Basin from the San Jose Hills to the Puente Hills. Understanding the geologic and current/future groundwater conditions in this area will likely be critical to assessing the long-term sustainable management of the Spadra Basin and the potential impacts of Spadra Basin management on the adjacent groundwater basins, and vice versa. There are very few deep boreholes/wells located in this area to characterize the geologic and current/future groundwater conditions, which represents a gap in the monitoring network. A new monitoring well(s) in this area is needed to fill the data gap.
- Historically, groundwater-pumping and groundwater-level data been collected by well owners in the Spadra Basin in an uncoordinated fashion and at a maximum frequency of once per month. Improved methods to measure and record these data at higher frequency and

accuracy will: improve the hydrogeologic conceptual understanding of the aquifer system and the fault barriers, which can be used to improve the Spadra Basin Groundwater Model; provide groundwater-pumping and groundwater-level data of high accuracy and resolution which can be used to improve the Spadra Basin Groundwater Model; support the design of capital facilities associated with GSP implementation, such as new wells and treatment facilities; and support any required monitoring and mitigation requirements associated with GSP projects. These data can be acquired by implementing a coordinated monitoring program that includes the installation of transducers in wells that measure and record high-frequency water-level data and utilizes the supervisory control and data acquisition (SCADA) systems of the well owners.

- Historically, groundwater-quality monitoring in the Spadra Basin has been infrequent and limited in scope. The groundwater-quality analysis in *Section 2.2.3 Groundwater Quality* was not based on a robust data set regarding the number of monitoring locations, the frequency of sample collection, the constituents analyzed, and the laboratory detection limits used. Hence, there is a limited understanding of groundwater-quality conditions and their potential impact on the beneficial uses of the groundwater. For example, perchlorate and 1,2,3-TCP are groundwater contaminants that could have originated from various overlying agricultural and/or industrial land uses. However, both constituents have not been commonly analyzed for using laboratory detection limits equivalent to the regulatory standards. A more robust groundwater-quality monitoring program is necessary to characterize TDS, nitrate, regulated contaminants, and emerging contaminants in the Spadra Basin; assist in the identification of the sources of the contaminants; and assist in the development and evaluation of future treatment and cleanup projects.
- Currently, there is little information on the location and status of private wells in the Spadra Basin, and there is no coordinated monitoring of pumping, groundwater quality, and groundwater levels at the private wells. These data are fundamental to the development and implementation of sustainable groundwater management practices in the Spadra Basin. A private well canvass should be performed, and based on the results of the canvass, a program to collect and compile groundwater data from the private wells may be recommended as part of the GSP monitoring program.
- Currently, there is no coordinated monitoring program of surface-water discharge from storm or dry-weather runoff. These discharges represent a potential source of artificial recharge to the Spadra Basin. A surface-water monitoring program is needed to better characterize the availability and magnitude of these potential sources of recharge.
- Land subsidence has occurred in the Spadra Basin, as well as in the adjacent groundwater basins, particularly the northwestern portion of the Chino Basin. It is important to understand and monitor land subsidence and its causes because it can cause damage to vulnerable infrastructure at the land surface. Currently, the only subsidence monitoring that is ongoing is the CBWM's monitoring of ground motion by InSAR, which is a method that utilizes radar imagery from an Earth-orbiting satellite to map ground motion over time. However, the CBWM's data sets cover only the eastern portion of the Spadra Basin. The CBWM determines the scope of its monitoring efforts annually. The Spadra Basin GSA should consider future subsidence monitoring via InSAR that includes the entire basin. Collaboration with the CBWM's subsidence monitoring program may be the most efficient method to conduct this monitoring effort.

The subsequent development and calibration of the Spadra Basin Groundwater Model (described in Appendix I) also indicated the following areas of uncertainty and data gaps:

- The calibrated model indicates the potential existence of an unmapped hydraulic barrier along the boundary with the Chino Basin which is simulated by very low horizontal hydraulic conductivities. This model conceptualization may not be an accurate representation of the actual hydrogeology of the area. Currently, there is not enough hydrogeologic data in this area to understand the exact location and hydraulic properties of the presumed barrier. Additional hydrogeologic data would need to be acquired in this area to improve the conceptual and numerical models, which may require the construction of new monitoring wells and implementation of a monitoring program.
- The properties of the San Jose Fault and the hydrogeology of the narrow area that separates the Spadra Basin from the Six Basins is not well understood. In addition, there are no wells or water-level observations in this area. This lack of data and hydrogeologic understanding limits the ability to model the subsurface flows between the Six Basins and Spadra Basin with any confidence. Additional hydrogeologic data would need to be acquired in this area to improve the conceptual and numerical models, which may require the construction of new monitoring wells and implementation of a monitoring program.

SECTION 3
Sustainability Management Criteria

3.1 SGMA DEFINITIONS OF SUSTAINABLE MANAGEMENT CRITERIA

SGMA defines sustainable groundwater management as the management and utilization of groundwater in a manner that can be maintained over a 50-year planning horizon without causing "Undesirable Results." The avoidance of Undesirable Results is key to the success of a GSP. To achieve and demonstrate sustainable groundwater management, the SGMA requires that a GSP establishes "Sustainable Management Criteria" for the groundwater basin. These criteria include:

- **A Sustainability Goal**. The goal of a GSP is to achieve sustainable groundwater management. The "Sustainability Goal" is the detailed characterization of the sustainable conditions for the basin and the specific implementation measures that the GSA will implement to ensure the basin is operated within its Sustainable Yield by 2040. "Sustainable Yield" is the maximum annual quantity of groundwater, calculated over a base period representative of long-term conditions in the basin, that can be withdrawn without causing an Undesirable Result.
- **Undesirable Results**. An Undesirable Result is one or more of the following adverse effects caused by groundwater conditions occurring throughout the basin:
  - Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning horizon. A decline in groundwater levels over a period of drought is not sufficient to constitute "chronic lowering" if groundwater pumping and recharge are managed to ensure that the reductions in groundwater levels during the drought are offset by increases during other periods.
  - Significant and unreasonable reduction of groundwater storage. Overdraft (pumping in excess of Sustainable Yield) over a period of drought is not sufficient to constitute a "significant and unreasonable reduction" if groundwater pumping and recharge are managed as necessary to ensure that reductions in storage during the drought are offset by increases in storage during other periods.
  - Significant and unreasonable seawater intrusion.
  - Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
  - Significant and unreasonable land subsidence that substantially interferes with land uses.
  - Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

Because the avoidance of Undesirable Results is the key indicator of sustainable groundwater management for the SGMA, the DWR defines each of the above effects as "Sustainability Indicators." When a Sustainability Indicator becomes "significant or unreasonable," then it is an Undesirable Result. For each Sustainability Indicator, a GSA must describe: (i) the causes that can lead to an Undesirable Result; (ii) the potential effects of the Undesirable Result on the beneficial use and users of groundwater in the basin; and (iii) the criteria used to define when and where the effects of the groundwater conditions cause the Undesirable Result. Undesirable Results must be eliminated or avoided through the implementation of projects and management actions, and the progress toward their elimination or avoidance must be demonstrated with empirical data.

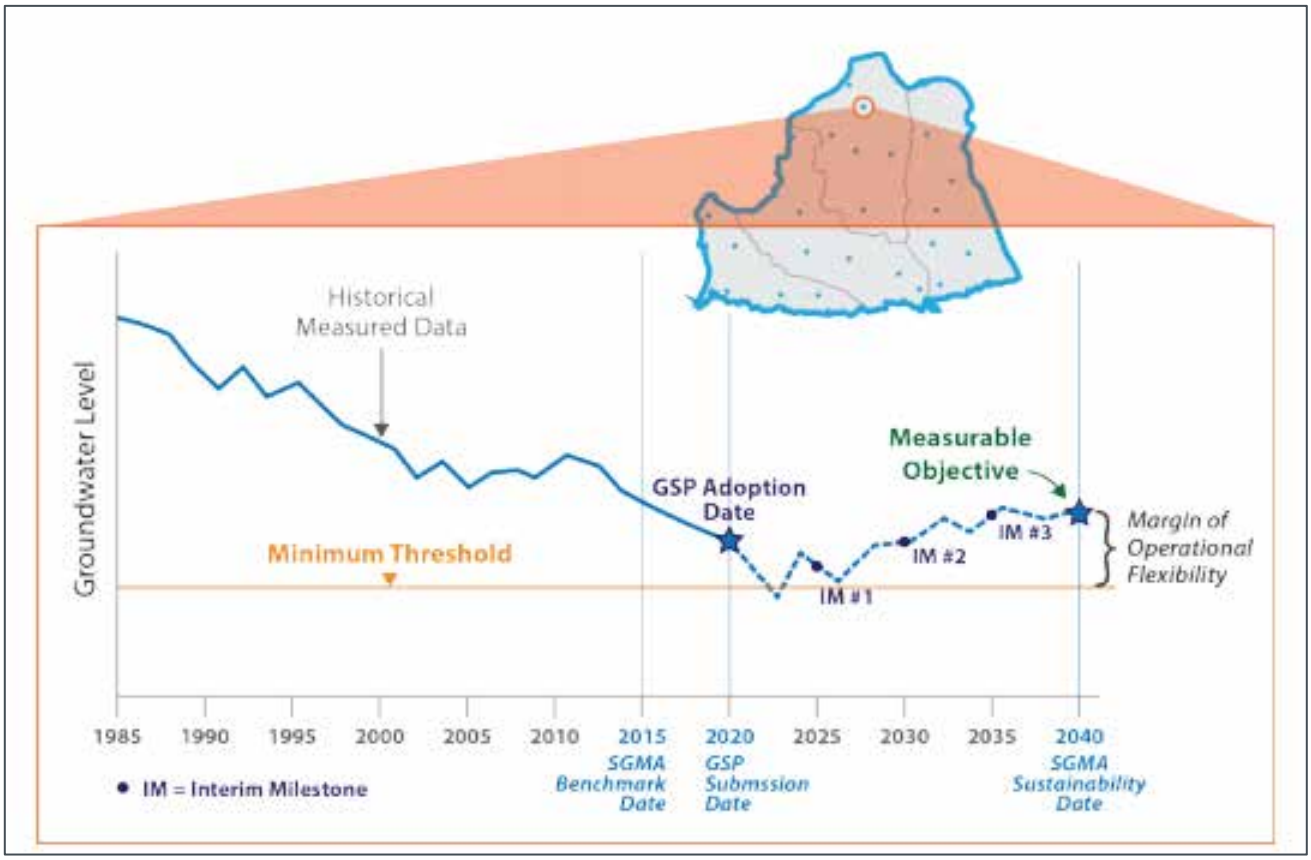
- **Minimum Thresholds**. A "Minimum Threshold" is the quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with Minimum Thresholds at other monitoring sites, may cause an Undesirable Result(s) in the basin. GSAs are required to define Minimum Thresholds at representative monitoring sites for each applicable Sustainability Indicator after considering the interests of beneficial uses and users of groundwater, land uses, and property interests in the basin. Minimum Thresholds should be set at levels that do not impede the ability to meet Minimum Thresholds or Sustainability Goals defined for adjacent basins.
- **Measurable Objectives**. The GSP Regulations define "Measurable Objectives" as specific, quantitative goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted GSP to achieve the Sustainability Goal for the basin. Measurable Objectives are defined for each Sustainability Indicator at the same set of representative monitoring sites, and using the same metrics, for which Minimum Thresholds have been defined. Measurable Objectives should be set such that there is a reasonable margin of operational flexibility within the operating band between the Minimum Threshold and Measurable Objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. There are exceptions to this general rule. For example, if the Minimum Threshold for land subsidence is zero (e.g., no subsidence), the Measurable Objective may also be zero. The diagram below illustrates the relationship between the Minimum Threshold, Measurable Objectives, and margin of operational flexibility within an operating band of sustainable groundwater conditions.

The diagram below is from the DWR Best Management Practices guidance document for Sustainable Management Criteria (DWR, 2017), shows the relationship between the Minimum Thresholds, Measurable Objectives, Interim Milestones, and margin of operational flexibility for the Sustainability Indicator of chronic lowering of groundwater levels for a representative monitoring site within a theoretical basin.

Projects and management actions included in the GSP should be designed to achieve and maintain groundwater conditions within the operating band between the Measurable Objectives and Minimum Thresholds, with descriptions of how those projects and management actions will enable operations within the margin of operational flexibility.

In addition, quantitative "Interim Milestones" towards meeting the Measurable Objectives must be defined in five-year increments for each of the representative monitoring sites. These Interim Milestones should be established based on the projected groundwater conditions that will result from implementing the projects and management actions proposed by the GSA to achieve sustainability. The milestones are used by the DWR and the GSA to track progress towards meeting the Sustainability Goal.

The Sustainable Management Criteria should be defined based on the hydrogeologic conceptual model, current and historical groundwater conditions, and the water budget. For the Spadra Basin, this information is described in Section 2.2 Basin Setting.



Defining the Sustainable Management Criteria for a Basin can be an iterative process. The initial criteria may need to be adjusted if future monitoring data provide improved information about the basin that suggests different criteria are appropriate to address potential effects on the beneficial uses and users of groundwater, land uses, and property interests. The GSP Regulations (23 CCR § 356.4[f]) require GSAs to evaluate GSPs at least every five years (and whenever amended) to assess groundwater conditions relative to each Sustainability Indicator and its Minimum Thresholds, Measurable Objectives, and Interim Milestones. The evaluation must also assess whether new information obtained since the last GSP update warrants changes to any aspect of the GSP, including the Sustainable Management Criteria. If adjustments to the Sustainable Management Criteria are determined necessary for the Spadra Basin, they will likely occur during future updates to the GSP.

3.2 SUSTAINABILITY INDICATORS APPLICABLE TO THE SPADRA BASIN

The default position for GSAs is that all six Sustainability Indicators apply, unless there is evidence that the indicator is not applicable for the basin. Based on the hydrogeologic conceptual model, current and historical groundwater conditions, and the water budget of the Spadra Basin, only four Sustainability Indicators are applicable to the Spadra Basin. The four applicable Sustainability Indictors are:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage

- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence

In other words, it is possible that significant and unreasonable occurrence of these Sustainability Indicators could occur within the Spadra Basin and therefore constitute an Undesirable Result(s).

The following two Sustainability Indicators are not applicable, because they cannot occur in the Spadra Basin:

- **Significant and unreasonable seawater intrusion**. Seawater intrusion into the Spadra Basin is impossible because the Spadra Basin is not adjacent to or near the Pacific Ocean or other sea-water sources.
- **Surface water depletions that have significant and unreasonable adverse impacts on beneficial uses of the surface water.** Surface water depletion is not possible because there are no areas in the Spadra Basin where surface waters are directly connected with groundwater. This is demonstrated by the following: (i) all streams that cross the basin are concrete-lined flood-control channels which prohibits groundwater/surface-water interactions; (ii) through recorded history, depth to groundwater has nearly always exceeded 30 ft below the ground surface which is the maximum rooting depth for groundwater dependent ecosystems (GDEs); and (iii) there are no mapped areas of rising groundwater or GDEs in the Spadra Basin.

3.3 UNDESIRABLE RESULTS, MINIMUM THRESHOLDS, AND MEASURABLE OBJECTIVES FOR THE SPADRA BASIN SUSTAINABILITY INDICATORS

This section describes the Undesirable Results, Minimum Thresholds, and Measurable Objectives for each of the four Sustainability Indicators that are applicable to the Spadra Basin. These criteria were established based on currently available data and information, which was presented in the Section 2.2 Basin Setting.

3.3.1 Chronic Lowering of Groundwater Levels

3.3.1.1 Undesirable Results

Spadra Basin groundwater is primarily used by the overlying water purveyors and private well owners for the following beneficial uses: potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply. Chronic lowering of groundwater levels within the Spadra Basin could occur if total discharge exceeded the total recharge over a prolonged period and could adversely impact these beneficial uses and users of groundwater.

The components of discharge from the Spadra Basin are:

- Subsurface outflow to the neighboring Chino Basin and Puente Basin. Subsurface outflow is controlled by the hydraulic gradients between the groundwater basins and the hydraulic conductivities of the aquifer sediments at the basin boundaries.
- Groundwater pumping. Groundwater is a source of water supply for the overlying water purveyors and water users and the volume pumped is dependent on the end user demands.

The components of recharge from the Spadra Basin include the deep infiltration of precipitation and applied water (DIPAW) and subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills). These two recharge terms are mainly controlled by precipitation falling on the tributary watershed and by the application of water for irrigation on the overlying land uses.

The most likely potential causes of chronic lowering of groundwater levels are (i) over pumping; (ii) a prolonged dry period; (iii) reductions in water applied to overlying outdoor land uses; and/or (iv) declining groundwater levels in the adjacent groundwater basins.

If groundwater levels were to decline to elevations such that well owners could no longer pump their wells at the desired rates, this would represent a significant and unreasonable depletion of the groundwater supply and is an Undesirable Result. The Minimum Thresholds established for the chronic lowering of groundwater levels are set to avoid this Undesirable Result.

Other potential adverse effects from the chronic lowering of groundwater levels in the Spadra Basin are: (i) land subsidence that adversely impacts the overlying infrastructure and land uses; (ii) significant and unreasonable reduction of groundwater storage; and (iii) reduced subsurface outflow to the neighboring groundwater basins, which could potentially cause Undesirable Results to occur in those basins.

3.3.1.2 Minimum Thresholds

The Minimum Threshold for the chronic lowering of groundwater levels is the elevation below which an Undesirable Result will occur at a representative monitoring site.

As described in the *Basin Setting* in Section 2.2 of this GSP, groundwater levels have fluctuated across the Spadra Basin within a defined range of elevation over the 40-year historical period of 1978 to 2018. During this period, groundwater pumping ranged between 700 and 2,200 afy and averaged 1,280 afy. The long-term trends in groundwater levels appear to be consistent at all wells across the basin, suggesting that all wells were influenced by the same regional stresses of pumping and recharge. Generally, groundwater levels appear to increase in response to hydrologic wet periods and decrease in response to hydrologic dry periods. There are no known records of well owners reporting or describing adverse impacts to pumping rates due to low groundwater levels for this historical period. Based on this, it is reasonable to assume that the range of observed groundwater levels over the historical period are protective against the primary Undesirable Result of a significant and unreasonable depletion of the groundwater supply (i.e., well owners no longer can pump at the desired rates). Hence, the Minimum Threshold will be set at the lowest historical elevations across the Spadra Basin.

Seven wells were selected as representative sites to establish the Minimum Thresholds based on their location and historical record of groundwater levels. The location of these wells are shown in Figure 3-1. The seven wells include: a well located close to the Chino Basin boundary (MW-5); a well located close to the Puente Basin boundary (Industry Well); and five wells located along the axis of the basin where the majority of groundwater production occurs (OMW-3, P-19, P-28, CPP-1, and CPP-4). These seven wells are spatially distributed throughout the Spadra Basin along the center axis of the basin, which is the thickest and main portion of the aquifer and are dispersed to represent groundwater-level conditions for the entire basin.

For each well, Figure 3-1 shows a time-series chart of historical groundwater elevations, the model-estimated groundwater elevations from the calibration of the Spadra Basin Groundwater Model, and the proposed Minimum Threshold. The Minimum Thresholds are based on the lowest historical groundwater elevations (measured or model estimated), observed across the Spadra Basin which generally occurred in 1978.

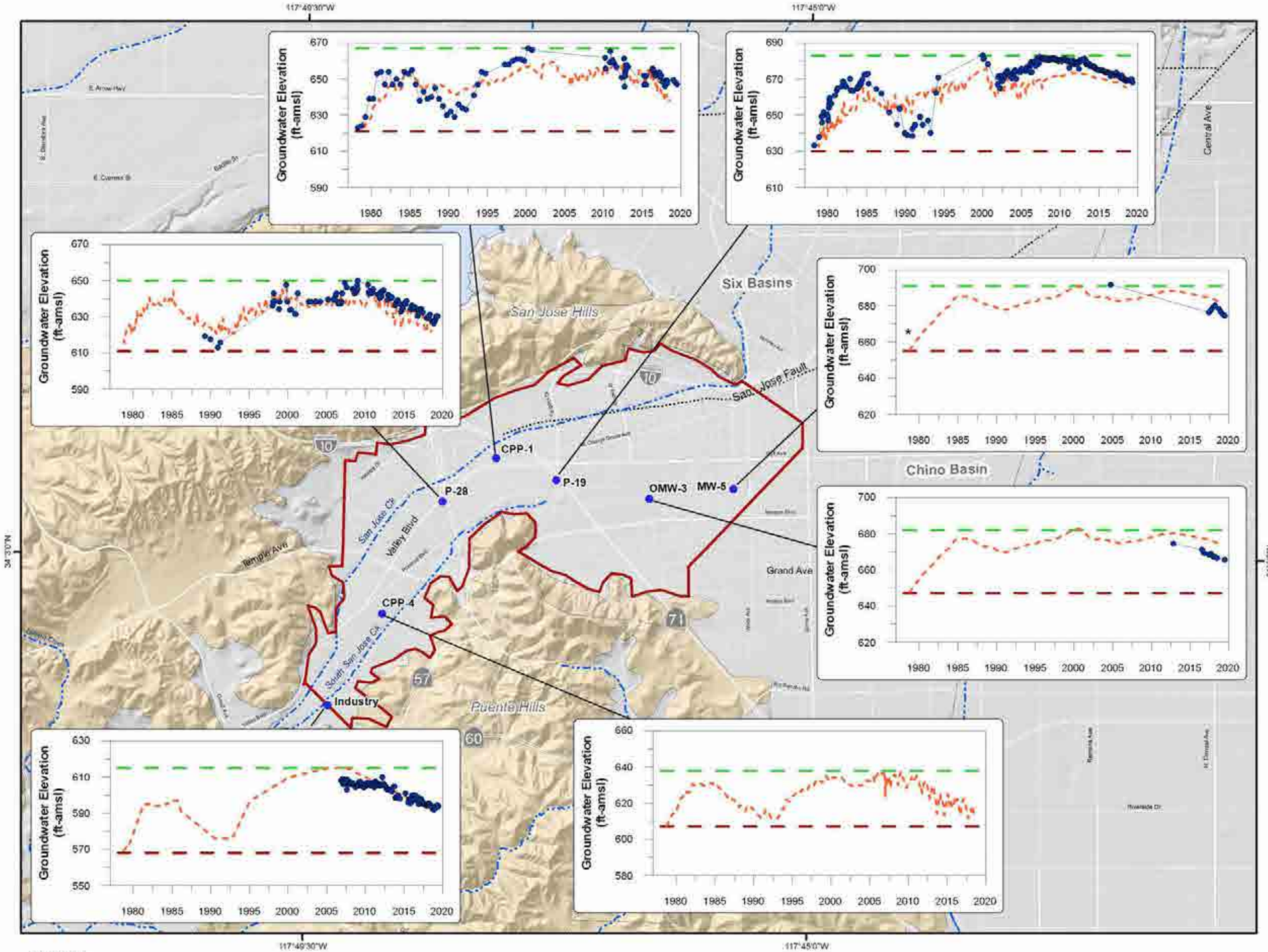
To avoid Undesirable Results, groundwater elevations at the representative monitoring sites should remain above the Minimum Thresholds listed in Table 3-1 below:

Table 3-1. Minimum Thresholds for Groundwater Levels in the Spadra Basin

Well	Well Type and Status	Minimum Threshold, ft-amsl
MW-5	Monitoring Well (Active)	655
OMW-3	Monitoring Well (Active)	647
P-19	Municipal Production Well (Inactive)	630
P-28	Municipal Production Well (Active)	611
CPP-1	Municipal Production Well (Active)	621
CPP-4	Municipal Production Well (Active)	607
Industry	Municipal Production Well (Active)	568

The proposed Minimum Thresholds for groundwater levels are preliminary estimates based on the historical operations from 1978 to 2018 and the belief that there were no Undesirable Results. To justify the proposed Minimum Thresholds for application across the entire basin, the information on the depth of the pump bowls for every active pumping well in the Spadra Basin was collected.[1] These depths were converted to elevations and compared to the Minimum Threshold elevation at the representative monitoring sites, or the lowest historical groundwater elevation if the well is not a representative monitoring site, to ensure that these Minimum Thresholds promote pumping sustainability at all active wells in the Spadra Basin. This analysis confirmed that all the proposed Minimum Thresholds or lowest groundwater elevations are 32 ft or more above the pump bowls.

[1] There is one active pumping well where the depth of the well and depth of the pump bowl is unknown (CPP-3). And there is one active pumping well where the depth of the pump bowl is unknown, and the depth of the well less 100 ft was used to estimate the pump bowl depth (CPP-1).



Groundwater Elevation Time Series Charts

- Model-Simulated Groundwater Elevation
- Measured Static Groundwater Elevation
- Measurable Objective
- Minimum Threshold

* The model-simulated and measured groundwater elevations at MW-5 differ. This area of Spadra Basin near Chino Basin is an area of uncertainty identified during calibration of the Spadra Basin Groundwater Model, and an identified data gap in the hydrogeologic conceptual model. The model-simulated groundwater elevations on this chart are the model-simulated groundwater elevations for nearby well OMW-3 plus 8 ft, which is the average difference between the measured data at MW-5 and OMW-3. These computed groundwater elevations were used to define the Minimum Threshold, Measurable Objectives, and Interim Milestones for MW-5, and should be reevaluated during the GSP implementation.

- Wells with Sustainable Management Criteria for Groundwater Levels
- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-1-GWE Time Series.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN

Sustainable Management Criteria
For Chronic Lowering of Groundwater Levels

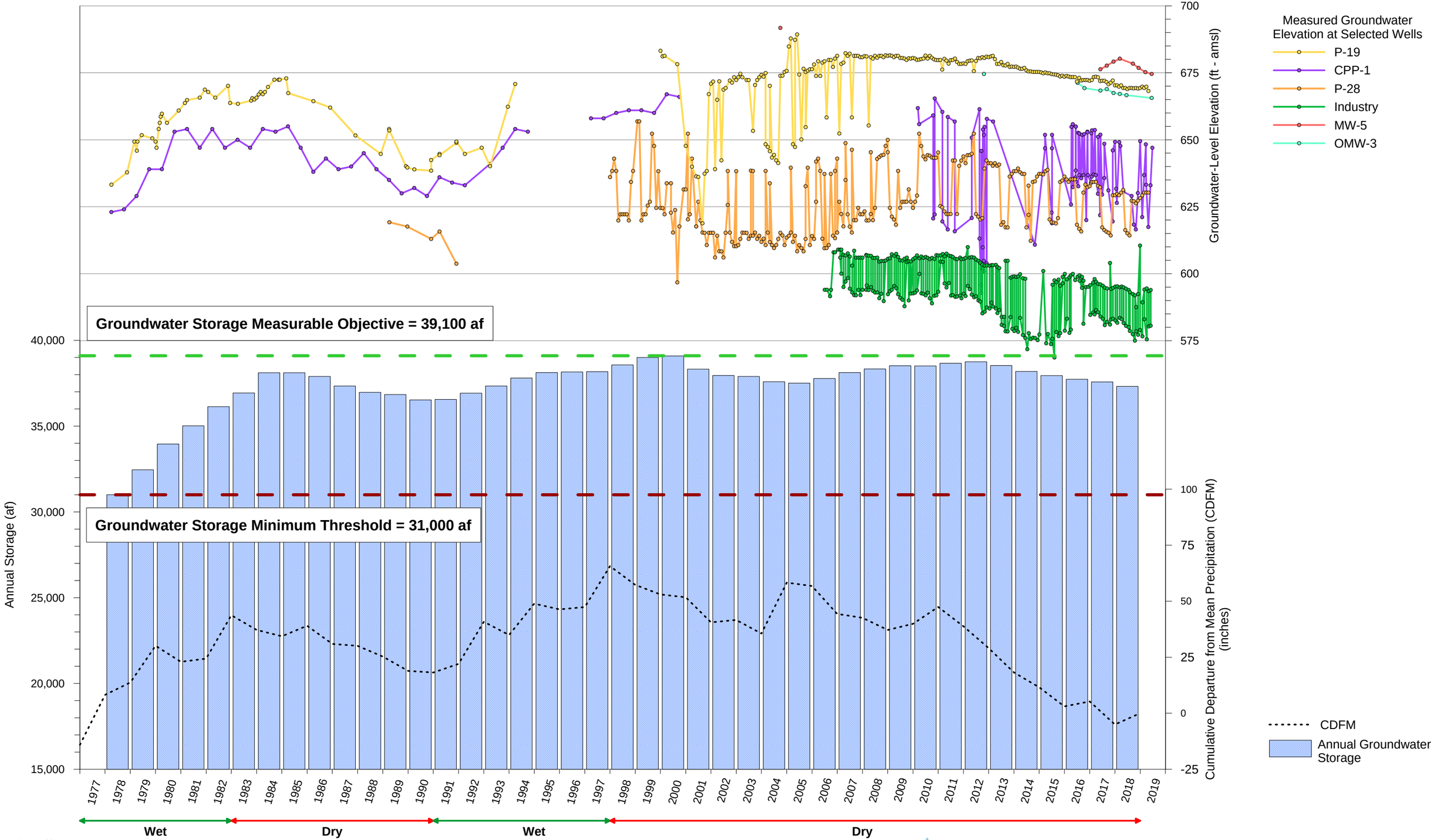
Figure 3-1

Monitoring of groundwater levels at the seven representative monitoring sites will be conducted by installing pressure transducers within each well casing (if possible) to measure and record groundwater elevation once every 15 minutes. This high-frequency data is sufficient to fully understand the short-term, seasonal, and long-term trends in the groundwater levels to evaluate the conditions across the Spadra Basin. If static groundwater elevations decline below a Minimum Threshold for an entire year at any well, this constitutes an Undesirable Result. The lowest static groundwater-elevation measurement during fall (September – November) will be used to compare to the Minimum Threshold established at each well to monitor for potential Undesirable Results related to the chronic lowering of groundwater levels. If the lowest static fall groundwater elevation measurement at all of the representative monitoring wells are below respective Minimum Thresholds, for two consecutive years, this may cause an Undesirable Result.

Maintaining groundwater levels above the Minimum Thresholds should also avoid Undesirable Results related to the Sustainability Indicators of groundwater storage and land subsidence, as discussed in the following sections. And maintaining groundwater levels above the Minimum Thresholds is likely to protect against contributing to the occurrence of Undesirable Results in the adjacent groundwater basins. That said, the interaction with adjacent basins is not fully understood. The Spadra Basin Groundwater Model estimated that over the historical period of 1978 to 2018, subsurface outflow from Spadra Basin to Puente Basin ranged from about 1,000 to 2,000 afy. This may be a significant source of recharge to the Puente Basin that supports its sustainable yield and the beneficial uses and users of groundwater in that basin, and hence, should be investigated in collaboration with the Puente Basin agencies. The Spadra Basin groundwater model-estimated that over the historical period, subsurface outflow from Spadra Basin to Chino Basin ranged from about 250 to 950 afy. Although these rates of subsurface inflow are relatively minor compared to the total storage (~12 million af) and the Safe Yield (131,000 afy) of the Chino Basin, the Chino Basin experienced land subsidence during the 1978 to 2018 period in the area near where Spadra Basin discharges into the Chino Basin. The potential impacts of changes in subsurface outflows from the Spadra Basin to the Chino Basin should be monitored in collaboration with the Chino Basin Watermaster.

3.3.1.3 Measurable Objectives

The Measurable Objectives for groundwater levels in the Spadra Basin are defined as the highest historical groundwater elevations across the Spadra Basin over the period of 1978-2018. These Measurable Objectives establish a reasonable margin of operational flexibility between the Measurable Objectives and the Minimum Thresholds and will promote sustainable groundwater management by accommodating wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin, including artificial recharge, pump-and-treat, and conjunctive use projects. The time-series charts of historical groundwater elevations on Figure 3-2 show the Measurable Objective along with the Minimum Threshold at each of the seven representative monitoring sites. The highest historical groundwater elevation at each well typically occurred in 2000. The Measurable Objectives for groundwater levels are summarized in the Table 3-2.



Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 20200730
Filename: Fig 3-2_GWE_Storage_Precip

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Sustainable Management Criteria
For Reduction of Groundwater Storage

Figure 3-2

Table 3-2. Measurable Objectives for Groundwater Levels in the Spadra Basin		
Well	Well Type and Status	Measurable Objective, ft-amsl
MW-5	Monitoring Well (Active)	691
OMW-3	Monitoring Well (Active)	682
P-19	Municipal Production Well (Inactive)	683
P-28	Municipal Production Well (Active)	650
CPP-1	Municipal Production Well (Active)	667
CPP-4	Municipal Production Well (Active)	638
Industry	Municipal Production Well (Active)	615

3.3.2 Reduction of Groundwater Storage

3.3.2.1 Undesirable Results

Spadra Basin groundwater is primarily used by the overlying water purveyors and private well owners for the following beneficial uses: potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply. A significant and unreasonable reduction of groundwater storage within the Spadra Basin could occur if total discharge exceeded the total recharge over a prolonged period and could adversely impact the beneficial uses and users of groundwater.

The components of discharge from the Spadra Basin are:

- Subsurface outflow to the neighboring Chino Basin and Puente Basin. Subsurface outflow is controlled by the hydraulic gradients between the groundwater basins and the hydraulic conductivities of the aquifer sediments at the basin boundaries.
- Groundwater pumping. Groundwater pumping is a source of water supply for the overlying water purveyors and water users and the volume pumped is dependent on the end user demands.

The components of recharge from the Spadra Basin include the deep infiltration of precipitation and applied water (DIPAW) and subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills). These two recharge terms are mainly controlled by precipitation falling on the tributary watershed and by the application of water for irrigation on the overlying land uses.

The most likely potential causes of a reduction of groundwater storage are (i) over pumping; (ii) a prolonged dry period; (iii) reductions in water applied to overlying outdoor land uses; and/or (iv) declining groundwater levels in the adjacent groundwater basins.

If groundwater storage in the Spadra Basin were to decline to a volume such that wells could no longer pump at the desired rates, this would represent a significant and unreasonable depletion of the groundwater supply and is an Undesirable Result. The Minimum Thresholds established for the reduction of groundwater storage are set to avoid this Undesirable Result.

Other potential adverse effects from a reduction of groundwater storage in the Spadra Basin are: (i) land subsidence that adversely impacts the overlying infrastructure and land uses; (ii) significant and unreasonable lowering of groundwater levels; and (iii) reduced subsurface outflow to the neighboring groundwater basins, which could potentially cause Undesirable Results to occur in those basins.

3.3.2.2 Minimum Thresholds

Figure 3-2 shows the annual groundwater storage in the Spadra Basin during 1978-2018 as estimated during calibration of the Spadra Basin Groundwater Model (see water budget in Table 2-7 and Appendix I). Also shown on Figure 3-2 are: the time-series of groundwater elevations at the seven wells that are representative monitoring sites for groundwater levels and the cumulative departure from the mean precipitation curve (CDFM). The annual groundwater in storage in the Spadra Basin fluctuated over the 40-year historical period of 1978 to 2018. During this period, groundwater storage appears to rise in response to hydrologic wet periods and fall in response to hydrologic dry periods. These model-estimated changes in storage are consistent with the trends observed in the measured groundwater elevations at the wells across Spadra Basin. The annual volume of groundwater storage ranged from about 31,000 af to 39,100 af over the 40-year historical period. The lowest groundwater storage of 31,000 af over this period occurred in 1978 which is also the period of the lowest groundwater levels in the Spadra Basin.

By proxy, the Minimum Thresholds for the chronic lowering of groundwater levels defined at representative monitoring sites in Table 3-1 will be used to assess reduced groundwater storage. The Minimum Thresholds for groundwater levels and by proxy groundwater storage are based on the lowest historical elevation between 1978-2018 and the assumption that the range of observed groundwater levels over the historical period are protective against Undesirable Results for groundwater storage, since there were no Undesirable Results over the historical period. Maintaining groundwater levels above the Minimum Thresholds should avoid Undesirable Results for groundwater storage because the Undesirable Results are the same, and because changes in groundwater storage are directly related to changes in groundwater levels.

A secondary Minimum Threshold for groundwater storage will be set at the lowest historical volume of 31,000 af (see Figure 3-2). The analyzes of this Minimum Threshold can be done as a subsidiary analysis during the required GSA annual reporting to the DWR (Water Code § 10728). A requirement of the annual reporting is an estimate of the annual change in storage. This annual estimate will include updating the Spadra Basin Groundwater Model with hydrology, pumping, and recharge through the current year to extend the historical model simulation and produce a water budget for the Spadra Basin through the current year. The water budget will include the estimate of the annual volume and change in groundwater storage through the current year. The annual volume of groundwater storage can be compared to the secondary Minimum Threshold of 31,000 af (see Figure 3-2) that was set as the lowest storage between 1978-2018 and was also the year of the lowest groundwater levels. The analysis can be used and compared to the analysis of the groundwater level Minimum Thresholds used as a proxy.

Maintaining groundwater levels above the Minimum Thresholds is likely to protect against contributing to the occurrence of Undesirable Results in the adjacent groundwater basins. That said, the interaction with adjacent basins is not fully understood. The Spadra Basin Groundwater Model estimated that over the historical period of 1978 to 2018, subsurface outflow from Spadra Basin to Puente Basin ranged from about 1,000 to 2,000 afy. This may be a significant source of recharge to the Puente Basin that supports its sustainable yield and the beneficial uses and users of groundwater in that basin, and hence, should be investigated in collaboration with the Puente Basin Watermaster. The Spadra Basin Groundwater Model estimated that over the historical period of 1978-2018, subsurface outflow from Spadra Basin to Chino Basin

ranged from about 250 to 950 afy. Although these rates of subsurface inflow are relatively minor compared to the total storage (~12 million af) and the Safe Yield of the Chino Basin (131,000 afy), the Chino Basin experienced land subsidence during the 1978 to 2018 period in the area near where Spadra Basin discharges into the Chino Basin. The potential impacts of changes in subsurface outflows from the Spadra Basin to the Chino Basin should be monitored in collaboration with the Chino Basin Watermaster.

3.3.2.3 Measurable Objectives

By proxy, the Measurable Objectives defined for chronic lowering of groundwater levels in Table 3-2 will be used to assess reduced groundwater storage. The Measurable Objectives for groundwater levels and by proxy groundwater storage are based on the highest historical elevation between 1978-2018 and representative of the upper boundary of the operating band for groundwater levels and storage, to achieve and maintain sustainable groundwater management. These Measurable Objectives for groundwater levels can be used as a proxy to evaluate sustainable conditions for groundwater storage because there were no observed Undesirable Results for groundwater storage, and the observed trends in groundwater storage and groundwater levels over the historical 1978-2018 period are related. These Measurable Objectives allow a reasonable margin of operational flexibility between the Measurable Objective and the Minimum Threshold that will accommodate wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin, including artificial recharge, pump-and-treat, and conjunctive use projects.

A Measurable Objective for groundwater storage will be set at the highest historical volume of 39,100 af (see Figure 3-2). The analyzes of this Measurable Objective can be done as a secondary analysis during the required annual reporting for the GSA to the DWR which includes an annual change in storage estimate and can be compared to the analysis of the proxy Measurable Objective (see Section 4.2.2.).

3.3.3 Degraded Water Quality

3.3.3.1 Undesirable Results

The Spadra Basin is part of the Bulletin 118 San Gabriel Valley Basin which has the following designated beneficial uses for groundwater in the *Water Quality Control Plan, Los Angeles Region* (LA Basin Plan [LA Regional Board], 2019): municipal and domestic supply (MUN), industrial service supply (IND), industrial process supply (PROC), and agricultural supply (AGR). As described in the Basin Setting, groundwater quality in the Spadra Basin is generally poor, many of the supply wells have constituent concentrations that are higher than drinking-water primary and secondary MCLs and the TDS and nitrate concentration objectives within the LA Basin Plan and requires treatment or blending for potable use. The Basin Setting identifies six contaminants of concern in Spadra Basin: TDS, nitrate, TCE, PCE, 1,1-DCE, and perchlorate.

Most of the groundwater pumped in the Spadra Basin is used for agricultural and urban irrigation and other non-potable uses and thus is not required to meet drinking-water standards. There are various point-source contaminant sites in the Spadra Basin, but the extent of the contaminant plumes associated with the individual point-sources have not been mapped. Many of the supply wells in the basin produce water containing similar contaminants as those associated with the point-source contamination sites, such as TCE, PCE, and 1,1-DCE, but the potential source(s) and parties responsible for the contaminants present at any given well have yet to be identified.

The six contaminants of concern in the Spadra Basin can be grouped in two types: the inorganic contaminants of TDS, nitrate, and perchlorate; and the synthetic organic contaminants of TCE, PCE, and 1,1-DCE. The sources and causes of these two types of contaminants in groundwater are different. The inorganic contaminants of TDS, nitrate, and perchlorate are chemicals that enter groundwater from non-point source origins as a result of human activity on the overlying lands. The main sources include: the application of water to the land surface for agriculture and landscape irrigation and the resulting concentrated return flows to groundwater and the application of fertilizers on crops and irrigated landscapes which can dissolve into percolating groundwater. The organic contaminants of TCE, PCE, and 1,1,-DCE are man-made chemicals used in industrial solvents that can enter groundwater from the unregulated release or spills of these contaminants at a point source.

Because the sources and causes of these two types of contaminants in groundwater are different, the degraded groundwater quality conditions that are considered an Undesirable Result are different depending on the contaminant type and the beneficial use of groundwater:

- If the concentrations of the inorganic contaminants from non-point sources increase at a well to concentrations that would impact the current beneficial uses of groundwater from that well and the inability to use a well for its current use, this would represent a significant and unreasonable degradation of water quality and an Undesirable Result.
- If the concentrations of the organic contaminants from point-sources are above the Primary MCL at a well, this represents a significant and unreasonable degradation of water quality with an Undesirable Result of preventing all potential beneficial uses in the basin.

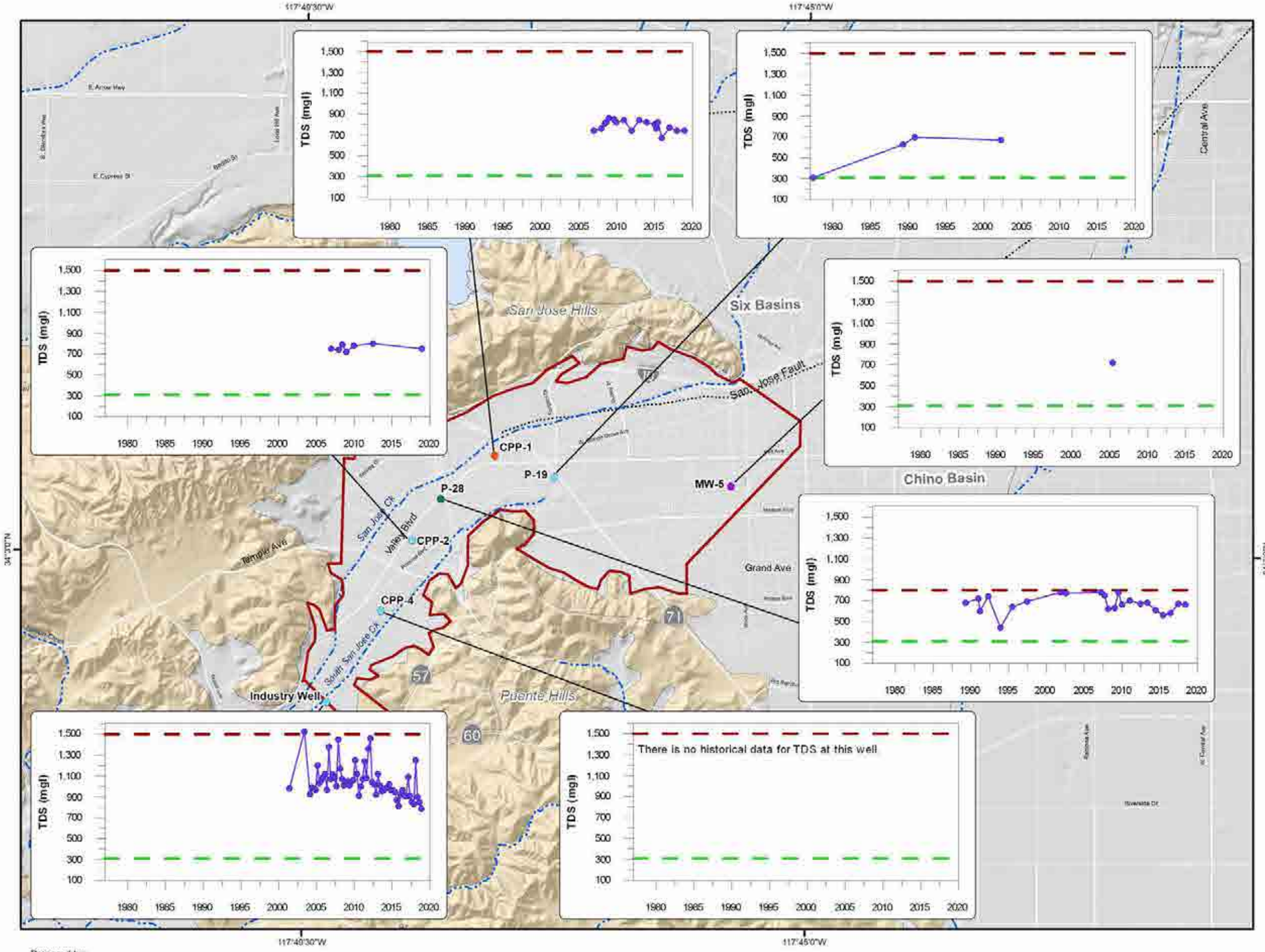
The Minimum Thresholds established for degraded water quality are set to avoid these Undesirable Results.

Other potential adverse effects from degraded water quality in the Spadra Basin are increases in operational costs for treatment to enable beneficial use, and water quality degradation of neighboring groundwater basins.

3.3.3.2 Minimum Thresholds

The Minimum Threshold for degraded water quality is the contaminant concentration above which an Undesirable Result will occur at a representative monitoring site.

Minimum Thresholds are defined for each of the six contaminants of concern. Seven wells were selected as representative monitoring sites across the basin based on their location, well type, and well use. Figures 3-3a through 3-3f show the locations of the representative monitoring sites. These seven wells selected as are representative monitoring sites spatially distributed throughout the Spadra Basin along the center axis of the basin which is the thickest and main portion of the aquifer and are dispersed to represent groundwater quality conditions for the entire basin. These wells are either production wells with water quality data representative of the different beneficial uses or they are monitoring wells for point-source contamination of groundwater. The wells include: three non-potable supply wells along the central axis of the basin (P-19, CPP-2, and CPP-4); one potable supply well in the center on the basis (P-28); one potable supply well in the center of the basin that is a non-potable source used for potable supply after treatment (CPP-1); one non-potable supply well located along the boundary with the Puente Basin (Industry); and one non-potable monitoring well associated with the Calsol Inc. point-source contaminant site located near the Chino Basin boundary (MW-5). Figures 3-3a through 3-3f includes time-series charts of historical groundwater-quality data at each representative monitoring site well for the 1978 to 2018 period and the proposed Minimum Thresholds.



Groundwater Quality Time-Series Charts

- Total Dissolved Solids (TDS) Concentration
- Minimum Threshold
- Measurable Objective

Wells with Sustainable Management Criteria for Water Quality

- Potable Supply Well
- Non-Potable Supply Well
- Potable Supply Well – Non-Potable Source with Treatment
- Point-Source Contaminant Site Monitoring Well

- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-3a WQ Time Series-TDS.mxd

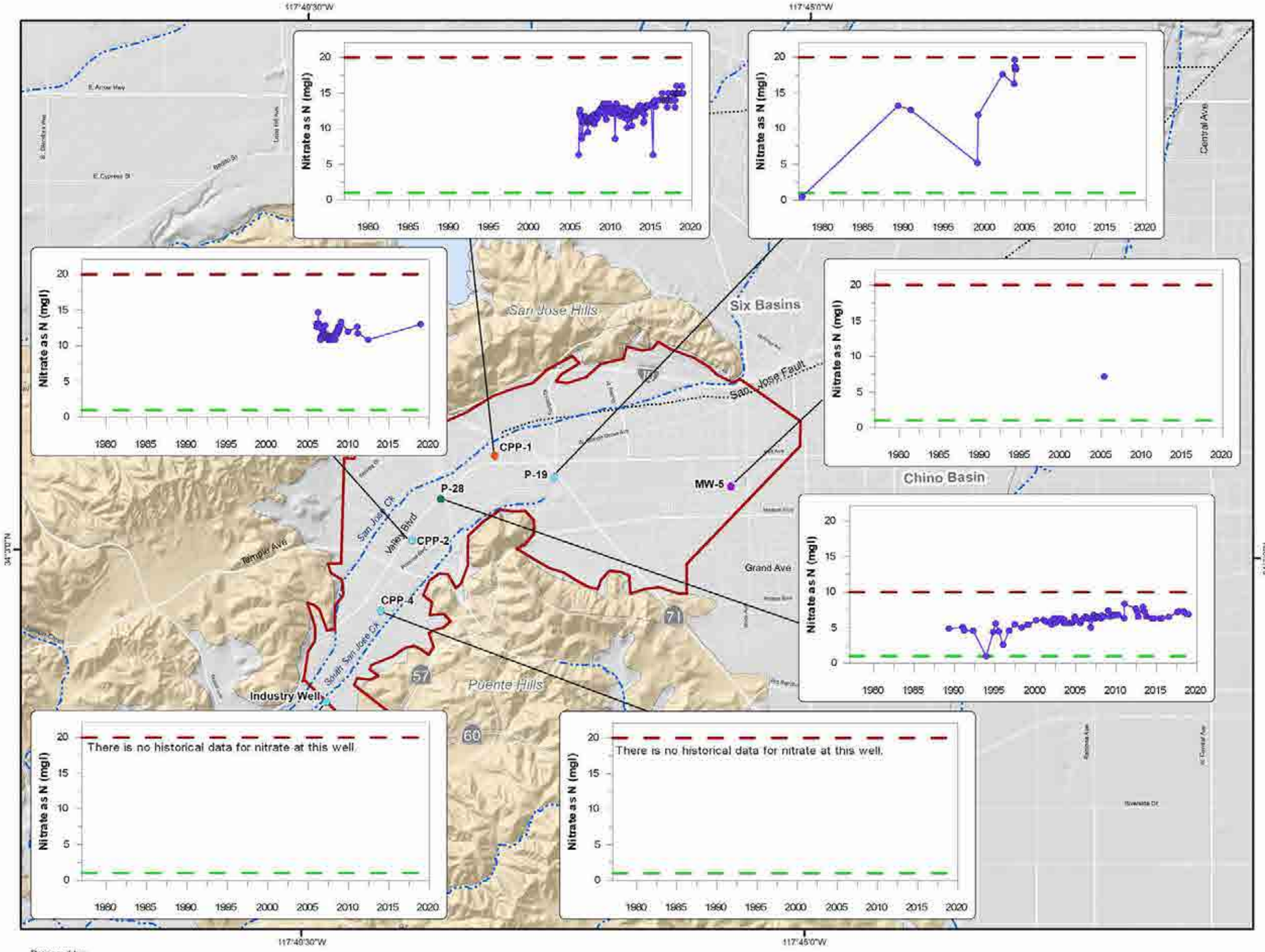
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Sustainable Management Criteria
For Degraded Water Quality - TDS

Figure 3-3a



Groundwater Quality Time-Series Charts

- Nitrate (as N) Concentration
- Minimum Threshold
- Measurable Objective

Wells with Sustainable Management Criteria for Water Quality

- Potable Supply Well
- Non-Potable Supply Well
- Potable Supply Well – Non-Potable Source with Treatment
- Point-Source Contaminant Site Monitoring Well

- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-3b-WQ Time Series-N.mxd

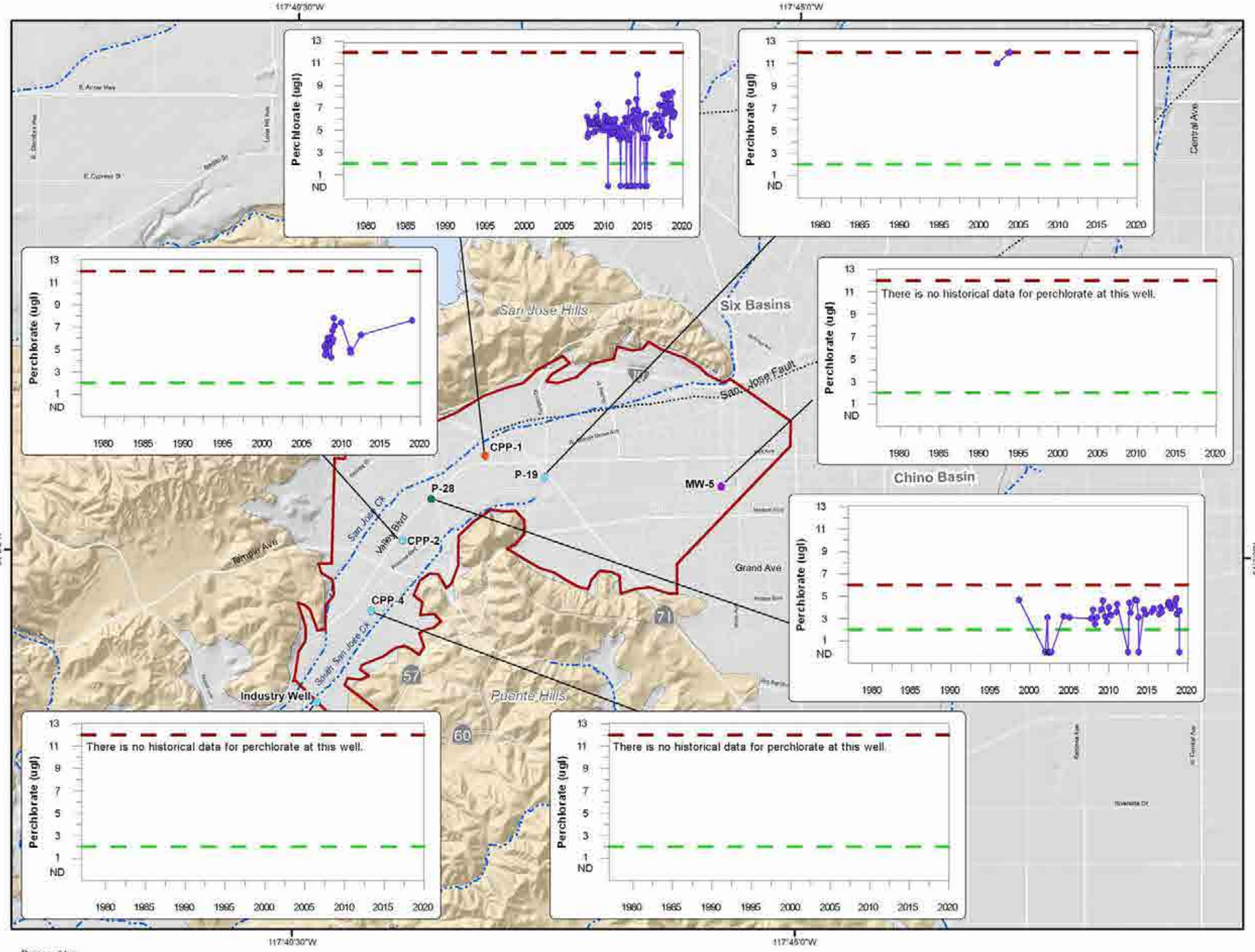
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY

Sustainable Management Criteria
For Degraded Water Quality - Nitrate-N

Figure 3-3b



Groundwater Quality Time-Series Charts

- Perchlorate Concentration
- Minimum Threshold
- Measurable Objective

Wells with Sustainable Management Criteria for Water Quality

- Potable Supply Well
- Non-Potable Supply Well
- Potable Supply Well – Non-Potable Source with Treatment
- Point-Source Contaminant Site Monitoring Well

- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-3c-WQ Time Series-Perchlorate.mxd

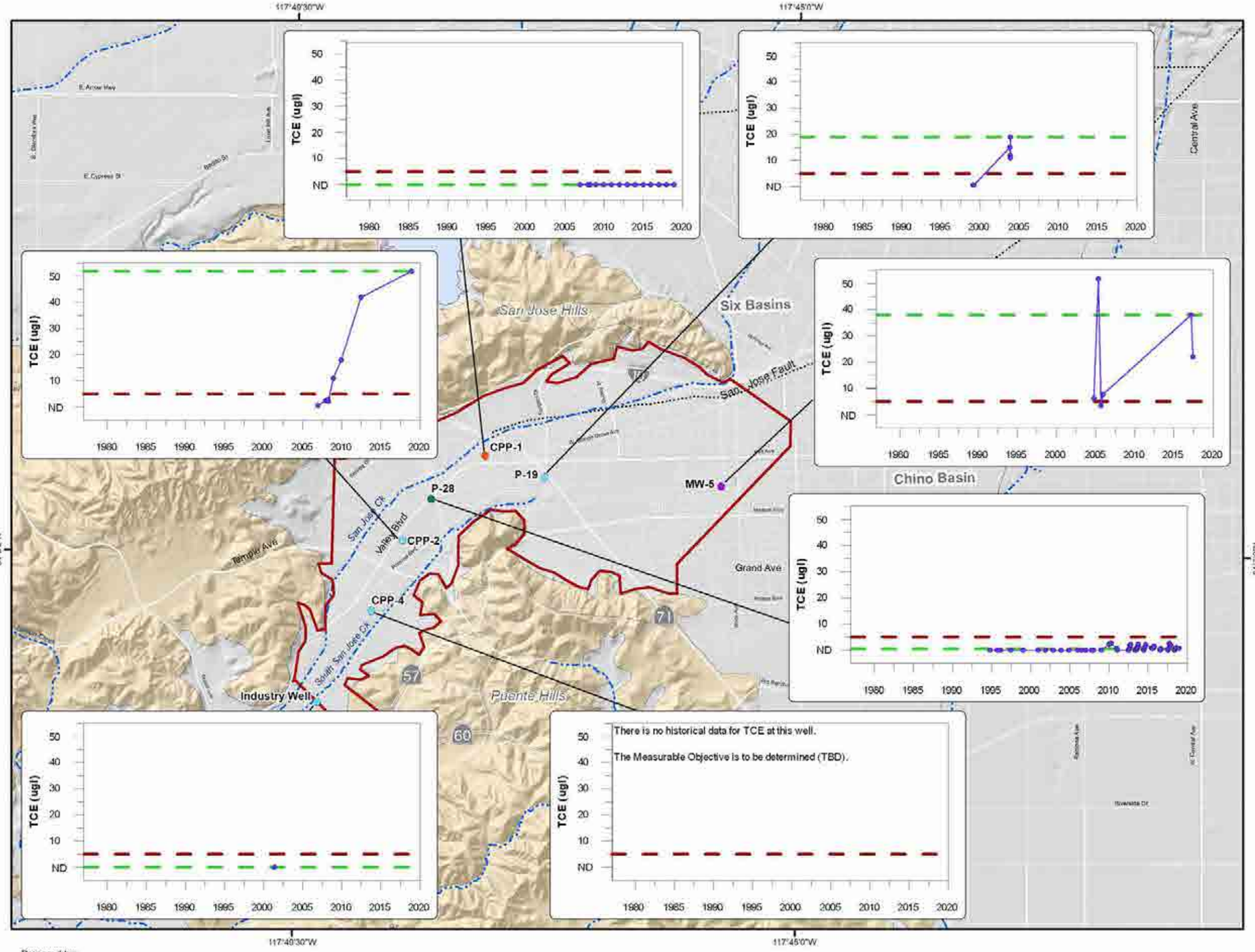
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Sustainable Management Criteria
For Degraded Water Quality - Perchlorate

Figure 3-3c



Groundwater Quality Time-Series Charts

- Trichloroethene (TCE) Concentration
- Minimum Threshold
- Measurable Objective

Wells with Sustainable Management Criteria for Water Quality

- Potable Supply Well
- Non-Potable Supply Well
- Potable Supply Well – Non-Potable Source with Treatment
- Point-Source Contaminant Site Monitoring Well

- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-3d WQ Time Series-TCE.mxd

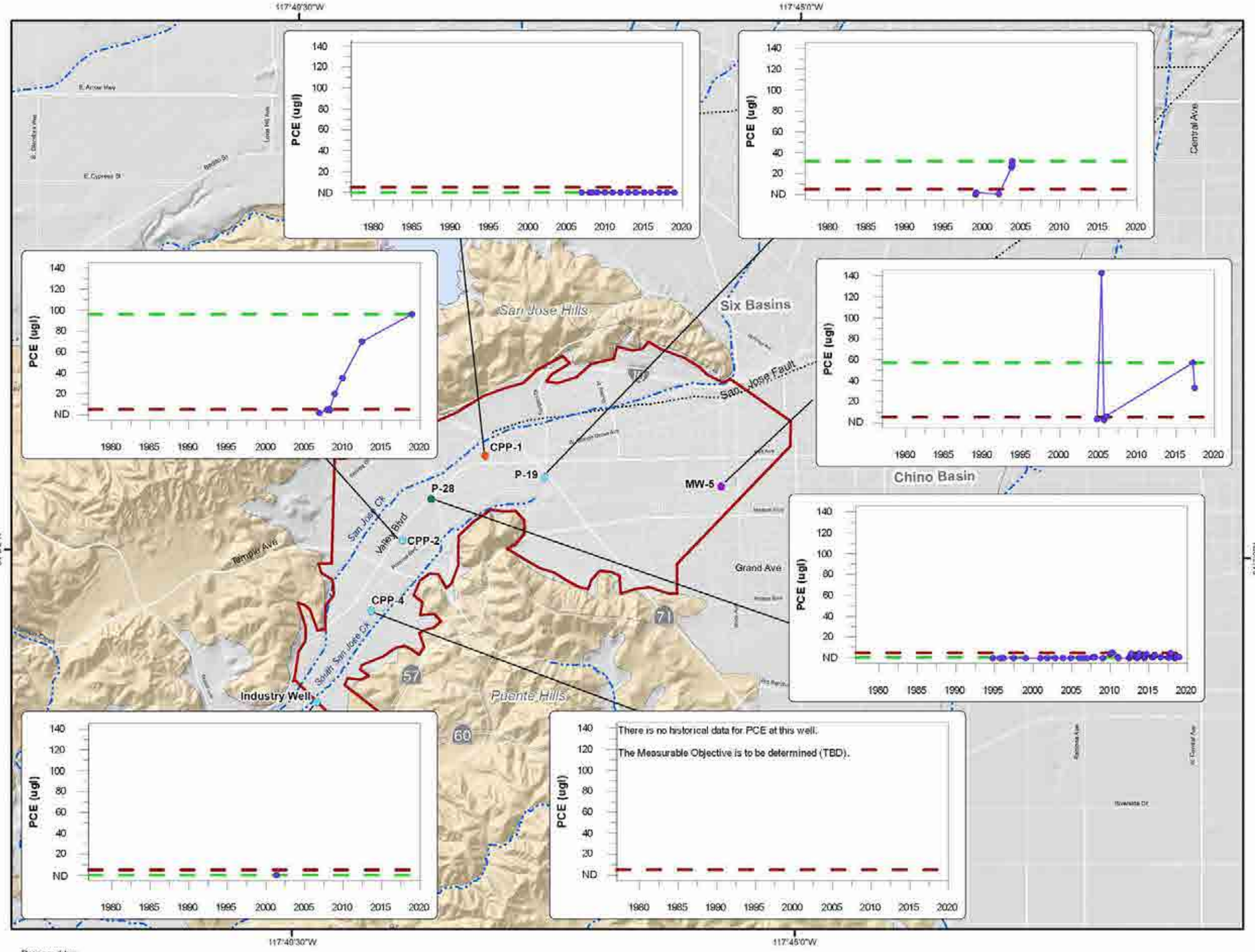
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Sustainable Management Criteria
For Degraded Water Quality - TCE

Figure 3-3d



Groundwater Quality Time-Series Charts

- Tetrachloroethene (PCE) Concentration
- Minimum Threshold
- Measurable Objective

Wells with Sustainable Management Criteria for Water Quality

- Potable Supply Well
- Non-Potable Supply Well
- Potable Supply Well – Non-Potable Source with Treatment
- Point-Source Contaminant Site Monitoring Well

- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-3e-WQ Time Series-PCE.mxd

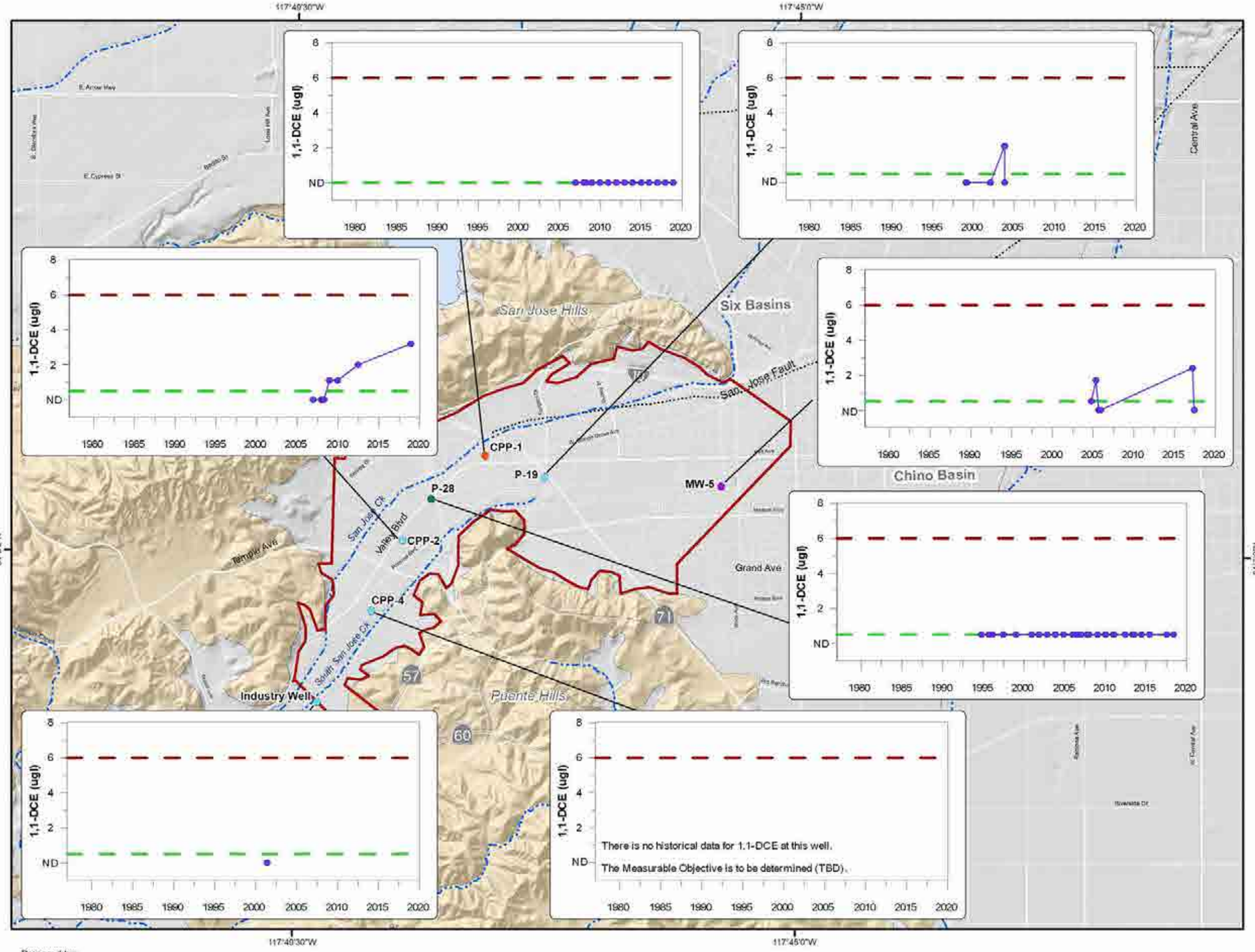
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Sustainable Management Criteria
For Degraded Water Quality - PCE

Figure 3-3e



Groundwater Quality Time-Series Charts

- 1,1-dichloroethene (1,1-DCE) Concentration
- Minimum Threshold
- Measurable Objective

Wells with Sustainable Management Criteria for Water Quality

- Potable Supply Well
- Non-Potable Supply Well
- Potable Supply Well – Non-Potable Source with Treatment
- Point-Source Contaminant Site Monitoring Well

- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:
WEST YOST
Water. Engineered.

Author: LH
Date: 7/31/2020
File: Figure 3-3f WQ Time Series 1,1-DCE.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Sustainable Management Criteria
For Degraded Water Quality - 1,1-DCE

Figure 3-3f

The Undesirable Results for degraded water quality defined in Section 3.3.3.1 are different based on the type of contaminant and beneficial uses of groundwater, hence, the proposed Minimum Thresholds are dependent on the contaminant type and beneficial use:

- For the inorganic contaminants (TDS, nitrate, and perchlorate), the Minimum Thresholds are set to be protective of the current beneficial uses of groundwater at each well.
  - For the non-potable wells (C-19, CPP-2, CPP-4, Industry, and MW-5), and the well that is non-potable and treated for potable supply (CPP-1), the Minimum Threshold is defined as the highest historical concentration of the contaminant historically at all of the non-potable representative monitoring wells.. This assumes that concentrations equal to or below historical concentrations are sustainable for the well's beneficial use.
  - For the potable well (P-28), the Minimum Threshold for TDS which has a Secondary MCL, is defined as the highest historical concentration at the potable well, and the Minimum Thresholds for nitrate and perchlorate which have Primary MCLs is defined as the MCL.
- For the organic contaminants (TCE, PCE, and 1,1-DCE), the Minimum Thresholds are set so that point-source discharge of contaminants do not impair all potential beneficial uses of groundwater. Hence, the Minimum Thresholds are defined as the Primary MCL.

To avoid Undesirable Results, concentrations of the six contaminants of concern at the representative monitoring sites should remain below the Minimum Thresholds listed below in Table 3-3.

Table 3-3. Minimum Thresholds for Groundwater Quality in the Spadra Basin

	TDS, mgl	Nitrate-N, mgl	Perchlorate, ugl	TC, ugl	PCE, ugl	1,1-DCE , ugl
Primary MCL:	--	10	6	5	5	6
Secondary MCL:	500	--	--	--	--	--
Basin Plan Obj.	550	10	--	--	--	--
Minimum Threshold						
Minimum Thresholds for Non-Potable Wells (Industry, CPP-4, CPP-2, P-19, and MW-5), and Non-Potable Well Treated to Potable (CPP-1)	1,500	20	12	5	5	6
Minimum Threshold for Potable Well (P-28)	800	10	6	5	5	6

The proposed Minimum Thresholds for the inorganic contaminants are preliminary estimates based on the maximum historical concentration of the contaminants at all the representative monitoring sites in the basin. These Minimum Thresholds are intended to represent the concentrations that cause the Undesirable Result that the well could no longer be used for its current beneficial use. Input from the well owners is required to finalize and refine these Minimum Thresholds prior to the preparation of the final GSP, and the final Minimum Thresholds may be set differently at the individual wells.

The proposed Minimum Thresholds for the organic contaminants indicate that Undesirable Results currently exist at three of the representative monitoring sites (MW-5, P-19, CPP-2). Figures 3-3d and 3-3f show that TCE and PCE concentrations at these three wells were above the proposed Minimum Thresholds prior to 2015. The SGMA Regulations (Water Code §10727.2[b][4]) indicate that a GSP "*may, but is not required to, address undesirable results that occurred before, and have not been corrected by January 1, 2015*" and a GSA "*has discretion as to whether to set Measurable Objectives and the timeframes for achieving any objectives for Undesirable Results that occurred before, and have not been corrected by January 1, 2015.*" The DWR Best Management Practices guidance document for Sustainable Management Criteria (DWR, 2017) provides that if an Undesirable Result occurred prior to January 1, 2015, the GSA should set Measurable Objectives to either maintain or improve upon the conditions that were occurring in 2015. The Measurable Objectives were set for these organic contaminants to maintain 2015 conditions, or better, as discussed below for the Measurable Objectives.

Monitoring of groundwater quality at the seven representative monitoring sites will be conducted by collecting triennial samples (at a minimum) for the six contaminants of concern. If a contaminant concentration is above the Minimum Threshold at any well, this may constitute an Undesirable Result. To verify the occurrence of an Undesirable Result, subsequent monitoring will be done within a year to verify the occurrence of an Undesirable Results.

3.3.3.3 Measurable Objectives

The Measurable Objective for degraded water quality is the contaminant concentration at a well that is representative of the lower boundary of the operating band for groundwater quality conditions to achieve and maintain sustainable groundwater management.

Measurable Objectives for groundwater quality are established for the same seven representative sites and six contaminants of concern as the Minimum Thresholds. Measurable Objectives are goals for all beneficial uses. Similar to the Minimum Thresholds, the proposed Measurable Objectives are set dependent on the contaminant type:

- For the inorganic contaminants (TDS, nitrate, and perchlorate), the Measurable Objectives are defined as the lowest detected concentration of the contaminant historically at all representative monitoring sites in the basin, or better. These Measurable Objectives are set as aspirational objectives to promote improving quality and reducing the need for treatment if the well is going to be used for all potential beneficial uses.

- For the organic contaminants (TCE, PCE, and 1,1-DCE), the Measurable Objectives are set based on if the current concentration is below or above the Primary MCL. The Measurable Objectives are defined as: the 2015 concentration, or better, for wells where the current concentration is above the Primary MCL, and non-detect concentration at the wells where the current concentration is below the Primary MCL. These Measurable Objectives are set to uphold that point-source discharge of contaminants should not impair all potential beneficial uses of groundwater.

The Measurable Objectives for the six contaminants at each of the seven representative monitoring sites are defined as the following concentrations, or better, shown in Table 3-4:

Table 3-4. Measurable Objectives for Groundwater Quality in the Spadra Basin

	TDS, mgl	Nitrate-N, mgl	Perchlorate, ugl	TCE, ugl	PCE, ugl	1,1-DCE, ugl
Primary MCL:	--	10	6	5	5	6
Secondary MCL:	500	--	--	--	--	--
Basin Plan Obj.	550	10	--	--	--	--
Well	Measurable Objective					
MW-5	310	1	2	38	57	ND (<0.5) [(a)]
P-19	310	1	2	19 [(a)]	32 [(a)]	ND (<0.5) [(a)]
P-28	310	1	2	ND (<0.5)	ND (<0.5)	ND (<0.5)
CPP-1	310	1	2	ND (<0.5)	ND (<0.5)	ND (<0.5)
CPP-2	310	1	2	52	96	ND (<0.5)
CPP-4	310	1	2	TBD	TBD	TBD
Industry	310	1	2	ND (<0.5) [(a)]	ND (<0.5) [(a)]	ND (<0.5) [(a)]

Notes:

(a) There was no recent (2015-2018) data to develop the measurable objective metric; the measurable objective value is based on historical data from over 15 years ago.

ND Non-detect concentration

TBD To be determined. There is no historical data available to establish a measurable objective; the measurable objective value will be determined from sampling in 2022 and 2023.

Figures 3-3a through 3-3f show the time-series of constituent concentrations and the Measurable Objectives at each of the seven representative sites. The Measurable Objectives defined for the organic contaminants protect against further degradation and promote improvements in groundwater quality from the current concentrations. The Measurable Objectives defined for the inorganic contaminants promote improvements in groundwater quality to the MCL concentrations or better. These Measurable Objectives allow a reasonable margin of operational flexibility between the Measurable Objectives and the Minimum Thresholds that will accommodate levels of uncertainty and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin. The ability to meet these Measurable Objectives will be partly dependent on the projects implemented by the GSA. The projects that could potentially maintain or improve groundwater quality include pumping and treating groundwater, recharging storm water and recycled water, or working with the Regional Board to identify point-source discharges that are impacting the quality at supply wells.

3.3.4 Land Subsidence

3.3.4.1 Undesirable Results

Spadra Basin groundwater is primarily used by the overlying water purveyors and private well owners for the following beneficial uses: potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply. Under certain conditions, the pumping of groundwater can cause permanent subsidence of the overlying land surface to occur, which could damage the overlying infrastructure and adversely impact the overlying land uses and property values. The process of pumping, lowering groundwater levels, aquifer-system compaction, and land subsidence within an alluvial aquifer system is described by the *aquitard-drainage model:*

- The aquifer system of the Spadra Basin consists of permeable sand and gravel layers (the aquifers) interbedded with less-permeable silt and clay layers (the aquitards). Pumping wells cause groundwater-level drawdowns in the aquifers which, in turn, cause the aquitards to slowly drain into the aquifers. The draining allows aquitard pore pressures to decay toward equilibrium with the reduced heads in the adjacent aquifers. Since the pressure of the pore water provides some internal support for the sedimentary structure of the aquitards, this loss of internal support causes the aquitards to compress, resulting in a small amount of subsidence at the land surface. When the pumping wells turn off, and water levels recover in the aquifers, groundwater migrates back into the aquitards and they expand, resulting in a small amount of rebound at the land surface. Over a limited range of water-level fluctuations this process can occur in a purely elastic fashion. That is, a recovery of water levels to their original values causes the land surface to rebound to its original elevation. However, when drawdown falls below a certain "threshold" level, elastic compression transitions to a non-recoverable inelastic compaction of the aquitards, resulting in permanent land subsidence. The "threshold" water level, referred to as the *preconsolidation stress*, is taken to be the maximum past stress to which the sedimentary structure had previously equilibrated under the gradually increasing load of accumulating sediments.
- Drawdowns exceeding a previous threshold water level result in an increase in the value of maximum past stress, and thus the establishment of a deeper threshold, accompanied by an increment of inelastic aquitard compaction. Concomitantly, the compaction results in the one-time irreversible mining of groundwater from the aquitards. The benefits of this process include not only the obvious economic value of the water produced but also the often-overlooked fact that, by establishing deeper thresholds, it increases the volume of confined groundwater storage available for cyclical drawdown and replenishment under strictly elastic conditions. The cost, of course, is the resulting deformation of the land surface and its impact on vulnerable infrastructure.

The land uses overlying the Spadra Basin are largely urban and commercial, including but not limited to streets, highways, homes, businesses, industry, flood-control, and gravity/pressurized pipelines. These land uses contain infrastructure that could be adversely impacted by permanent land subsidence. Permanent land subsidence can lead to deformation of the ground surface and ground fissuring that can damage the overlying infrastructure, reduce its capacity to function as designed, and/or lower property values. The most conservative position for the GSA is to deem that any occurrence of permanent land subsidence caused by groundwater basin management is significant and unreasonable, and thereby,

an Undesirable Result. The Minimum Thresholds established for land subsidence are set to avoid this Undesirable Result.

3.3.4.2 Minimum Thresholds

The *aquitard-drainage model*, described above, explained the *preconsolidation stress* as the "threshold" groundwater level, that when and where exceeded, elastic compression of the aquitards transitions to a non-recoverable inelastic compaction, resulting in permanent land subsidence. Hence, the lack of observed permanent land subsidence indicates the current groundwater levels are above the *preconsolidation stress*. The *preconsolidation stress* can be estimated as the deepest historical groundwater level to which the sedimentary structure had previously equilibrated. For these reasons, the Minimum Thresholds for groundwater levels, which are set at the deepest historical groundwater levels, will be used as a proxy for the Minimum Thresholds for land subsidence.

Section 2.2.4 Ground Levels in the *Basin Setting* Section of this GSP, demonstrated, through an analysis of InSAR estimates of vertical ground motion, that very little permanent land subsidence, if any, has occurred within the Spadra Basin since the mid-1990s. It appears from these InSAR estimates that recent vertical ground motion is small in magnitude (e.g., less than +/-0.1 ft) and elastic in nature. The objective should be is to have negligible downward elastic vertical ground motion (e.g., less than -0.1 ft) across the entire Spadra Basin.

By proxy, the Minimum Thresholds defined for chronic lowering of groundwater levels at the representative monitoring sites in Table 3-1 will be used to assess land subsidence. The Minimum Thresholds for groundwater levels, and by proxy land subsidence, are based on the lowest historical elevation between 1978-2018 and the assumption that the range of observed groundwater levels over the historical period are protective against Undesirable Results for land subsidence, since there were no Undesirable Results over the historical period. Hence, based on these observations and assumptions, maintaining groundwater levels above the Minimum Thresholds should avoid Undesirable Results for land subsidence.

The proposed Minimum Thresholds for groundwater levels are preliminary estimates based on the belief that there will be no Undesirable Results for land subsidence at groundwater levels above these Minimum Thresholds. The assessment of the Minimum Thresholds for groundwater levels, and by proxy land subsidence, can periodically be compared to available data of vertical ground motion measured by InSAR for the Spada Basin region. This includes: the TRE Altamira InSAR data made available by DWR; and the CBWM's InSAR data as part of their subsidence management plan in the neighboring Chino Basin that covers a portion of the Spadra Basin. The GSA will review these available InSAR data sets periodically (target of annually) to observe if there are any notable downward vertical ground motion in the Spadra Basin and compare to the assessment of the Minimum Thresholds set as the lowest groundwater elevations at the representee monitoring sites. The five-year assessments of the GSP implementation will include an analysis of vertical ground motion from available InSAR, and if there is observed permanent downward vertical ground motion greater than 0.1 ft, then the GSA will re-evaluate the need for expanded land subsidence monitoring and/or updated Minimum Thresholds.

3.3.4.3 Measurable Objectives

By proxy, the Measurable Objectives defined for chronic lowering of groundwater levels in Table 3-2 will be used to assess the land subsidence. The Measurable Objectives for groundwater levels and by proxy land subsidence are based on the highest historical elevation between 1978-2018 and representative of the upper boundary of the operating band for groundwater levels and storage, to achieve and maintain

sustainable groundwater management. These Measurable Objectives for groundwater levels can be used as a proxy to evaluate sustainable conditions for land subsidence because there were no observed Undesirable Results for land subsidence during the historical period at the observed groundwater elevations. These Measurable Objective allows a reasonable margin of operational flexibility between the Measurable Objective and the Minimum Threshold that will accommodate wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin, including artificial recharge, pump-and-treat, and conjunctive use projects.

3.4 SUSTAINABILITY GOAL

Per the GSP Regulations 23 CCR § 354.24, each GSA shall establish a Sustainability Goal for the basin that culminates in the absence of Undesirable Results within 20 years, and should include:

- A description of the Sustainability Goal, including information from the Basin Setting used to establish the Sustainability Goal.
- An explanation of how the Sustainability Goal is likely to be achieved within 20 years of the GSP implementation and is likely to be maintained through the planning and implementation horizon.
- A discussion of the measures that will be implemented to ensure the basin will be operated within its Sustainable Yield.

The Sustainability Goal of the Spadra Basin: In a collaborative effort between all Spadra Basin water purveyors, conjunctively use all water supplies available to the Spadra Basin to achieve and maintain groundwater sustainability, avoid Undesirable Results, maximize the beneficial use of the basin, and minimize cost.

The Sustainability Goal of the Spadra Basin was refined over the various steps in the GSP development process. The hydrogeologic information described in *Section 2.2 Basin Setting* of this GSP was used to construct and calibrate a numerical groundwater-flow model (Spadra Basin Groundwater Model documented in Appendix I), which was then used to simulate a Baseline Scenario to determine the long-term sustainability of the basin (see *Sections 5.1 and 5.2 Development and Evaluation of the Baseline Scenario*). The model results of the Baseline Scenario indicated that groundwater levels are projected to decline over the planning horizon by 20-25 ft throughout the basin, which was determined to be not sustainable when compared to the Sustainable Management Criteria described in this section of the GSP. Three Basin Optimization Scenarios, which included various projects to achieve sustainability and/or maximize the beneficial use of the basin, were then developed and evaluated with the Spadra Basin Groundwater Model and a cost model (see Sections 5.3 and 5.4 *Development and Evaluation of Basin Optimization Scenario*). A preferred Basin Optimization Scenario (Scenario 3) was then identified by the GSA that achieves sustainability and maximizes the beneficial use of the basin, and hence, achieves the Sustainability Goal.

The model evaluation of the Basin Optimization Scenario 3 indicates that the Sustainability Goal will be achieved within 20 years and throughout the rest of the planning horizon through implementation of the projects envisioned in Basin Optimization Scenario 3. These projects include the utilization of local available recycled water for artificial recharge and increasing pumping in the Spadra Basin to about 4,800 afy, which represents the long-term Sustainable Yield. A large portion of the Sustainable Yield will

be treated and used for potable water supplies, which will increase potable water-supply reliability by offsetting the need for less-reliable imported water supplies.

New hydrological data and information obtained through the GSP monitoring program described in Section 4 will be used for periodic updates and recalibration of the Spadra Basin Groundwater Model , at a minimum of every ten years. The updated model will be used to evaluate sustainability of current and future conditions for the Spadra Basin GSP implementation. The modeling results can inform if updates are required to the GSP to achieve the Sustainability Goal, and what updates are needed including adaptation of pumping and recharge and/or revisions to the Sustainable Management Criteria. These periodic model updates should coincide with the five-year evaluation requirements for a GSP (see Section 6.1.4).

3.5 INTERIM MILESTONES

In accordance with GSP Regulations 23 CCR § 354.30(e), a GSP shall develop Interim Milestones in five-year increments for each relevant Sustainability Indicator to describe a reasonable path to achieve the Sustainability Goal for the basin within 20 years of GSP implementation. The Interim Milestones are developed for each of the representative monitoring sites where Measurable Objectives and Minimum Thresholds have been set for each relevant Sustainability Indicator.

As described above in *Section 3.4 Sustainability Goal,* the path to achieve the Sustainability Goal within 20 years is to implement the projects and plans in Basin Optimization Scenario 3 (see Sections 5.3 and 5.4 *Development and Evaluation of Basin Optimization Scenario).* These projects and plans achieve the Sustainability Goal in part by maintaining groundwater levels in the basin above Minimum Thresholds and avoiding Undesirable Results (by proxy, the same applies to groundwater storage and land subsidence). Hence, Interim Milestones were established for chronic lowering of groundwater levels based on the projected groundwater elevations for Basin Optimization Scenario 3 at representative monitoring sites in the Spadra Basin.

Interim Milestones for groundwater levels, and by proxy groundwater storage and land subsidence, are listed in Table 3-5 below.

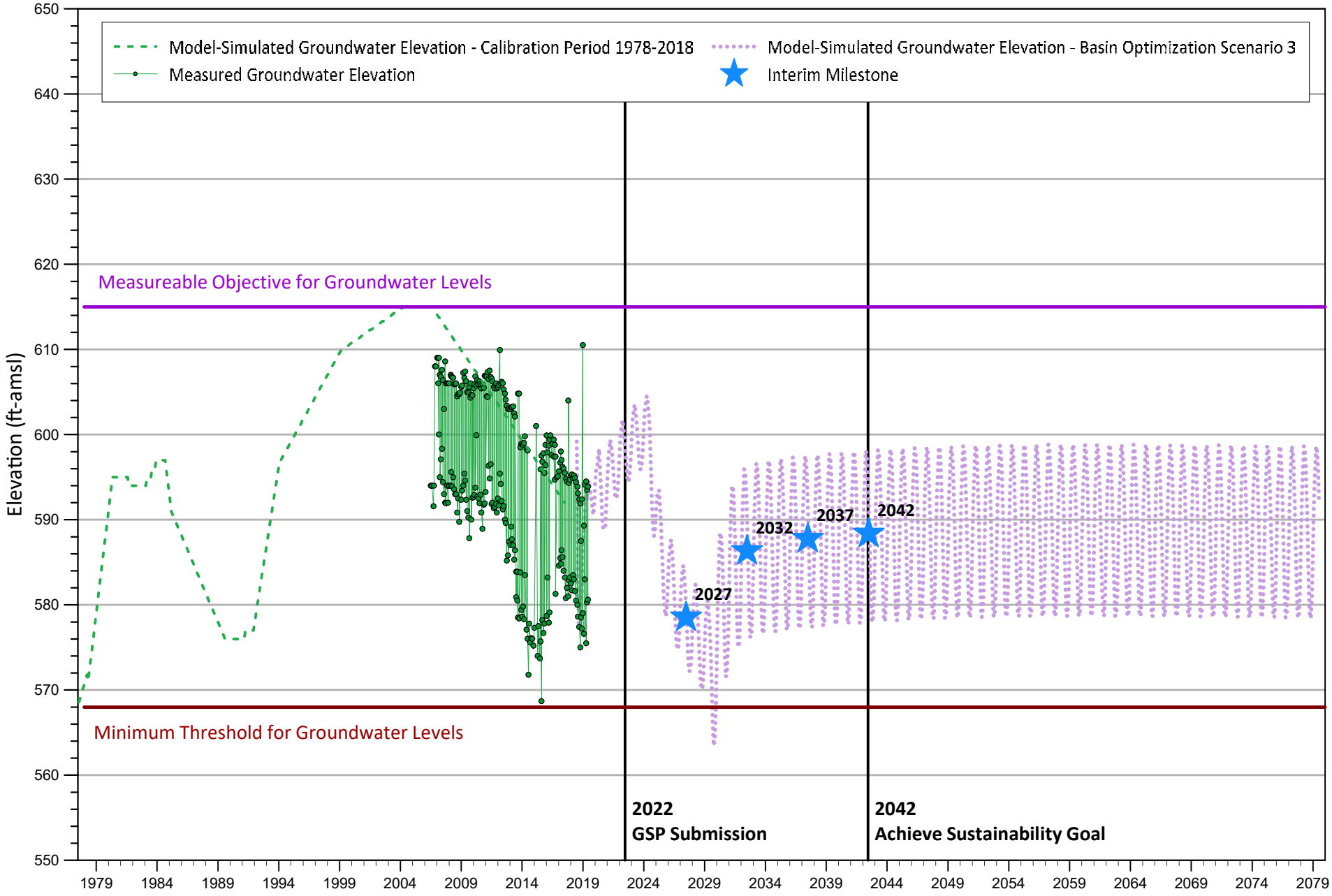
Table 3-5. Interim Milestones for Groundwater Levels in the Spadra Basin

Well	2027	2032	2037	2042
	Interim Milestone, ft-amsl			
Industry	579	586	588	588
CPP-4	606	615	616	617
P-28	613	622	623	624
CPP-1	631	636	638	638
P-19	655	644	646	647
OMW-3	671	658	658	659
MW-5	679	671	666	664

Figures 3-4a through 3-4g are time series charts that show the Interim Milestones graphically for each representative monitoring site, along with measured and modeled groundwater elevations, the Minimum Threshold, and the Measurable Objective. The charts indicate the time of the GSP submittal and the end of the 20-year period to achieve the Sustainability Goal.

Specific Interim Milestones for groundwater quality have not been established because they do not represent a path to achieve the Sustainability Goal for the basin. Interim Milestones for groundwater quality can be considered any concertation between the Minimum Thresholds and Measurables Objectives set at the representative monitoring sites.

Figure 3-4a. Five-Year Interim Milestones at Industry



WEST YOST

954-80-20-01 GRAPHER\GRF\TMs\TM5\Figure 3-4a

Figure 3-4b. Five-Year Interim Milestones at CPP-4

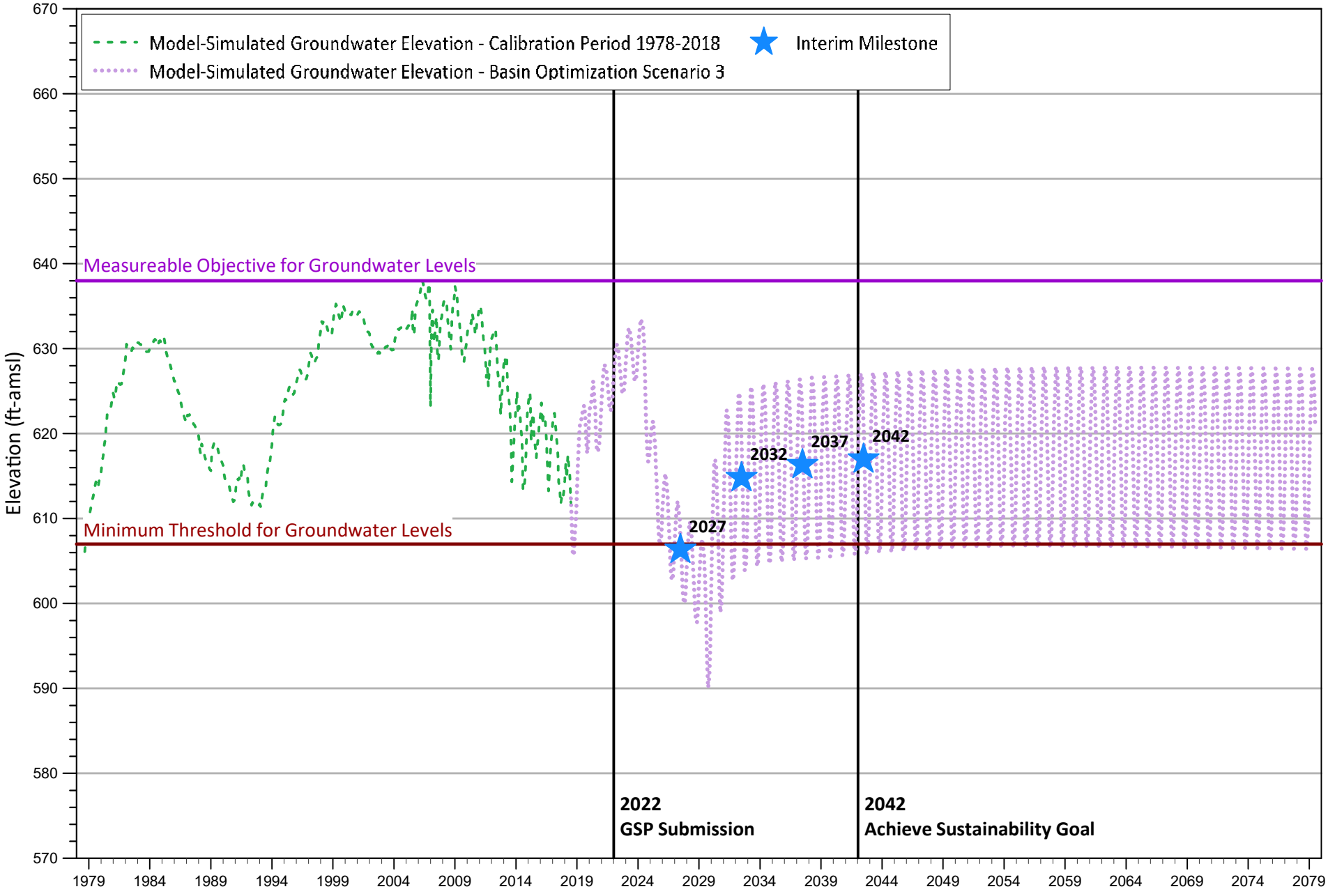


Figure 3-4c. Five-Year Interim Milestones at P-28

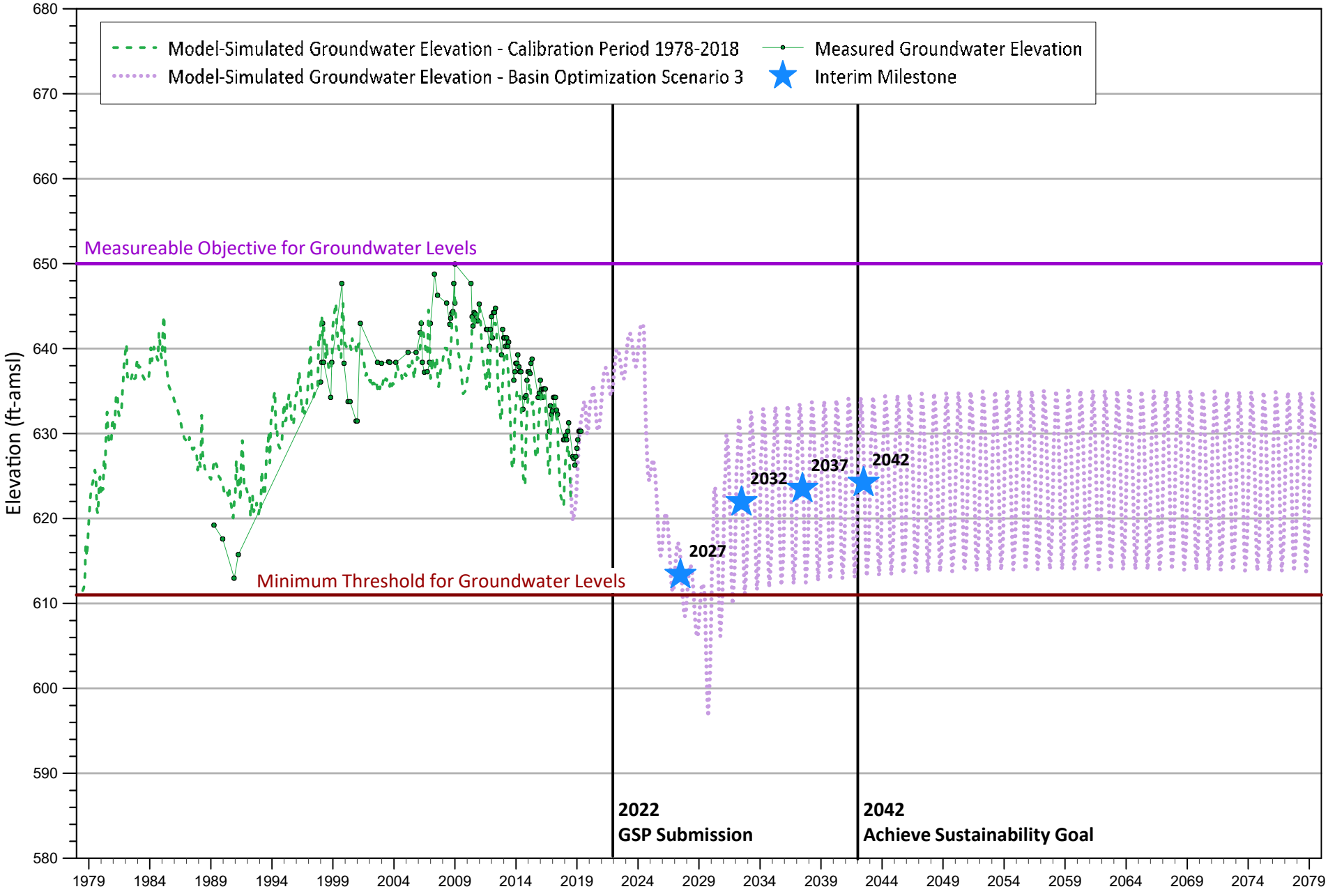


Figure 3-4d. Five-Year Interim Milestones at CPP-1

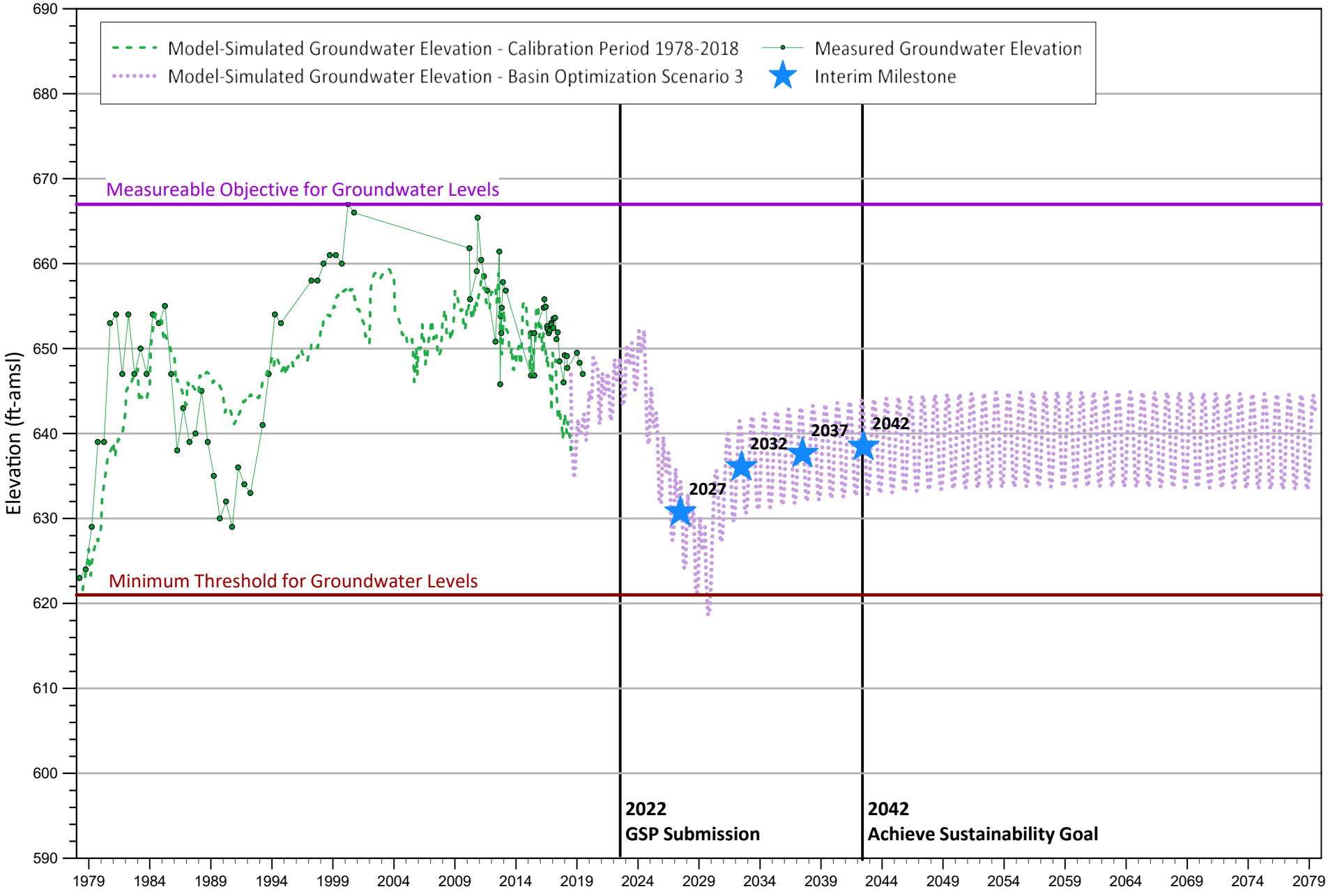


Figure 3-4e. Five-Year Interim Milestones at P-19

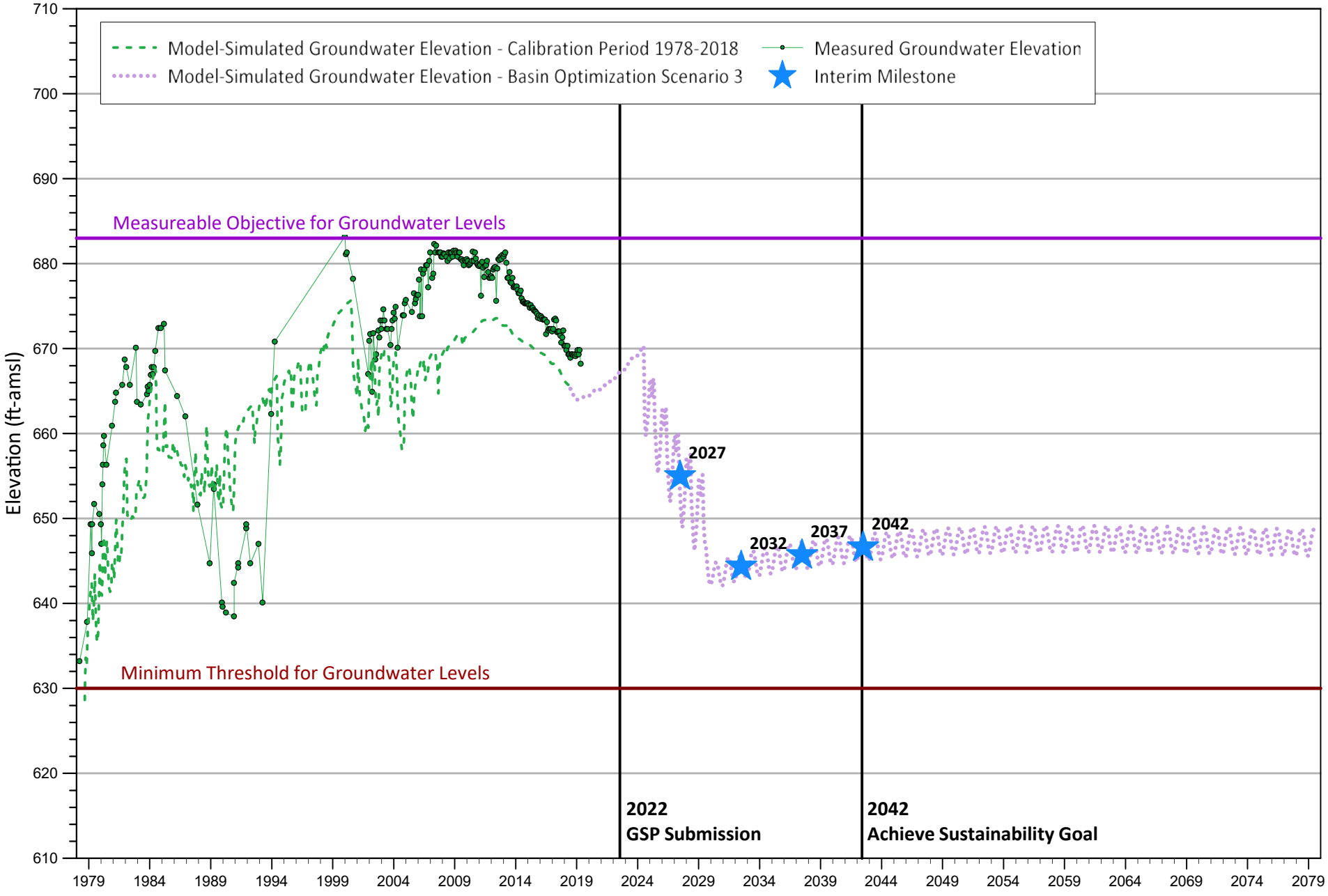


Figure 3-4f. Five-Year Interim Miletones at OMW-3

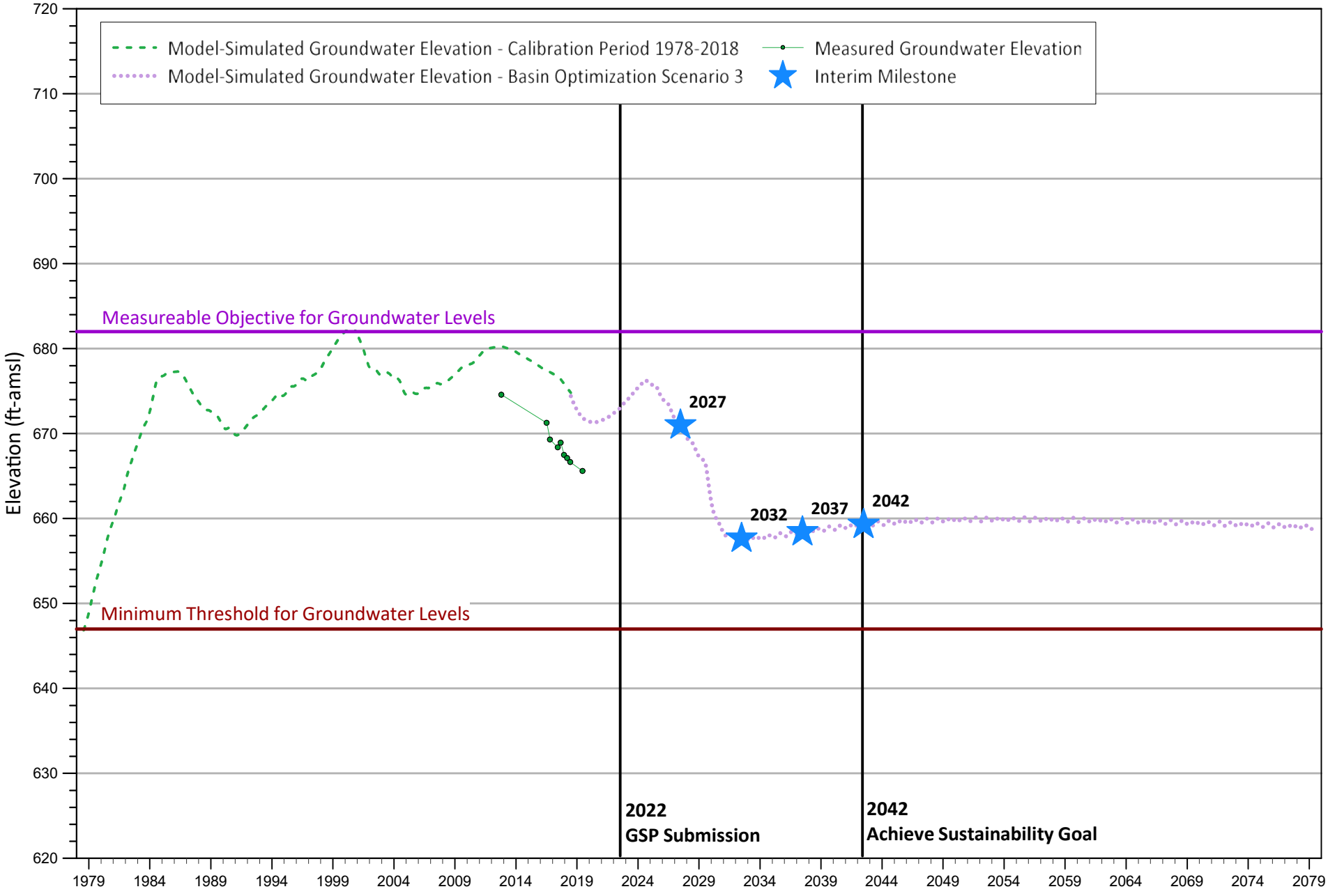
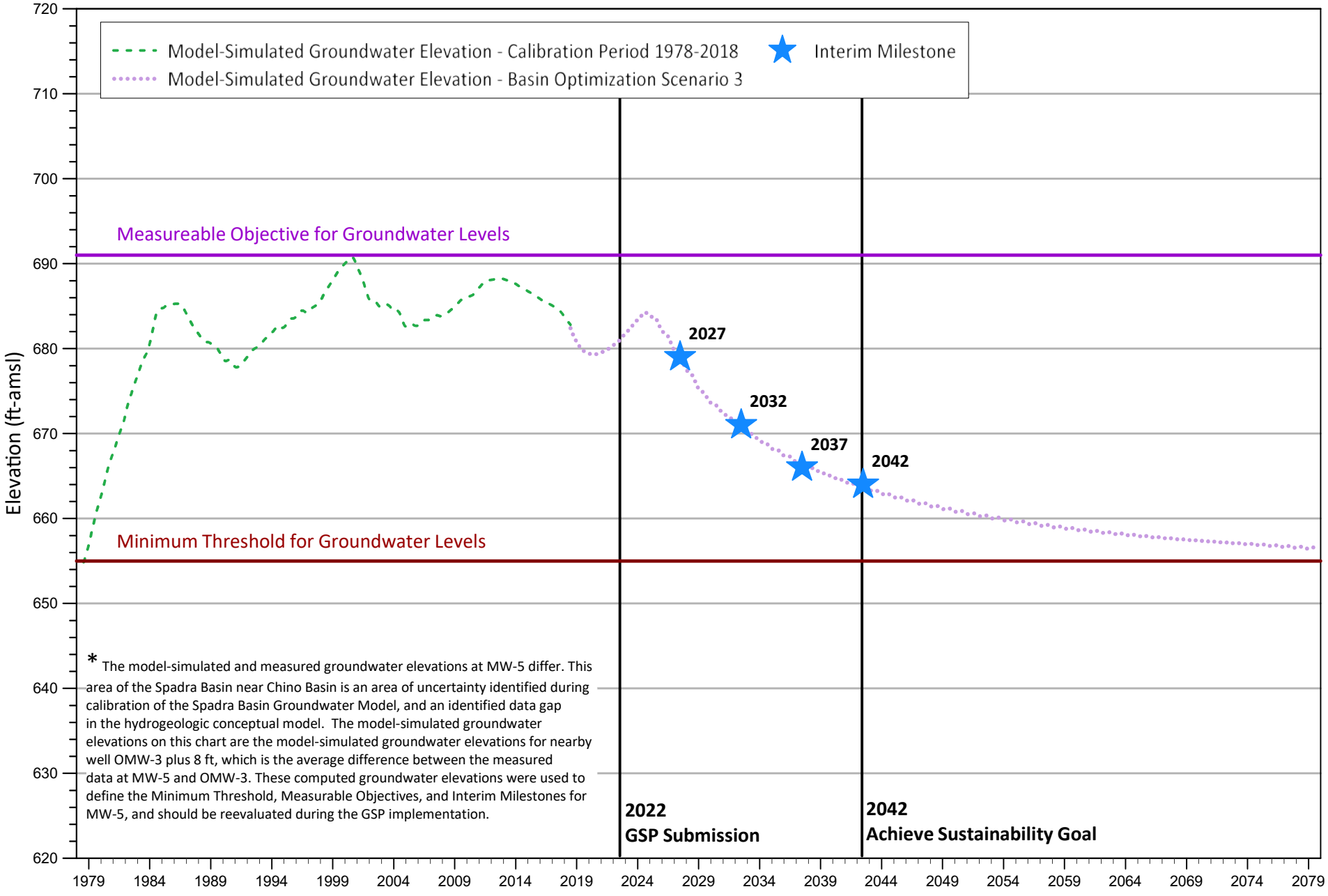


Figure 3-4g. Five-Year Interim Miletones at MW-5



SECTION 4
Monitoring Program

This section describes the GSP monitoring program in accordance with the GSP Regulations for monitoring networks (23 CCR § 354.32 Et seq.). The monitoring program is intended to provide data on the Sustainability Indicators for the Spadra Basin with sufficient accuracy and quantity to demonstrate that the basin is being sustainably managed. The Sustainability Indicators relevant to the Spadra Basin include:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage
- Degraded water quality
- Land subsidence

The objective of the monitoring program is to collect data of sufficient quality, frequency, and distribution to characterize conditions in the basin and evaluate GSP implementation as it relates to:

- Demonstrating short-term, seasonal, and long-term trends in groundwater and related surface conditions.
- Tracking changes in groundwater conditions relative to Minimum Thresholds.
- Detecting impacts to the beneficial uses and users of groundwater.
- Demonstrating progress toward achieving Interim Milestones and Measurable Objectives.
- Collecting data to be used in future updates to the groundwater model that can be used to evaluate groundwater conditions and quantify changes in water budget.

Historically there has been no formal coordinated monitoring effort implemented in the Spadra Basin. Groundwater monitoring was performed by the individual water purveyors and other well owners at various frequency for their own needs. The monitoring program developed for this GSP expands and improves upon the monitoring performed historically in a coordinated effort to achieve the monitoring objectives described above.

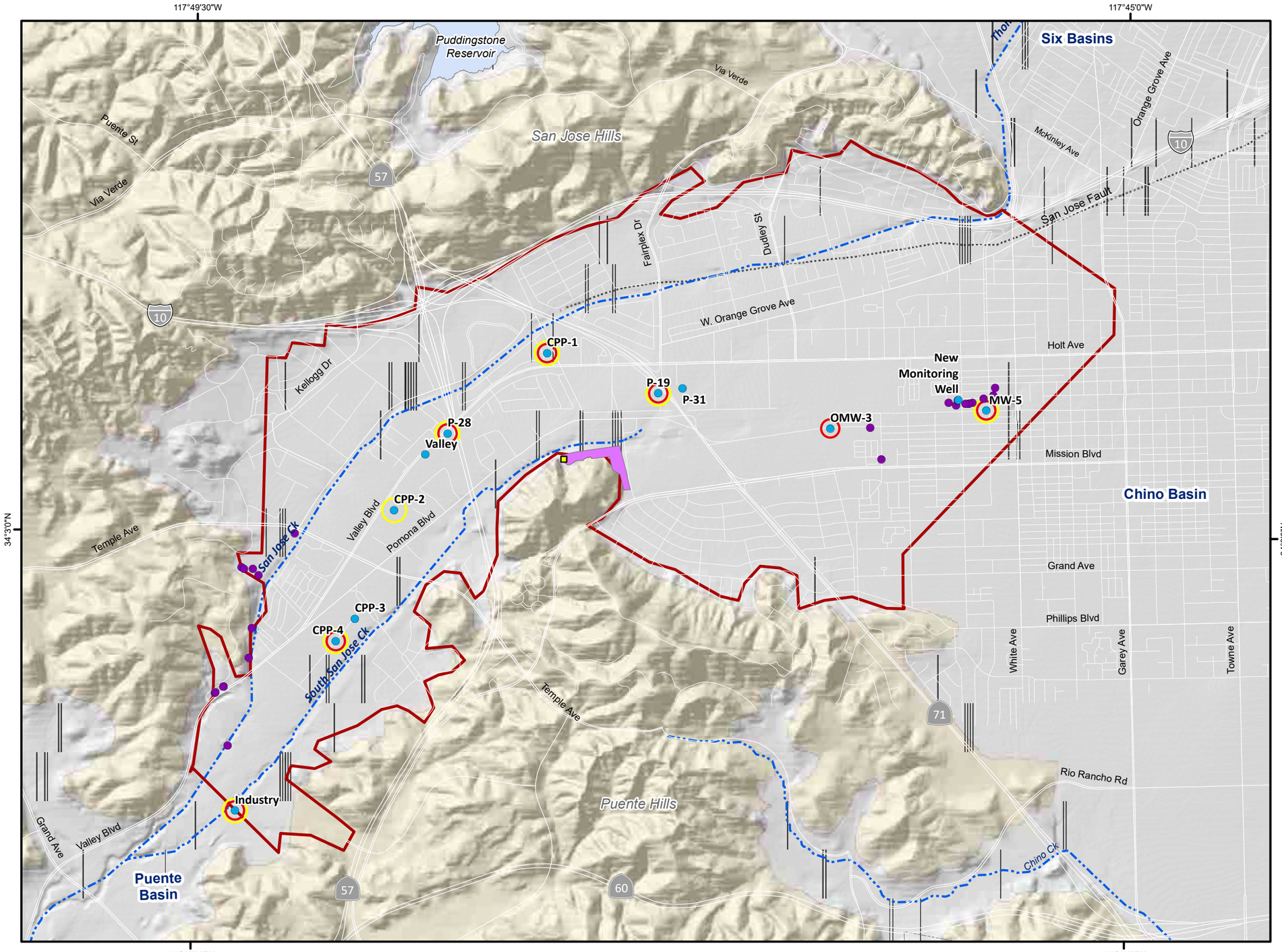
4.1 DESCRIPTION OF THE MONITORING PROGRAM

The Spadra Basin monitoring program includes monitoring of groundwater (levels, quality, and production), surface water, and land subsidence. For each of these data types this section describes:

- Monitoring locations and frequency, and methods of data collection and management.
- Monitoring protocols to ensure that data is collected and managed in a consistent, industry-standard fashion.
- Relation of monitoring program to representative monitoring sites described and established in *Section 3 Substantiable Management Criteria* for the relevant Sustainability Indicators to the Spada Basin.

4.1.1 Groundwater Monitoring

Groundwater monitoring is the primary component of the Spadra Basin monitoring program, and includes collecting groundwater level, groundwater quality, and production data at all existing wells in the basin. In addition, a new monitoring well is planned for construction in 2022 to fill a gap in the monitoring network. Figure 4-1 shows the wells in the groundwater monitoring network.



- Wells Monitored by the GSA for Groundwater Levels and Groundwater Quality
- Representative Monitoring Site for Groundwater Levels (by Proxy, Groundwater Storage and Land Subsidence)
- Representative Monitoring Site for Groundwater Quality
- Wells Sampled by Others and Data is Collected by the Spadra Basin GSA
- Pomona WRP
- Pomona WRP Effluent Discharge
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 1/14/2022
File: Figure 4-1.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Spadra Basin GSP Monitoring Network

Figure 4-1

4.1.1.1 Groundwater Levels

Groundwater-level monitoring by the GSA will occur at 12 wells. The 12 wells to be monitored by the GSA are shown on Figure 4-1 and listed below in Table 4-1.

Table 4-1. Wells to be Monitored by the GSA for Groundwater Levels and Groundwater Quality

Well	Well Type	Well Owner	Representative Monitoring Site for WL	Representative Monitoring Site for WQ
Industry	Production	WVWD	X	X
CPP-4	Production	CPP	X	X
CPP-3	Production	CPP		
CPP-2	Production	CPP		X
Valley	Monitoring	WVWD		
P-28	Production	Pomona	X	X
CPP-1	Production	CPP	X	X
P-19	Production	Pomona	X	X
P-31	Production	Pomona		
OMW-3	Monitoring	Calsol	X	
MW-5	Monitoring	Calsol	X	X
New Spadra Monitoring Well	Monitoring	Spadra GSA	n/a [(a)]	n/a [(a)]

(a) This monitoring well has not been constructed yet. When the well is constructed and monitoring has been initiated at this well, it will be considered for inclusion as a representative monitoring site.

These wells are spatially distributed throughout the basin at about every 0.25 mile to 0.75 mile. The wells include all water purveyor production wells in the basin, two monitoring wells at the Calsol Inc. contaminant site, and one future monitoring well that will be constructed by the GSA to fill a gap in the monitoring network.

The GSA will monitor for groundwater levels at these 12 wells using a pressure transducer (if possible) that measures and records water levels once every 15 minutes. These data will be retrieved in the field on a quarterly basis. If a pressure transducer cannot be installed in the well casing to collect the high-frequency data, then a manual measurement of depth-to-groundwater will be collected monthly. The high-frequency data collected by the transducers is sufficient to fully understand the seasonal and long-term trends in groundwater levels to evaluate the groundwater-level conditions, including the response of the basin to GSP implemented projects and comparison to the Sustainable Management Criteria.

The remaining wells shown in Figure 4-1 are dedicated monitoring wells primarily for the point-source contaminant monitoring at the Spadra Landfill and Calsol Inc. sites. Groundwater-level monitoring at these wells is performed at varying frequencies by the well owners. Annually, the GSA will collect all available groundwater-level data for these wells from the well owners.

4.1.1.1.1 Representative Monitoring

Seven of the 12 wells are representative monitoring sites established and described in Section 3 Sustainable Management Criteria for assessment of the Sustainability Indicators of chronic lowering of groundwater levels, and by proxy, reduced groundwater storage and land subsidence. The wells that are representative monitoring sites are indicated on Figure 4-1 and Table 4-1. Groundwater elevations will be measured and evaluated at the representative monitoring sites to assess sustainability in relation to the Measurable Objectives and Minimum Thresholds for groundwater levels, and by proxy for groundwater storage and land subsidence. The adequacy of using groundwater elevations as a proxy for groundwater storage and land subsidence is described in Sections 3.3.2 and 3.3.4.

4.1.1.1.2 Monitoring Protocols

The goal is for the GSA to install and use pressure transducers with data loggers that measure and record groundwater-elevation measurements every 15-minutes at the 12 wells monitored by the GSA. If it is not possible to install a transducer at a well, then the default measurement method will be manual measurements performed at the well monthly. The GSA will coordinate and conduct the monitoring via transducers or manually at the 12 wells in Table 4-1 using consistent procedures and protocols to ensure comparable data and methodologies The GSA will utilize the standard operating procedures (SOPs) in Appendix J for groundwater-level monitoring using transducers, and procedures for manual water-level measurements.

To set up the groundwater-level monitoring network, the GSA will need to coordinate and install transducers at the 12 wells in Table 4-1; this includes:

- Coordination with well owners to determine status of well, obtain access to well site and inside of the well.
- Performing a site visit at each well to inspect: the access to the well site; access to the inside of the well; if it is physically possible to install a transducer in the well; proper location to install transducer in well; the depth-to-groundwater, and the proper installation hardware and equipment to purchase.
- Obtain all necessary installation and monitoring equipment.
  - Transducers must be properly specified to have a sufficient measurement range to capture accurate data for each well. Historical groundwater-level data for the well or nearby wells will be used to guide in the selection of the transducer model with applicable range and depth for each well.
  - Direct read cables will be the default installation hardware for the transducers. If a direct read cable cannot be installed, then stainless-steel wire will be used for installation.
- Install transducers in wells via a direct cable or stainless-steel wire. At each well a sketch will be drawn that includes the well location, well construction in relation to the ground surface, location of the designated reference point for measuring depth-to-water, and measured distance from the ground to the designated refence point. Pictures of the well and well site will be taken. These photos and well sketches will be maintained in the data management system for the GSP, for easy access to this well information.

Two weeks after installation the transducers will be tested in the field to ensure they are working properly to prevent the loss of data due to malfunction or improper installation. At this time, any issues will be addressed immediately if needed. Following this two-week period, quarterly field visits will be conducted to download the 15-minute data from the transducers at the 12 wells. During download, manual

measurements of the depth-to-water in ft will be collected with a precision sounder to ensure accuracy of the 15-minute data from the transducers. Following each quarterly download, the 15-minute data will be checked and processed. The raw data-logger files from the monitoring wells will be converted from pressure to depth-to-water based on the manual water-level measurements collected in the field. The data will be checked for quality assurance and quality control (QA/QC) and uploaded to the data management system for the Spadra Basin GSA.

If needed, manual depth to water measurements using a sounder will be collected monthly by the GSA at a Spadra GSA monitoring well if a transducer is unable to be installed. Manual measurements shall be collected in accordance with the SOP in Appendix J. Following measurement in the field, all data will be processed, reviewed for QA/QC, and uploaded to the data management system for the Spadra Basin GSA.

For the remaining wells in the monitoring network that are not monitored by the Spadra GSA, water-level measurements will be collected by the well owners and/or monitoring entities and the GSA will collect this data. The measurement frequency is dependent on the well owner, but the GSA will encourage monthly measurements at a minimum. All data will be processed, reviewed for QA/QC, and uploaded to the Spadra Basin GSA data management system along with the rest of the data collected by the GSA at the Spadra GSA monitoring wells.

All water level data will be stored in the Spadra GSA data management system as both depth-to-water measurements in ft-bgs and groundwater elevations in ft-amsl. A depth-to-water measurement in ft will be collected via transducer or manual methods and groundwater elevation is calculated using the following equation:

$$GWE = RP - DTW$$

Where:

GWE = groundwater elevation (ft-amsl)

RP – reference point elevation (ft-amsl)

DTW – depth to water (ft-bgs)

All the groundwater elevation measurements will be refenced to a reference point elevation at the well that is determined from a consistent elevation datum. The ground surface elevation at the well will be determined from the 10-meter digital elevation model (DEM) in the National Geodetic Vertical Datum of 1929 (NGVD 29). At each well, a designated well reference point will be identified at the top of the well to manually measure depth-to-water from, and the distance from the ground surface to the reference point will be measured. A refence point elevation will be calculated using the following equation:

$$RP = GSE + (GS\ to\ RP)$$

Where:

RP – reference point elevation (ft-amsl)

GSE = ground surface elevation (ft-amsl)

GS to RP – the measured distance from the ground surface to the reference point (ft). The distance is a positive number if the distance is above ground, and a negative number if the distance is below ground.

The refence point elevation will be entered into the database and will be used to calculate a groundwater elevation from the depth to water measurement.

For the wells monitored by the GSA, custom field sheets will be made to indicate the designated well reference point to measure depth to water from, and if possible, the well reference point will be permanently marked at its location at the top of the well. Sketches of each GSP monitoring well will be done that include the well reference point and the measured distance from the reference point to the ground surface.

4.1.1.2 Groundwater Quality

Groundwater-quality data will be collected at the 12 wells monitored by the GSA shown in Figure 4-1 and listed in Table 4-1. The 12 GSP monitoring wells are spatially distributed along the axis of the basin, the thickest and main portion of the aquifer, and will represent groundwater-quality conditions for the entire basin. The wells include all water purveyor production wells in the basin, two monitoring wells at the Calsol Inc. contaminant site, and one future monitoring well that will be constructed by the GSA to fill a gap in the monitoring network.

Groundwater-quality sampling and analyses will occur at a minimum of every three years for the recommend analytes and laboratory analytical methods and detection limits listed in Table 4-2. The recommend analytes include general mineral and physical chemistry, VOCs, and perchlorate, which are necessary to assess current groundwater-quality conditions for contaminants of concern and compare to the Sustainable Management Criteria. These recommended analytes may need to be modified in the future based on the need to monitor for new or emerging contaminants identified by the GSA. Groundwater-quality sampling will be performed by the well owners and the data will be provided to the GSA along with all other groundwater-quality data collected by the well owners. If well owners are unable to monitor for the recommended analytes and frequency desired by the GSA, then the GSA can opt to perform the monitoring.

Table 4-2. Analyte List for Groundwater Quality Monitoring

Analyte	Method Detection Limit	Laboratory Analysis Method
Alkalinity in CaCO3 units	2 mgl	SM 2320B
Ammonia Nitrogen	0.05 mgl	EPA 350.1
Bicarbonate as HCO3	2 mgl	SM2330B
Calcium	1 mgl	EPA 200.7
Carbonate as CO3	2 mgl	SM2330B
Chloride	0.5 mgl	EPA 300.0
Hydroxide as OH	2 mgl	SM2330B
Magnesium, Total	0.1 mgl	EPA 200.7
Nitrate as Nitrogen	0.1 mgl	EPA 300.0
Nitrite as Nitrogen	0.05 mgl	EPA 300.0
Organic Nitrogen	0.2 mgl	EPA 351.2
pH	0.1	SM4500
Perchlorate	2 µgl	EPA 314.0
Potassium Total	1 mgl	EPA 200.7
Sodium Total	1 mgl	EPA 200.7
Specific Conductance, 25 C	10 µmhos/cm	SM2510B
Sulfate	0.05 mgl	EPA 300.0
Total Dissolved Solids (TDS)	10 mgl	E160.1/SM2540C
Total Hardness as CaCO3	3 mgl	SM 2340B
Total Organic Carbon	0.2 mgl	SM 5310C
Turbidity	0.1 NTU	EPA 180.1
Volatile Organic Compounds (VOCs)	Variable	EPA 524.2
1,2,3-Trichloropropane (low detection of 0.005 µgl)	0.005 µgl	CASRL 524M-TCP[(a)]

(a) Can use this method or a comparable laboratory specific method with a method detection limit of 0.005 µgl
NTU = nephelometric turbidity unit
µmhos/cm = micromhos per centimeter

The remaining wells shown in Figure 4-1 are dedicated monitoring wells primarily for the point-source contaminant monitoring at the Spadra Landfill and Calsol Inc. sites. Groundwater-quality monitoring at these wells is performed at varying frequencies by the well owners. Annually, the GSA will collect all available groundwater-quality data for the past year at these wells from sampling by the well owners.

4.1.1.2.1 Representative Monitoring

Seven of the 12 wells monitored by the GSA are representative monitoring sites for the Sustainable Management Criteria established in Section 3 of this GSP for the Sustainability Indicator of degraded water quality. Monitoring of groundwater quality at the seven representative monitoring sites will be conducted by collecting triennial samples (at a minimum) for the six contaminants of concern. If a contaminant concentration is above the Minimum Threshold set at any well, subsequent monitoring will be done within a year to verify the occurrence of an Undesirable Result.

4.1.1.2.2 Monitoring Protocols

Groundwater-quality monitoring is performed at wells in the Spadra Basin by the well owner. The 12 wells monitored by the GSA (Figure 4-1 and Table 4-1) will be sampled at a minimum for the analytes listed in Table 4-2 on a triennial basis. The groundwater-quality sampling will be performed by the well owners and/or monitoring entities and the data will be provided to the GSA along with all other groundwater-quality data collected by the well owners. If well owners are unable to monitor for the recommended analytes and frequency at the 12 wells in Table 4-1, then the GSA can opt to perform the monitoring. All groundwater-quality analyses are to be performed by laboratories certified under the State Environmental Laboratory Accreditation Program. For consistency that groundwater-quality monitoring at the 12 wells should use the laboratory methods indicated in Table 4-2.

Groundwater will be performed by multiple well owners and/or monitoring entities in the basin, including the GSA and parties to the GSA. The following general data collection protocols should be followed by each sampler:

- Prior to sample collection, order new sample bottles appropriate to each laboratory analysis from the designated laboratory certified under the State Environmental Laboratory Accreditation Program.
- Field forms should be complete for each sample site to document at a minimum: the date/time, sampler, conditions at well, depth-to-water measurement, and field water quality parameters.
- Purge the well casing prior to collecting a sample. Production wells should be sampled while the pump is running. Monitoring wells shall be purge using a submersible pump or bailer.
- Use a water-quality meter with probes that can measure multiple field water quality parameters. Recommended field water quality parameters include TDS, specific conductance, pH, temperature, and turbidity. Collect and log these parameters about every five minutes while purging the well and assure parameter stabilization (within 10 percent) for three consecutive measurements prior to collecting sample. And collet and log one round of field water quality parameters after the sample is collected.
- Based on the sampled constituent, water quality sample collection shall follow specific processing and treatment guidelines per the laboratory method and guidance to assure the accuracy of the data.
- After collection, all sample bottles shall be sealed in zip-closure polyethylene bags that are typically provided by the lab and placed in an insulated cooler with ice for transport to the laboratory. All samples shall be delivered to the laboratory following standard chain-of-custody procedures with these appropriate prescribed holding times.

The GSA will collect that water-quality data from the sampling performed by the multiple well owners/ monitoring entities at a minimum of once per year. Electronic data deliverables (EDDs) prepared by the laboratory, in Microsoft Excel, is the preferred format to the provided to the GSA. All data will be processed, reviewed for QA/QC, and uploaded to the data management system for the Spadra Basin GSA.

4.1.1.3 Groundwater Production

Groundwater production data are analyzed together with groundwater-level data to characterize the influence of pumping on groundwater levels. Groundwater-production data are also used as input to the Spadra Basin Groundwater Model that is used to evaluate past and future groundwater conditions, including the annual change in storage calculation that is required for annual reporting to the DWR (23 CCR § 356.2).

Groundwater production data will be collected at all active production wells in the basin. Currently, eight of the 12 wells monitored by the GSA are active or inactive water supply wells, with meters that have been installed by the well owner. The well owners will provide monthly production volumes measured at the water supply wells to the GSA. The data will be collected annually.

4.1.1.3.1 Monitoring Protocols

The DWR requires annual reporting by the GSA of all groundwater production volumes, the measurement method, and accuracy of the method (23 CCR § 356.2[b][2]). All groundwater pumping in the Spadra Basin will be measured via flow meters and reported to the GSA. The individual well owners in the Spadra Basin are responsible for the installation and maintenance of flow meters at their active wells. To ensure accurate reporting of the production volumes, meters should be tested and validated routinely. Each well owner is responsible for testing the flow meter every two years by a California-licensed pump contractor for meter accuracy. If test results are not within +/- 5 percent accuracy of 100 percent, follow-up testing can be performed, or the meter should be fixed or replaced. Reports of meter testing should be reported to the GSA within 30 days of completion of the test. Additionally, if a meter is broken, it is up to the well owner to resolve this issue as soon as possible to fix or install a new meter.

Once a year the GSA will collect production data for all active production wells in the Spadra Basin. The measurement frequency is dependent on the well owner, but the GSA will encourage monthly measurements at a minimum. Monthly production data should include the meter model and ID, meter units, a beginning and end meter recording, and the monthly production volumes in af. Data will be processed, reviewed for QA/QC, and uploaded to the data management system for the Spadra Basin GSA.

4.1.1.3.2 Representative Monitoring

There are no representative monitoring sites for production for the *Section 3 Substantiable Management Criteria*.

4.1.2 Surface Water Monitoring

Surface-water discharge in the concrete-lined channels exits the Spadra Basin towards the west via two main channels—San Jose Creek and South San Jose Creek. There are no active surface-water discharge monitoring stations within these two channels across the Spadra Basin.

Surface-water discharge and quality monitoring is performed by LACSD at the Pomona WRP for effluent discharged to the South San Jose Creek (see Figure 4-1 for location). The discharge from the Pomona WRP is a portion of the flow in the South San Jose Creek. The GSA will collect the discharge and water-quality data from the LACSD. The monitoring of the Pomona WRP discharge is important to the GSA to track and understand the volume and quality of water that exits the Spadra Basin from this channel because:

- Surface water that exits the Spadra Basin in the concrete-lined channels serves beneficial uses by downstream entities for groundwater recharge or is consumptively used by riparian vegetation in downstream unlined stream reaches.
- The surplus recycled water from the Pomona WRP that is discharged to South San Jose Creek is the source of water being considered for artificial recharge or expanded reuse in the proposed projects for consideration in this GSP (Sections 5.3 and 5.4) to achieve sustainability and maximize the beneficial use of the basin.

The surface-water discharge and quality monitoring data of the Pomona WRP effluent will be collected from the LACSD by the GSA annually.

4.1.2.1 Representative Monitoring

As described in *Section 2.2.5 Surface Water and Groundwater Dependent Ecosystems*, all streams that cross the Spadra Basin are concrete-lined flood-control channels which prohibits groundwater/surface-water interactions. Therefore, surface water data is not used to evaluate conditions in the Spadra Basin relative to the Sustainable Management Criteria for any relevant Sustainability Indicators of the Spadra Basin.

4.1.2.2 Monitoring Protocols

Monitoring of the Pomona WRP is performed by the LACSD in accordance with monitoring and reporting requirements in the NPDES permit *No. CA0053619 - Order No. R4-2021-0097 and WDRs for the Joint Outfall System Pomona Water Reclamation Plant, Los Angeles County, Discharge to the South Fork San Jose Creek.* Monitoring includes daily discharge, and for specified water quality parameters either daily, weekly, monthly, quarterly, or semi-annually. The GSA will collect the Pomona WRP discharge and water quality monitoring data that is available online from the State's California Integrated Water Quality System Project (CIWQS) website.[1] This data is important for the Spadra Basin GSA to track to understand the volume and quality of this water that is exiting the Spadra Basin and that potentially will be used for envisioned projects to achieve sustainability and maximize the beneficial use of the basin. All collected data will be processed, reviewed for QA/QC and uploaded to data management system for the Spadra Basin GSA.

4.1.3 Land Subsidence

As described in *Section 2.2.4 Ground Levels,* available data from the subsidence monitoring program in the neighboring Chino Basin indicates that minor downward ground motion has occurred across the Spadra Basin over the period of 1982-2018. The Minimum Thresholds set for the lowering of groundwater levels will be used as a proxy for the land subsidence Sustainability Indicator. However, monitoring of land subsidence will be conducted periodically (minimum of every five years) by the GSA via available InSAR data to verify that permanent land subsidence is not occurring.

[1] CA Waterboards/Public Report

4.1.3.1 Representative Monitoring

Monitoring for the Sustainability Indicator of land subsidence will be done by proxy through the groundwater-level monitoring network described in Section 4.1.1.1. The adequacy of using groundwater elevations as a proxy for land subsidence is described in Section 3.3.4.

4.1.3.2 Monitoring Protocols

There are two sources of vertical ground motion data measured by InSAR for the Spadra Basin area that will be periodically reviewed:

- ***The TRE Altamira InSAR data made available by DWR.*** This dataset is measurements of vertical ground surface displacements in over 200 populated groundwater basins across the State of California. Vertical displacement estimates are derived from InSAR data from the European Space Agency Sentinel-1A satellite and processed by TRE Altamira under contract with the DWR. The DWR provides this data set on the SGMA Data Viewer website[2] as part of its efforts to provide technical assistance and SGMA-relevant data to the GSAs for GSP development and implementation. The dataset is point or raster grid data for 100 x 100-meter area. The dataset covers the Spadra Basin area and is currently available from 2015 to 2020. As this dataset is continually updated, the GSA will periodically review an InSAR map of vertical ground displacement of the Spadra Basin area through the most available period.
- ***The CBWM's InSAR data as part of their subsidence management plan.*** The CBWM conducts a subsidence management plan in the neighboring Chino Basin to minimize or abate the occurrence of subsidence and ground fissuring. Currently the CBWM's efforts are focused on developing a specific management plan for the Northwest MZ-1 which is an area directly adjacent to the Spadra Basin. Part of CBWM's subsidence monitoring includes InSAR data that is acquired from the post-processing of land-surface displacement data from the TerraSAR-X satellite operated by the German Aerospace Center. The GSA will periodically review maps of the InSAR data in the annual reports that are prepared for the subsidence management plan which includes a portion of the Spadra Basin (West Yost, 2021).

The GSA will periodically review these InSAR data sets to observe if there is any notable downward vertical ground motion in the Spadra Basin and compare to the assessment of the Sustainable Management Criteria for groundwater levels that will be used as a proxy. Every five years, during the five-year elevations of the GSP described in Section 6.1.4, the GSA will collect and review these available InSAR data sets and provide a discussion of the results and an analysis of the proxy Minimum Thresholds for groundwater levels and the potential need to update any Sustainable Management Criteria for groundwater levels or land subsidence.

4.2 DATA MANAGEMENT

Pursuant to the GSP Regulations (23 CCR §352.6), each GSA shall develop and maintain a data management system capable of storing and reporting information relevant to the development or implementation of the GSP and the monitoring of the basin. During the initial stages of the development

[2] SGMA CA Water

of the GSP, the Spadra Basin GSA utilized a data management system to store all the historical and current data necessary to prepare the GSP. As described throughout this monitoring program all data collected from the GSA monitoring program will be routinely processed, checked for QA/QC to ensure data validity, and uploaded to the GSA's data management system.

4.3 ASSESSMENT AND IMPROVEMENT OF MONITORING PROGRAM

The monitoring program described herein is the first coordinated monitoring effort in the Spadra Basin, and addresses some of the data gaps identified in the *Basin Setting Section 2.2.7* of this GSP. The monitoring program includes either monitoring by the GSA or collecting data at all known existing and accessible wells in the Spadra Basin. The 12 wells that will be monitored by the GSA include a soon to be constructed monitoring well that fills data gaps identified in Section 2.2.7 for hydrogeologic data near the Chino/Spadra Basins boundary. Some additional actions that can be taken by the GSA upon GSP implementation to fill data gaps are:

- Continuing efforts with the owner of the only known private production well in the basin (Walnut Hills Mobile Home Park) for inclusion in the GSP monitoring program.
- Perform a well canvas for any other unknown private wells in the basin, and work with well owners for inclusion in the GSP monitoring program.
- Execute data sharing agreements with the CBWM and Puente Basin Water Agency (PBWA) for sharing data with the neighboring and hydrologically connected Chino and Puente Basins.
- The initiation of a program to collect high-resolution production data at the active production wells to understand how pumping patterns related to observed groundwater levels, better understand aquifer parameters, and improve the hydrogeologic conceptual model. This may include leveraging the water purveyors' existing SCADA systems.
- The addition of surface water gaging stations at upstream and downstream locations along San Jose Creek to monitor storm water and dry-weather runoff to better understand and characterize these potential sources of recharge to the basin.

Per the GSP Regulations (23 CCR § 354.38) the GSP monitoring network will be evaluated in each five-year assessment and update of the GSP, including a determination of uncertainty and if there are monitoring gaps that need to be filled. Future updates and adjustments to the GSP monitoring program could include:

- The addition of any newly constructed wells into the monitoring program.
- The addition of existing wells that are monitored by others to the group of designated GSP wells where frequent and coordinated monitoring is performed by the GSA, to fill spatial data gaps to achieve the objectives of the monitoring program.
- The construction of additional monitoring well/s to fill spatial data gaps in the hydrogeologic conceptual model and/or achieve the objectives of the monitoring program.
- The addition of subsidence monitoring in the basin in addition to the use of available InSAR datasets.

SECTION 5
Projects and Management Actions to Achieve Sustainability

23 CCR § 354.44 of the GSP Regulations requires that a GSP include a description of the projects and management actions that the GSA has determined will achieve the Sustainability Goal for the basin. To do this, the GSA must first understand the sustainability of expected future groundwater conditions in the absence of additional projects or management actions that could be included in the GSP (*i.e.,* a "Baseline Scenario"). Through a stakeholder process, the GSA developed and evaluated a Baseline Scenario that included the future expected water demands, water-supply plans, and groundwater management plans of the Spadra Basin stakeholders, and then used those results to guide the selection of projects and management actions to consider for the GSP to achieve the Sustainability Goal. Various combinations of the proposed projects were included in three "Basin Optimization Scenarios" that were evaluated and compared to the Baseline Scenario and each other. The steps of this effort included:

- Collect the current water demands and supply plans from the stakeholders and describe them as a Baseline Scenario. The Baseline Scenario is a description of how the Spadra Basin is planned to be utilized by the stakeholders absent of a GSP.
- Evaluate the hydrologic response of the Spadra Basin to the Baseline Scenario over a 60-year planning horizon using the Spadra Basin Groundwater Model. Use the model results to quantitatively evaluate and determine sustainability for each Sustainability Indicator.
- Compare the hydrologic response of the Spadra Basin to the Sustainable Management Criteria developed and described in Section 3 Sustainable Management Criteria to determine the long-term sustainability of the Baseline Scenario.
- Develop concepts for projects and management plans with the Spadra Basin stakeholders, identify preferred combinations of these projects and management plans, and describe these combinations as "Basin Optimization Scenarios."
- Evaluate the hydrologic response of the Spadra Basin to the Basin Optimization Scenarios over a 60-year planning horizon using the Spadra Basin Groundwater Model. Use the groundwater modeling results to quantitatively evaluate and determine sustainability for each Basin Optimization Scenario for each Sustainability Indicator.
- Compare the hydrologic response of the Spadra Basin for the Basin Optimization Scenarios to each other, and to the Baseline Scenario.
- Prepared a cost analysis of the total melded unit cost of the water supply for the Baseline Scenario and the Basin Optimization Scenarios and compare.
- Recommend a preferred Basin Optimization Scenario for the GSP that achieves the Sustainability Goal.

The results and outcome of this effort are summarized below.

5.1 DEVELOPMENT OF THE BASELINE SCENARIO

This section describes the development of the Baseline Scenario. The Baseline Scenario represents the future water demands and the independent water-supply plans of the water purveyors in the Spadra Basin—in the absence of a GSP. The Baseline Scenario was converted into input files for the Spadra Basin Groundwater Model, which was used to evaluate the physical response of the Spadra Basin to the Baseline Scenario (see *Section 3 Sustainable Management Criteria*).

The development of the Baseline Scenario included: establishing a future planning period; describing the assumptions for future land use and hydrology and using those assumptions to estimate future recharge to the Spadra Basin; and describing the future water demands and water-supply plans of the water purveyors to estimate future pumping and artificial recharge in the Spadra Basin. The development of the Baseline Scenario is described in more detail below.

5.1.1 Planning Period

SGMA legislation defines a "planning and implementation horizon" as a "50-year time period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield." The planning period should be representative of the long-term hydrologic and cultural conditions in the basin. The planning period for the Baseline Scenario is the 60-year period from July 1, 2018 to June 30, 2079. The start date was selected because it follows the end date of the calibration period for the groundwater-flow model (July 1, 1977 to June 30, 2018), and the model is used to evaluate the Baseline Scenario. The 60-year period following July 1, 2018 was selected to comply with the SGMA

5.1.2 Assumed Land Use and Hydrology for the Planning Period

This section describes how the R4 surface-water model was used to estimate recharge to the Spadra Basin over the planning period for the Baseline Scenario.

5.1.2.1 Land Use

Current (2020) land use information was determined using the land-use map developed from SCAG surveys for 2016 and comparing to current aerial imagery and land use zoning maps for Pomona, who is the primary land use planning agency in the Spadra Basin. Staff from Pomona and CPP (who owns lands for university operations and their agricultural program) were consulted to confirm the 2020 land use map and to review general plans for development and changes to land use over the planning period.

Figure 5-1 is a map that illustrates the land use in the Spadra Basin as of 2020. The lands overlying the Spadra Basin are mostly developed, consisting primarily of urban residential, commercial, and industrial uses, and some irrigated agriculture. Both Pomona and CPP verified that the current land use types are not anticipated to change over the planning period. Therefore, the 2020 land use types and designations are assumed to stay constant over the planning period.

117°49'30"W

117°45'0"W

34°3'0"N

Puddingstone Reservoir

Six Basins

San Jose Hills

Puente Hills

Chino Basin

Puente Basin

Via Verde

Puente St

Orange Grove Ave

McKinley Ave

San Jose Fault

Fairplex Dr

Dudley St

W. Orange Grove Ave

Holt Ave

Kellogg Dr

San Jose Ck

Valley Blvd

Pomona Blvd

South San Jose Ck

Temple Ave

Mission Blvd

Grand Ave

Phillips Blvd

White Ave

Garey Ave

Towne Ave

Rio Rancho Rd

Chino Ck

57

10

71

60

Land Use Type

- Native Vegetation/Vacant
- Irrigated Field Crops, Pasture, Fruit and Nuts
- Irrigated and Non-Irrigated Citrus
- Urban Residential
- Urban Commercial
- Urban Industrial
- Special Impervious

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:

WEST YOST

Author: AP

Date: 12/22/2020

File: Fig 2-1_Land_Use.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Current and Projected Land Use in the Spadra Basin

Figure 5-1

5.1.2.2 Hydrology

To support the development of GSPs across California, the DWR has provided climate change datasets in the form of change factors of precipitation, ET, and surface runoff based on 20 global climate projections (DWR, 2018). According to the Guidance for Climate Data Change Use During Groundwater Sustainability Plan Development (DWR, 2018), change factor ratios were calculated as the future scenario (2030 or 2070) divided by the 1995 historical temperature detrended (1995 HTD) scenario. The 1995 HTD scenario represents historical climate conditions where the observed temperature increasing trend is removed.

The change factors are provided as monthly time-series over the period of 1915 to 2011 for each grid cell of the DWR's Variable Infiltration Capacity (VIC) model, which covers the State of California. The DWR provides these change factors for 2030 and 2070 future scenarios. The VIC model grid was overlaid with the R4 model domain – the model used to estimate recharge to the Spadra Basin. Review of these change factors for the VIC model grids for 2030 and 2070 conditions that overly the Spadra Basin model domain indicate that average precipitation is projected to decrease, and average ET is projected to increase.

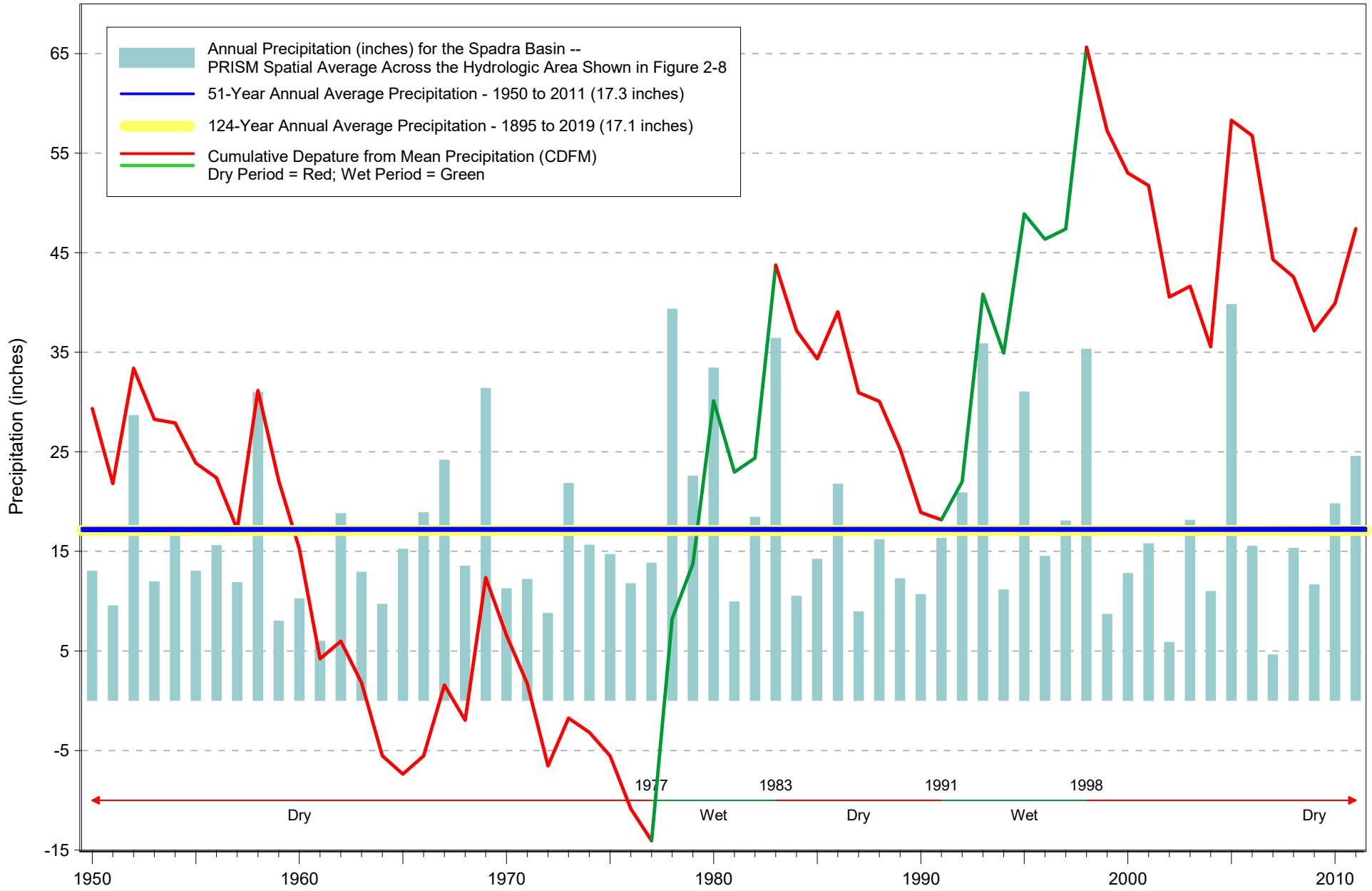
The assumed precipitation and ET over the planning period is based on the historical precipitation and ET for the period 1950 to 2011. Figure 5-2 shows the historical precipitation for the Spadra Basin hydrologic area for the 1950 to 2011 historical period. This is the latest 62-year period that overlaps with the change factor time series provided by the DWR. Note that the average annual precipitation over the Spadra Basin area is equal to long-term precipitation averages (1896 to 2019). Using the historical precipitation record during 1950-2011 for the planning period of 2018-2079 is appropriate because the annual average precipitation (17.3 inches) is virtually equal to the long-term average for 1896 to 2019 (17.1 inches).

5.1.2.2.1 Cultural Conditions, Climate Change, and Estimated Recharge

This section describes how this historical precipitation and ET datasets, along with the climate change factors provided by the DWR, were used to estimate recharge to the Spadra Basin over the planning period for the Baseline Scenario. This process is described below for the Spadra Basin portion of the Chino Valley Model (CVM) domain.

- For the current (2020) cultural condition:
  - The R4 surface-water model is executed using the 2020 land use data and the daily precipitation and ET datasets from 1950 to 2011 with a climate change factor of 1 (no change).
  - The average monthly deep infiltration from precipitation and applied water (DIPAW) is calculated based on the results of the R4 simulation.
- For the 2030 cultural condition:
  - The daily precipitation and ET datasets from 1950 to 2011 are multiplied with the DWR monthly change factors for 2030.
  - The R4 model is executed using the 2030 land use data and the modified precipitation and ET datasets.
  - The average monthly DIPAW is calculated based on the results of the R4 simulation.

Figure 5-2. Historical Precipitation for Spadra Basin and Tributary Watersheds - Hydrologic Period 1950-2011 Used for the Baseline Scenario



- For the 2070 cultural condition:
  - The daily precipitation and ET datasets from 1950 to 2011 are multiplied with the DWR monthly change factors for 2070.
  - The R4 model is executed using the 2070 land use data and the modified precipitation and ET datasets.
  - The average monthly DIPAW is calculated based on the results of the R4 simulation.
- Prepare DIPAW input files for the Spadra Basin Groundwater Model over the planning period.
  - The estimated average monthly DIPAW values are linearly interpolated between the 2020, 2030, and 2070 cultural conditions, and the results are used as input for recharge to the Spadra Basin Groundwater Model.
  - For those portions of the model domain that overly the bordering hills, the DIPAW estimates are translated into estimates of delayed subsurface inflow from the bedrock fractures and sediments in bordering hills.
  - For those portions of the model domain that overly the groundwater basin, the DIPAW estimates are translated into estimates of delayed surface recharge.

5.1.3 Pumping and Artificial Recharge over the Planning Period

5.1.3.1 Sources of Water Supply

To estimate future pumping and artificial recharge in the Spadra Basin over the planning period for the Baseline Scenario, the water purveyors provided planning information on their projected demands and their future water supply plans to meet those demands.

Water-supply sources available to the water purveyors in the Spadra Basin include: groundwater from the Spadra Basin, Six Basins, Chino Basin, Puente Basin, Main San Gabriel Basin, and Central Basin; surface water from the San Antonio Creek watershed; imported water purchased from the TVMWD; and recycled water from the Pomona WRP. It is important to quantify the use of these water supplies in the Baseline Scenario so that cost estimates of the water supply plans can be derived and compared to the costs associated with the water-supply plans for various projects and management actions in the Basin Optimization Scenarios developed and evaluated in *Sections 5.3 and 5.4* of this GSP. The cost estimate for the Baseline Scenario is described in *Section 5.5 Cost analyses of the Baseline and Basin Optimization Scenarios*. Each water-supply source is described below.

5.1.3.1.1 Spadra Basin Groundwater

Section 2.2 Basin Setting describes the physical characteristics of the Spadra Basin. The Spadra Basin is not adjudicated and pumping by the three water purveyors in the basin has averaged 1,280 afy over the long- term historical period of 1977 to 2018. The percentage of the total pumping in the Spadra Basin between the three water purveyors during 1977 to 2018 was 51 percent by Pomona, 46 percent by CPP, and 3 percent by WVWD. Spadra Basin is primarily used as a supplemental non-potable supply by the water purveyors. Some groundwater is used for potable supply but requires pumping strategies or treatment to manage water quality. The historical water budget for the Spadra Basin developed from the calibrated Spadra Basin Groundwater Model (Table 2-7) estimates a developed yield to be a 1,430 afy. This is about 170 af greater than the average pumping from the Spadra Basin over the same time period, indicating that higher sustainable pumping rates are possible in the Spadra Basin.

5.1.3.1.2 Six Basin Groundwater

The Six Basins are a group of six interconnected groundwater basins, located just south of the San Gabriel Mountains in eastern Los Angeles and western San Bernardino Counties. The Six Basins are one of three sub-basins that make up the DWR Bulletin 118 San Gabriel Groundwater Basin. The Six Basins are located across a major watershed divide that separates the San Gabriel River watershed to the west from the Santa Ana River watershed to the east.

The main source of groundwater replenishment to the Six Basins is surface-water runoff from precipitation that falls on the San Gabriel Mountains and recharges at spreading grounds located along the foot of the mountain range—predominantly at the San Antonio Spreading Grounds (SASG). The water- supply agencies also use imported surface water from the Metropolitan Water District of Southern California (Metropolitan) for artificial recharge at the SASG (and for direct consumptive uses).

The pumping and storage rights for the Six Basins were adjudicated in 1998 through a stipulated judgment titled "Southern California Water Company vs. City of La Verne, et al" in the Superior Court of California for the County of Los Angeles, Case No. KC029152. The Judgment prescribes a physical solution for the coordinated management of the Six Basins with the objective that the Parties to the Judgment can reliably pump their respective rights and maximize the beneficial use of groundwater. The Judgment established the Six Basins Watermaster to implement the physical solution.

The Judgment established the Safe Yield of the Six Basins as 19,300 afy and established a base annual production right for each Party, which is a percentage of the Safe Yield. However, the physical solution states that Watermaster will determine an operating safe yield (OSY) for the Four Basins area (Canyon Basin, Upper Claremont Heights Basin, Lower Claremont Heights Basin, and Pomona Basin), and the Parties can produce their share of the OSY from the Four Basins without incurring a replacement obligation. Each year, the Watermaster determines the OSY based on recent and expected recharge, pumping, and groundwater levels. The OSY is allocated to each Party based on their base annual production right. Production in the Two Basins is reserved for one Party, the City of La Verne, and is not subject to any limitations provided that production does not substantially injure the rights of any other Party.

Replenishment is the Watermaster's program to augment the recharge of native surface water in the Six Basins and is carried out by the Pomona Valley Protective Association (PVPA) at the direction of Watermaster. Replenishment Water is native surface water spread by the PVPA at the SASG and the Thompson Creek Spreading Grounds. The first 130 afy of native water spread by the City of Pomona and all native water spread by the LA County Flood Control District in the Two Basins is considered Replenishment Water.

In addition to each Party's share of the OSY, the following additional production rights are provided for in the Judgment:

- The Annual carryover of a Party's unproduced rights (Carryover Rights) are limited to 25 percent of their share of the OSY.
- Utilization of unused storage capacity in the Four Basins, subject to an approved Storage and Recovery Agreement with Watermaster.
- Transfer of production rights, carryover, or stored water may be transferred, in whole or in part, among the Parties on either a temporary or permanent basis.

- A Party's implementation of a Special Project for controlling groundwater levels or for the remediation of water quality problems in the Four Basins, subject to the Watermaster's approval.
- Access to Temporary Surplus rights declared by the Watermaster during times it is in the Parties' best interest for the control of high groundwater, water quality remediation, or other reasons deemed necessary.

Each year, a Party's total allowable production right is the sum of its share of the OSY, Carryover Rights from the previous year, total recoverable water in storage, transfers from other Parties, water from an approved special project, and Temporary Surplus water. To the extent that any Party's total production exceeds its total allowable production, that Party is obligated to recharge Replacement Water in an amount equal to the excess production. The Parties may obtain Replacement Water by directly purchasing imported water from the TVMWD or the Inland Empire Utilities Agency, arranging for the delivery of a native water supply other than that used for Replenishment, or by paying a Replacement Water assessment to Watermaster so that it may acquire Replacement Water.

The Watermaster is required to operate the Four Basins in a manner that protects against the threat of rising groundwater. In the event that Watermaster determines that Replenishment has to be terminated or curtailed in any year to protect against rising groundwater or that Replenishment Water is rejected due to insufficient storage capacity, some or all of the following rights may be lost, listed in order of priority of loss: other water in storage, imported water in storage, native water in storage, Carryover Water, and Replenishment Water. The amount of water subject to loss is equal to the quantity of Replenishment Water that was curtailed or rejected.

5.1.3.1.3 Chino Basin Groundwater

The Chino Basin is one of the largest groundwater basins in Southern California, containing approximately 12 million af of water. The Chino Basin covers approximately 220 square miles of the upper Santa Ana River watershed and lies within portions of San Bernardino, Riverside, and Los Angeles Counties. The Chino Basin is bounded by: the Cucamonga Basin and the San Gabriel Mountains to the north; the Rialto/Colton Basins to the east; the Jurupa Hills, the Santa Ana River, and the Temescal Basin to the south; the Chino and Puente Hills to the southwest; and the Spadra Basin, San Jose Hills and the Six Basins to the northwest.

The Chino Basin is administered by the CBWM, which was established under a Judgment entered in the Superior Court of the State of California for the County of San Bernardino, entitled "Chino Basin Municipal Water District *v.* City of Chino *et al.*" (originally Case No. SCV 164327, the file was transferred August 1989 by order of the Court and assigned Case No. RCV 51010). The CBWM records groundwater production and recharge, collects assessments, assesses over-producers to buy replenishment water and recharges that water into the Chino Basin, accounts for storage and transactions among Parties, performs certain administrative functions, and supervises the implementation of the Optimum Basin Management Program.

The Chino Basin Judgment resulted from studies and discussions that began in the early 1970s and continued for several years. The Judgment numerically defined the Safe Yield of the Chino Basin as 140,000 afy, and it was allocated among the three producer pools: (1) overlying agricultural pool (82,800 afy), (2) overlying non-agricultural pool (7,366 afy), and (3) appropriative pool (49,834 afy). Pursuant to the Chino Basin Optimum Basin Management Program Implementation Plan, CBWM is

required to recalculate the Safe Yield every ten years starting in 2011. The 2021 Safe Yield was recalculated as 131,000 afy (WEI, 2020).

The overlying Agricultural Pool consists of all overlying producers that produce groundwater for uses other than industrial or commercial and the State of California. The Overlying Non-Agricultural Pool consists of overlying producers that produce groundwater for industrial and commercial uses. The Appropriative Pool consists of owners of appropriative rights. All Parties were assigned to a pool when the Judgment was entered. The City of Pomona is an Appropriative Pool party.

A fundamental premise of the Chino Basin Judgment is that it allows all Chino Basin water users to pump sufficient water from the basin to meet their requirements. To the extent that a party's groundwater pumping exceeds its share of the Safe Yield, assessments are levied by the CBWM, and the CBWM uses these assessments to purchase supplemental water to replace overproduction. The Judgment also provides that any subsequent change in the Safe Yield shall be debited or credited to the Appropriative Pool parties, meaning that if the CBWM determines that the Safe Yield has changed, the change would be exclusively debited or credited to members of the Appropriative Pool and the rights allocated to the other pools and their respective parties would remain unchanged.

In addition to each appropriator party's share of the Safe Yield, the following additional production rights are allocated by the CBWM:

- Annual transfers of unproduced water from the overlying Agricultural Pool
- Transfers of rights from an overlying Agricultural Pool when the agricultural land used by a party is converted to another land use, requiring service by an Appropriative Pool party
- New yield from new stormwater recharge
- Recycled water recharged by the Inland Empire Utilities Agency, credited according to each appropriator's percent contribution of total wastewater sent to the Inland Empire Utilities Agency.

Appropriative Pool parties can store unused production rights in the basin, and they may also sell unused water rights and/or water in storage to each other and to the CBWM.

The reliability of Chino Basin groundwater supplies is certain due to the Judgment requirement to replenish production in excess of the Safe Yield.

5.1.3.1.4 Puente Basin Groundwater

The Puente Basin is a small shallow basin that underlies the Puente Valley bound by the San Jose Hills to the north; the Spadra Basin to the east; the Puente Hills to the south; and the Main San Gabriel Basin to the west. The Puente Basin is one of three adjudicated sub-basins (Six Basins, Main San Gabriel Basin, and Puente Basin) that make up the DWR Bulletin 118 San Gabriel Groundwater Basin. Puente Basin groundwater is tributary to the Main San Gabriel Basin. The main sources of recharge to the Puente Basin are infiltration of precipitation and applied water on the valley floor and subsurface inflow from the Spadra Basin and the bounding bedrock hills.

Groundwater produced from the basin is used primarily by municipalities for non-potables uses including supplemental water for recycled-water distribution systems. Puente Basin groundwater is non-potable due mainly to high concentrations of TDS, nitrate, and total VOCs.

There are no barriers to groundwater flow between the Puente Basin and the Main San Gabriel Basin, but both basins are adjudicated and managed separately. In 1972, the Puente Narrows Agreement was developed and adopted between the Upper San Gabriel Valley Municipal Water District and the PBWA, a Joint Powers Authority between the Rowland Water District and WVWD to govern subsurface flow from the Puente Basin to the Main San Gabriel Basin. The agreement requires an average Base Underflow of 580 afy from the Puente Basin to the Main San Gabriel Basin. Any quantity above the Base Underflow is credited to PBWA, and any quantity less than the Base Underflow is a debit from PBWA.

Pumping rights for the Puente Basin were adjudicated in 1986 through a Judgment entered in the Superior Court of the State of California for the County of Los Angeles, entitled *"Puente Basin Water Agency, a joint powers agency, et. al vs. City of Industry, a municipal corporation, et al."* (Case No. C 369 220). The Judgment prescribes a physical solution for the management of the Puente Basin and provisions of the Judgment are managed and administered by the court-ordered Puente Basin Watermaster which consists of: one appointee nominated by WVWD and Rowland Water District; one appointee nominated by the City of Industry and Industry Urban Development Agency; and one appointee nominated jointly by the first two Watermaster appointees.

The Puente Basin Judgment declares a Safe Yield of 4,400 afy, however the basin is managed on an OSY determined annually by the Puente Basin Watermaster. Pursuant to the Judgment, the Puente Basin Watermaster determines an OSY for the succeeding five years on an annual basis. The OSY is equally divided in an Annual Pumping Right for four Principal Pumpers in the basin, WVWD, Rowland Water District, City of Industry, and the Successor Agency to Industry Urban Development Agency. Pumping in excess of the Annual Pumping Right is categorized two ways:

- Allowable Excess Pumping - which is up to ten percent of the Pumper's share of the OSY.
- Unauthorized Excess Pumping - which is charged against production for the following year and may be subject to remedies as deemed appropriate by the Court.

In addition to each Party's share of the OSY, the following additional production rights are provided by the Judgment:

- Return Flow Credits for imported waters (both imported water from Metropolitan or recycled water from LACSD) delivered and applied for use on lands overlying the Puente Basin. A Return Flow Credit is allocated to the Primary Pumpers who import and apply these waters in the Puente Basin that are in excess of the quantity imported in fiscal year 1984 to 1985. The Primary Pumpers are jointly issued a Return Flow Credit for use in the succeeding year. The Rowland Water District and WVWD are the Primary Pumpers who import and apply these waters in the Puente Basin.
- Carry Over Rights for underproduced rights. The portion of a Primary Pumper's OSY that is not pumped in a year can be carried over to the succeeding year. These Carry Over Rights are intitled to be used first in the succeeding year and will be lost if not used that year.

5.1.3.1.5 Central Basin Groundwater

Central Basin is approximately 227 square miles located in Los Angeles County and is a subbasin in the northeastern half of the DWR Bulletin 118 Coastal Plain of Los Angeles Groundwater Basin in Los Angeles County. The other subbasin of the Coastal Plain of Los Angeles Groundwater Basin is the West Coast Basin which is separated from the Central Basin by the Newport Inglewood fault system. The Elysian, Repetto, Merced, and Puente Hills bound it on the northeast and east. The Orange County Basin is the southeastern boundary along Coyote Creek. The concrete-lined Los Angeles, Rio Hondo, and San Gabriel Rivers flow over the surface of the Central Basin on their way to the Pacific Ocean. Natural replenishment of groundwater in the basin occurs mainly from surface flow and underflow through Whittier Narrows from the San Gabriel Valley. Intentional replenishment is done through the capture and spreading of the Rio Hondo and San Gabriel River Spreading Grounds at the Montebello Forebay. A portion of the surface water that is captured and recharged at these spreading grounds is recycled water from the Pomona Water Reclamation Plant (WRP) discharged to San Jose Creek in the Spadra Basin.

The Water Replenishment District (WRD) was formed in 1959 to manage the artificial recharge in both the Central and West Coast Basins for groundwater replenishment to reduce overdraft that had occurred historically. The Central Basin was adjudicated with the adoption of the Judgment in 1965 (Central and West Basin Water Replenishment District vs. Charles E. Adams et al, Los Angeles County Superior Court Case No. 786,656), and court appointed the DWR as the Watermaster. The 1965 adjudicated pumping rights were set at 267,900 afy, and the amounts of the rights that could be pumped each year were limited to 80 percent of the total adjudicated amount, or 217,367 afy. In the years following adjudication, groundwater levels rebounded, and overdraft was halted. In 2013, a third amendment to the Central Basin Judgment was entered by the Los Angeles Superior Court transferring duties from DWR to a new Watermaster composed of three bodies: the Water Rights Panel, the Administrative Body, and the Storage Panel. The Water Rights Panel is made up of seven Central Basin water rights holders, the Administrative Body consists of WRD, and the Storage Panel consists of the Water Rights Panel and WRD.

There are about 130 Parties to the Central Basin Judgment with Allowed Pumping Allocation in the Central Basin, mostly consisting of public utilities companies, cities and other water public and private water suppliers, but also including school districts, individuals, family trusts, landowners, businesses, religious institutions, cemeteries, nurseries, country clubs, and golf courses. In addition to each Party's Allowed Pumping Allocation, the following provisions are provided for in the Judgment:

- Storage of water in the basin for Parties with water rights upon approval of the Storage Panel.
- Transfer of Allowed Pumping Allocation and stored water between Parties through sales and leases.
- One-year carryover of unused rights for use in the succeeding year up to the greater of: 1) 60 percent of their Allowed Pumping Allocation plus or minus any leases with flex or 20 af, whichever is more, less the amount of water in a Party's storage account; or 2) 20 percent of a Party's Allowed Pumping Allocation.
- Permitted over extractions up to 20 percent of a Parties Allowed Pumping Allocation.
- Option to purchase more water from an Exchange Pool if a Party estimates that their water requirements exceeds their supply for the year. A request to purchase water from the Exchange Pool must be done by April 1 of each year.

Generally, the groundwater quality in Central Basin is of high quality and suitable for potable uses.

5.1.3.1.6 Main San Gabriel Basin Groundwater

The Main San Gabriel Basin is a large basin bound by the San Gabriel Mountains to the north, the Raymond Basin on the northwest, the Puente Basin on the southeast, and the Central Basin on the south. The Main San Gabriel Basin covers most of the DWR Bulletin 118 San Gabriel Groundwater Basin. The storage capacity in the basin is estimated to be 10,438,000 af (Main San Gabriel Basin Watermaster, 2020). The major sources of natural recharge to the Basin are infiltration of rainfall on the valley floor and runoff from the nearby mountains. The Main San Gabriel Basin is the first of a series of basins to receive the benefit of mountain runoff, and the basin interacts hydrologically and institutionally with adjoining basins, including the Puente, Central, and West Coast Basins. The San Gabriel River and Rio Hondo River flow over the Main San Gabriel Basin and out through the Whitter Narrows to the Central Basin. Recharge of supplemental imported water at spreading basins is managed by the Main San Gabriel Watermaster for intentional replenishment of the basin. Strom water is diverted to spreading basins in coordination with the County of Los Angeles Department of Public Works for groundwater replenishment in coordination with replenishment of other supplemental water.

The water demand in the Main San Gabriel Basin is satisfied 85 percent by the local groundwater and another 5 percent from other local supplies (recycled and surface water) (Main San Gabriel Watermaster, 2020). Imported water from the State Water Project (SWP) used in the basin is supplied by three member agencies of Metropolitan: TVMWD, Upper San Gabriel Valley Municipal Water District, and San Gabriel Valley Municipal Water District[1].

Due to a need to guarantee a defined amount of water to downstream Central and West Coast Basin, the Main San Gabriel Basin was adjudicated in 1973 through a stipulated Judgment "Upper San Gabriel Valley Municipal Water District vs. City of Alhambra, et al. in the Superior Court of California for the County of Los Angeles, Case No. 924128". The Main San Gabriel Basin Judgment defined the water rights of 190 original parties, created the Main San Gabriel Basin Watermaster as the governing body, and described a physical solution for the management of water in the basin and adjudicates both groundwater and surface water rights. Since the Judgment was originally entered, there have been subsequent amendments to it that extend and clarify Watermaster's role. Two other Judgments acknowledged in the Main San Gabriel Basin adjudication include: the 1965 Long Beach Judgment which guarantees an average of 98,000 afy of flow through the Whitter Narrows from Main San Gabriel Basin to the Central and West Coasts Basins; and the Puente Narrows Agreement described above that guarantees an average of 580 afy from the Puente Basin to Main San Gabriel Basin.

The Main San Gabriel Watermaster is a nine-person board comprised of six individuals elected by the pumpers and three nominated by the retail water agencies. The Main San Gabriel Watermaster manages and controls the withdrawal of groundwater and surface water, coordinates water deliveries and recharge in the basin, and raises replenishment water revenue by means of assessments and acquires and recharges replacement water.

[1] The San Gabriel Valley Municipal Water District is a direct State Water Project Contractor, and the TVMWD and Upper San Gabriel Valley Municipal Water District are Metropolitan Member Agencies.

The Main San Gabriel Basin Judgment determined the natural safe yield of the basin to be 152,700 af based on the 1967 conditions. The Judgment requires that an OSY be redefined on a yearly basis by the Main San Gabriel Basin Watermaster. The OSY is the amount of groundwater that can be pumped in a year without Replacement Water Assessments. The fiscal year 2019-2020 OSY was 150,000 af. Pumpers can pump in excess of their annual pumping right but must pay. And unproduced groundwater right can be carried over for use in the subsequent year. Any entity that wishes to spread or store supplemental water within the basin for later extraction can do so with a cyclic storage agreement with the Watermaster that has a five-year term. Over the past five years, production in the Main San Gabriel Basin ranged from about 200,000 afy to 189,000 afy (Main San Gabriel Basin Watermaster, 2020).

In 1991 Watermaster was authorized to recharge of up to 30,000 afy of recycled water as supplemental water, and in 2012 was authorized to develop a Resources Development Assessment to purchase about 40,000 afy of untreated imported water to be stored in the Main San Gabriel Basin for an emergency reserve in the event untreated imported water was not available to satisfy a replacement water obligation and to supplement the lack of stormwater replenishment during drought conditions.

5.1.3.1.7 San Antonio Creek Surface Water

The San Antonio Creek Watershed originates in the San Gabriel Mountains and generally flows from north to south towards the Six Basins. The San Antonio Dam at the edge of the mountains was constructed in 1956 by the United States Army Core of Engineers (USACE) for flood control and water conservation purposes. The drainage area behind the dam is about 26 square miles. The SASG resides directly below the dam and is about 980 acres of land where surface water released from the dam can be recharged in the Six Basins. The San Antonio Channel below the Dam is concrete-lined.

The surface water rights of San Antonio Creek from the San Antonio Canyon were assigned in the early 1900s are generally described as:

- About 60 percent of the flow in San Antonio Creek is diverted by San Antonio Water Company (SAWCo).
- About 40 percent of the flow in San Antonio Creek is diverted by the City of Pomona
- All flow in the San Antonio Creek that is not diverted by SAWCo or Pomona is available to the PVPA for diversion and recharge at the SASG.

Most of the surface water runoff generated in the San Antonio Creek watershed enters a “60/40” splitter box where the flow is split and diverted to SAWCo and Pomona conveyance facilities.

Water diverted by SAWCo is used for potable and non-potable uses and is also used for recharge at the SASG and/or at spreading grounds in the Cucamonga Basin. Surface flows diverted at the 60/40 splitter box are directed to the San Antonio Tunnel Ponds or south of the dam to the distribution systems of SAWCo and the City of Upland (the majority shareholder of SAWCo). Water diverted to the Tunnel Ponds percolates into underground “tunnels” that direct flow under the dam and are discharged into the San Antonio’s potable distribution system. Surface flows that bypass the Tunnel Ponds are either sent to SAWCo’s non-potable distribution system or to the San Antonio Canyon Treatment Plant where flows are treated before entering the City of Upland’s potable distribution system. Over the last ten years (2010-2019), SAWCo has diverted about 1,050 to 7,700 afy for potable and non-potable reuse.

Water diverted by Pomona at the 60/40 splitter box is combined with surface-water flows diverted from Evey Canyon and flows by gravity in a shallow underground pipeline called the Canon Pipeline to Pomona's Pedley Treatment Plant, where the water is treated and served for direct potable use. The Pedley Treatment Plant is located adjacent to the Pedley Spreading Grounds. The surface water diverted to the Canon Pipeline generally exceeds the treatment capacity of the Pedley Treatment Plant, so surplus water is recharged at the SASG or the Pedley Spreading Grounds. Over the last ten years (2010-2019) Pomona has diverted between 1,000 to 4,300 afy for direct potable use.

Runoff from the San Antonio Creek watershed that is in excess of what can be used by SAWCo and the City of Pomona is captured behind the San Antonio Dam. The PVPA works with the USACE to coordinate releases from the dam for diversion and recharge at the SASG. Surface water releases from the dam that are not diverted for recharge at the SASG are discharged to the concreted-lined San Antonio Channel where it flows south across Six Basins and Chino Basin. The outflow from San Antonio Dam varies significantly between wet and dry years and range from 0 afy during dry years to up to 60,000 afy in very wet years. On average about 60 percent of the surface water discharged from the dam is diverted for recharge at SASG and about 40 percent is discharged to San Antonio Creek.

5.1.3.1.8 Imported Water

Imported water is available to the Spadra Basin water purveyors from the TVMWD, a member agency of Metropolitan. Metropolitan is a consortium of 26 cities and water districts that provide drinking water to about 19 million people in parts of Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties—a service area of about 5,200 square miles. Metropolitan currently delivers about two million afy of imported water to its service area from the State Water Project (SWP) and the Colorado River.

The TVMWD was established in 1950 as a wholesale water agency that supplies imported water to the cities and communities in the Pomona, Walnut, and San Gabriel Valleys of Los Angeles County, including the Cities of Claremont, Covina (including the areas of Charter Oak and Covina Knolls), Diamond Bar, Glendora, Industry, La Verne, Pomona, Rowland Heights, San Dimas, Walnut, and West Covina. The TVMWD serves imported water to its member agencies from the Metropolitan's Weymouth Water Treatment Plant (Weymouth WTP) or from its Miramar Water Treatment Plant (Miramar WTP).

The Weymouth WTP can deliver up to 520 million gallons of potable water per day to customers in Los Angeles and Orange Counties. Most of the water treated at Weymouth originates from the Colorado River, with a small amount originating from the SWP. The three water purveyors in the Spadra Basin (Pomona, WVWD, and CPP) are all member agencies of TVMWD and all receive water from the Weymouth WTP via the Pomona-Walnut-Rowland Joint Water Line.

The TVMWD operates the Miramar WTP, which is located at its headquarters in the City of Claremont. The Miramar WTP receives untreated SWP water from the MWDSC's Foothill Feeder and treats it for potable use. Water deliveries from the Miramar WTP are supplemented with Six Basins groundwater produced by the TVMWD. Currently, groundwater makes up about four percent of the total deliveries from the TVMWD's Miramar system. The City of La Verne and Golden State Water Company (for their Claremont and San Dimas systems) have a 50/50 share of the available water from the Miramar WTP, but they currently do not utilize the total water available. Excess water can be delivered to the City of Pomona,

WVWD, and Rowland Water District on an interruptible basis.

The ability of the TVMWD to meet its member agencies' water demands is dependent on Metropolitan's ability to deliver water. Although the Metropolitan continues to face ongoing water-supply challenges for both the SWP and Colorado River systems, through the implementation of programs to increase the reliability of local water supplies in Southern California (e.g. conjunctive use, conservation, water shortage planning, transfer and storage programs, tiered water rates, etc.), Metropolitan predicts it will be able to meet its overall system demands through 2040 (Metropolitan, 2016; TVMWD, 2016; Civiltec Engineering, 2011a; City of Upland, 2011; Kennedy/Jenks, 2011; RMC, 2011a).

From 2002 through 2007, Metropolitan's average rates increased by about six percent per year. From 2007-2012, Metropolitan's average water rates increased by about ten percent per year. And from 2012 through 2016, Metropolitan's average water rates increased by about two or three percent per year. In 2017 Metropolitan's average water rates increased by 11 percent and from 2018 to 2020 increased from three to five percent per year Metropolitan's full-service untreated Tier 1 rate for 2021 is $777 per acre-foot. Metropolitan is projecting a rate increase of three percent by 2022 (Metropolitan, 2020).

A brief summary of the imported water supply challenges on the SWP and Colorado River is provided below.

State Water Project. The SWP is owned by the State of California and operated by the DWR. The SWP transports Feather River water, stored in and released from Lake Oroville, and unregulated flows diverted directly from the Delta south via the California Aqueduct to the Metropolitan service area (Metropolitan, 2016). In the Antelope Valley, the California Aqueduct divides into the East and West Branches. The East Branch carries water to Silverwood Lake and Lake Perris. From Silverwood Lake, SWP water is conveyed to the San Bernardino area at the Devil Canyon Afterbay. Metropolitan supplies SWP water to the TVMWD area from its Foothill Feeder Pipeline, which starts at the Devil Canyon Afterbay and traverses westward toward Los Angeles. In a 100-percent allocation year, based on their contract, the DWR will provide Metropolitan with a maximum of 1,911,500 af of SWP water (Table A amount) (DWR, 2020).

In August 2020, the DWR published the Final State Water Project Delivery Capability Report for 2019 (California DWR, 2020). This report updates the DWR's estimate of current (2019) and future (2040) SWP water delivery reliability. The report is produced every two years as part of a settlement agreement that was signed in 2003. The 2019 report shows that current and future SWP deliveries will be impacted by two significant factors: i) a significant restriction on the SWP and Central Valley Project (CVP) Delta pumping, as required by the biological opinions issued by the United States Fish and Wildlife Service (December 2008) and the National Marine Fisheries Service (June 2009); and ii) climate change, which is altering hydrologic conditions in Delta and throughout the State. In addition to concerns over climate and environmental issues, the 2019 report indicates that the continued subsidence of Delta islands, many of which that are already below sea level, are a threat to a catastrophic levee failure as water pressure increases on the fragile levee system that is used to convey water from the Sacramento River to the Harvey O. Banks pumping station.

This levee system is also threatened by earthquakes and floods. Should a major levee failure occur, SWP water exports from the Delta could be interrupted for several years (WEI, 2012). The report emphasizes the "need for local agencies to develop resilient and robust water sources and infrastructure to maximize the efficient use of a variable water supply" (California DWR, 2014).

Colorado River. The Colorado River was Metropolitan's original source of imported water when the agency was established in 1928. Metropolitan constructed the Colorado River Aqueduct (CRA) to transport water from Lake Havasu, located at the border of Arizona and California, to Southern California. The CRA is 242 miles long and terminates at Lake Mathews in Riverside County. The capacity of the CRA is 1.2 million afy. Metropolitan has a legal entitlement to receive water from the Colorado River under a permanent service contract with the United States. Secretary of the Interior (Metropolitan, 2016).

The Colorado River is managed and operated under numerous federal laws, compacts, decrees, contracts, court decisions, and regulatory guidelines that are collectively referred to by the United States Bureau of Reclamation (USBR) as The Law of the River. The Colorado River Compact of 1922 apportioned 15 million afy of water between the seven states: 7.5 million afy was apportioned to the upper basin states of Colorado, New Mexico, Utah, and Wyoming, and 7.5 million afy was apportioned to the lower basin states of Arizona, California and Nevada. The Boulder Canyon Project Act of 1928 divided the lower basin's 7.5 million afy between the three states, of which 4.4 million afy was allocated to California (USBR, 2008). The California Seven Party Agreement of 1931 set the basis for priorities among California contractors to utilize the State's 4.4 million afy allocation. Of this, Metropolitan has a fourth priority right to 550,000 afy, a fifth priority right to an additional 662,000 afy and a right of up to 180,000 afy when surplus flows are available (Metropolitan, 2016). For many years, California contractors utilized more than their 4.4 million afy limit, but as population and water demands began to grow in Arizona and Nevada, California was eventually required to cut back use to the agreed upon 4.4 million afy apportionment (USBR, 2008). Many years of court battles, some of which are still not resolved, ensued within California as contractors struggled to secure their respective rights that were not all clearly defined in the 1931 Seven Party Agreement. Metropolitan now has a firm supply of 550,000 afy of Colorado River water. To increase its allocation, Metropolitan has developed a multitude of conservation, storage, and transfer programs with various parties inside and outside of California (Metropolitan, 2016).

Metropolitan's Colorado River supplies also face other threats to reliability, including a long-term drought that has greatly reduced storage on the river system; costly pest control programs and a loss of operational flexibility due to the spread of invasive quagga mussels throughout the CRA distribution system; the management of high salinity levels, which require that river water be blended with lower-salinity SWP water to meet regulatory limitations for TDS concentrations in many of the Metropolitan service areas; other water quality concerns related to uranium, perchlorate, and hexavalent chromium; and climate change (Metropolitan, 2016).

5.1.3.1.9 Recycled Water

Domestic and commercial wastewater originating in the Spadra Basin and a portion of the Six Basins is treated by the LACSD at the Pomona WRP. Recycled water from the Pomona WRP is the available source of recycled water for reuse in the Spadra Basin. The Pomona WRP has a treatment capacity of up to 15 million gallons per day (mgd). Currently, flows vary from 4 mgd to 15 mgd and average about 9 mgd. The LACSD has agreements to deliver up to one-third of its recycled water available from the Pomona WRP to the WVWD[2] and the remaining two-thirds to the City of Pomona (Carollo Engineers, 2009). Based on this agreement and the average plant production, the amount of recycled water available to the WVWD is about 3,360 afy and the amount available to Pomona is 6,720 afy. A portion of Pomona's

[2] A small portion of the one-third of recycled water flow sent to WVWD is used at the LACSD Spadra Landfill and purchased directly by CPP for use at the university Land Lab located at the landfill.

recycled water is purchased directly by CPP Pomona for use at the university campus, the Forest Lawn Cemetery located just outside the City of Pomona boundary, and on agricultural lands.

Recycled water that is not utilized by the WVWD and Pomona is discharged to the concrete-lined South San Jose Creek channel. It flows in the channel to the San Gabriel River about 15 miles downstream where it is diverted for groundwater recharge at spreading grounds in the Montebello Forebay overlying the Central Basin. In 2020, approximately 50 percent of the recycled water from Pomona WRP was reused within the Spadra Basin and Puente Basin, and 50 percent was discharged to the South San Jose Creek channel (Hartling, E., personal communication, 2022).

5.1.3.2 Water Demands and Water-Supply Plans

A comprehensive data request was submitted to the three water purveyors in the Spadra Basin (Pomona, WVWD, and CPP) to collect water supply and demand plans for 2020 to 2070, including the well pumping plans for their Spadra Basin wells. The water purveyors were asked to provide projections of their demands and various water supplies to meet those demands for years: 2020, 2025, 2030, 2035, 2040, 2050, 2060, and 2070. These projections were reviewed, and follow-up with each water purveyor was done as necessary. For each water purveyor, their total demands must equal the sum of their various water supplies.

Table 5-1 summarizes the current (2019) and projected (2020 through 2070) total water demand and the water supplies for Pomona, WVWD, and CPP. The plans for each water purveyor are described below in more detail.

5.1.3.2.1 City of Pomona

Figure 5-3 is a stacked bar chart showing Pomona's historical (2010-2019) and projected (2020-2070) total water demands and water supplies by source. The water supplies available to Pomona include: groundwater from the Spadra Basin, Chino Basin, and Six Basins; imported water purchased from the TVMWD; recycled water from the Pomona WRP; and native surface water from San Antonio Creek.

Pomona's historical water demand from 2010 to 2019 averaged about 21,900 afy. During the last five years of that historical period (2015-2019), the total water demand declined to about 20,500 afy due to

water conservation measures required by the State of California to reduced urban water consumption 20 percent by 2020. Pomona expects water demands to increase to about 23,500 af in 2020, and average about 23,700 afy over the planning period.

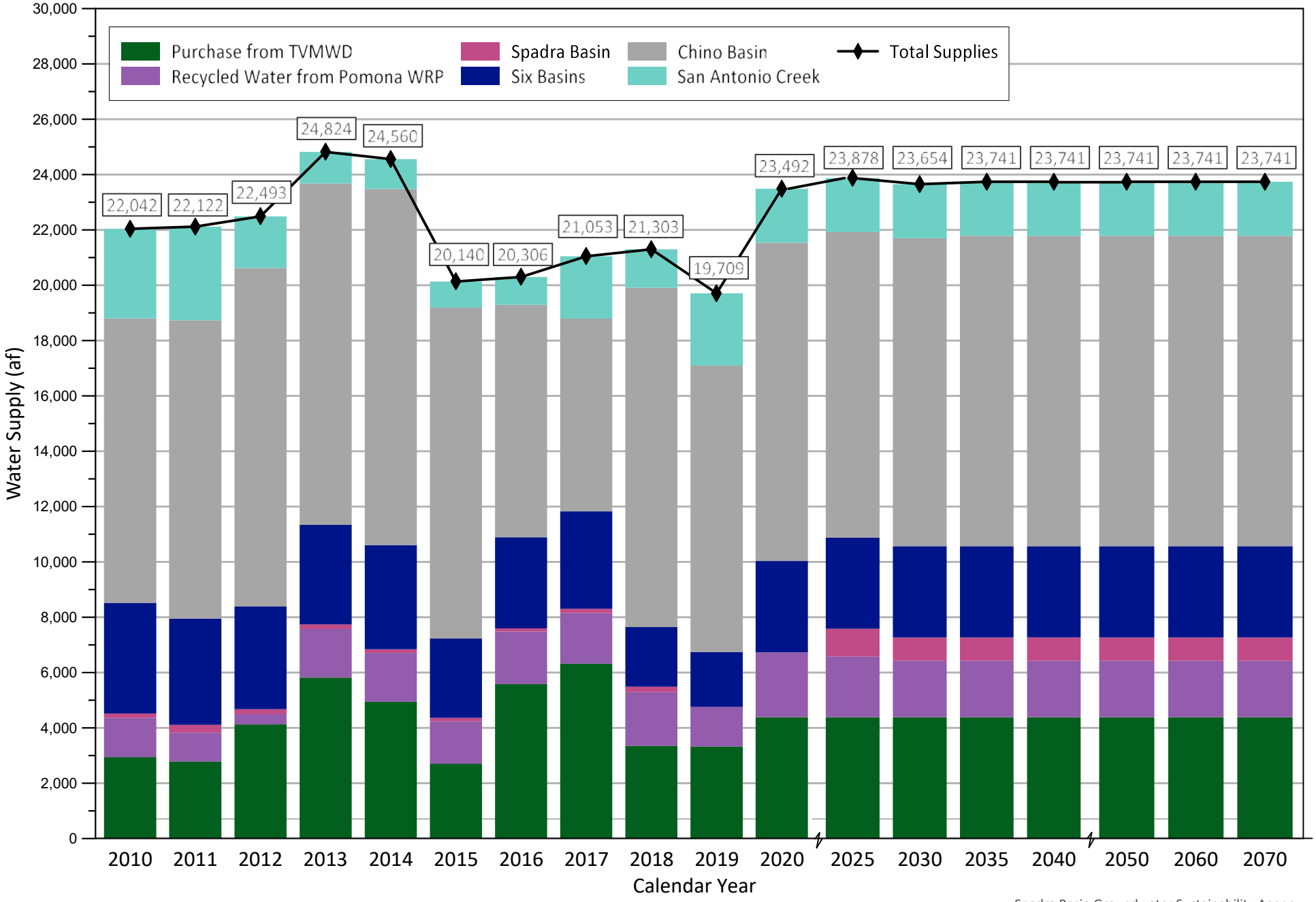
Historically, Pomona's water-supply plan has been to maximize the use of local potable supplies (Six Basins, Chino Basin, Spadra Basin, and surface water from San Antonio Creek) and local non-potable supplies (Spada Basin and recycled water), and purchase the balance from the TVMWD. Figure 5-3 shows that from 2010 to 2019, local water supplies satisfied about 81 percent of the total demand, and Pomona pumped an average of 150 afy of groundwater from the Spadra Basin as part of the local supplies.

Over the planning period, Pomona plans to continue to maximize the use of local supplies and purchase the balance from TVMWD to meet total demands. Figure 5-3 shows that from 2020-2070, local water supplies are projected to satisfy about 82 percent of the total demand, and that Pomona will pump about 850 afy of groundwater from the Spadra Basin as part of the local supplies.

Table 5-1. 2019 and Projected (2020-2070) Water Demand and Supply Plans of the Water Purveyors in the Spadra Basin

Agency	Year	Total Water Demand	Water Supply Sources Available to the Spadra Basin Agencies									
			Groundwater						Imported Water	Recycled Water		
				Other								
			Spadra Basin	Six Basins	Chino Basin	Puente Basin	Main San Gabriel Basin	Central Basin	Purchased from TVMWD	From the Pomona WRP	San Antonio Creek	Total Supply
City of Pomona	2019	19,708	0	1,984	10,348	-	-	-	3,331	1,431	2,614	19,708
	2020	23,492	0	3,300	11,509	-	-	-	4,390	2,343	1,950	23,492
	2025	23,878	1,000	3,300	11,045	-	-	-	4,390	2,193	1,950	23,878
	2030	23,654	845	3,300	11,131	-	-	-	4,390	2,038	1,950	23,654
	2035	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2040	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2050	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2060	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2070	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
Walnut Valley Water District	2019	17,595	53	0	-	662	0	0	15,795	1,085	-	17,595
	2020	21,191	110	0	-	1,359	0	0	17,518	2,204	-	21,191
	2025	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2030	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2035	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2040	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2050	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2060	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2070	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
Cal Poly Pomona	2019	1,824	735	-	-	-	-	-	105	984	-	1,824
	2020	1,621	591	-	-	-	-	-	118	911	-	1,621
	2025	1,860	817	-	-	-	-	-	43	1,000	-	1,860
	2030	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2035	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2040	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2050	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2060	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2070	1,865	856	-	-	-	-	-	9	1,000	-	1,865
Aggregate for all Agencies	2019	39,127	788	1,984	10,348	662	0	0	19,231	3,500	2,614	39,127
	2020	46,304	701	3,300	11,509	1,359	0	0	22,026	5,458	1,950	46,304
	2025	46,745	1,922	3,925	11,045	1,291	2,500	2,000	16,826	5,286	1,950	46,745
	2030	46,526	1,806	3,925	11,131	1,291	2,500	2,000	16,792	5,131	1,950	46,526
	2035	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2040	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2050	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2060	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2070	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613

Figure 5-3. Historical and Projected Water Supplies for the City of Pomona



WEST YOST

954-80-20-01 GRAPHER\GRF\GSP\Figure 5-3

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan (GSP)
Last Revised: 1-13-22

5.1.3.2.2 Walnut Valley Water District

Figure 5-4 is a stacked bar chart showing WVWD's historical (2010-2019) and projected (2020-2070) total water demands and water supplies by source. The water-supply sources available to the WVWD include: imported water purchased from the TVMWD; groundwater from the Spadra Basin, Puente Basin, Main San Gabriel Basin, Central Basin, and Six Basins; and recycled water from the Pomona WRP.

WVWD's historical water demand from 2010 to 2019 averaged about 20,800 afy. During the last five years of that historical period (2015-2019), the total water demand declined to about 19,200 afy due to water conservation measures required by the State of California to reduced urban water consumption 20 percent by 2020. WVWD expects water demands to increase to about 21,200 af in 2020, and average about 21,000 afy over the planning period.

Historically, WVWD's water-supply plan has been to use imported water purchased from TVMWD as the primary water supply for all the potable demands. Figure 5-4 shows that from 2010 to 2019, the imported water was on average 90 percent of the total water supply to meet all demands. The remaining ten percent are the local supplies of recycled water from Pomona WRP, Puente Basin groundwater, and Spadra Basin groundwater to meet non-potable demands. WVWD pumped an average of 71 afy of groundwater from the Spadra Basin as part of the local supplies.

Over the planning period, WVWD plans to diversity its local water-supply portfolio and increase its use of local supplies to decrease its reliance on imported water. To achieve this objective, WVWD has formed partnerships with neighboring water agencies to implement three different projects that will be operational before 2025:

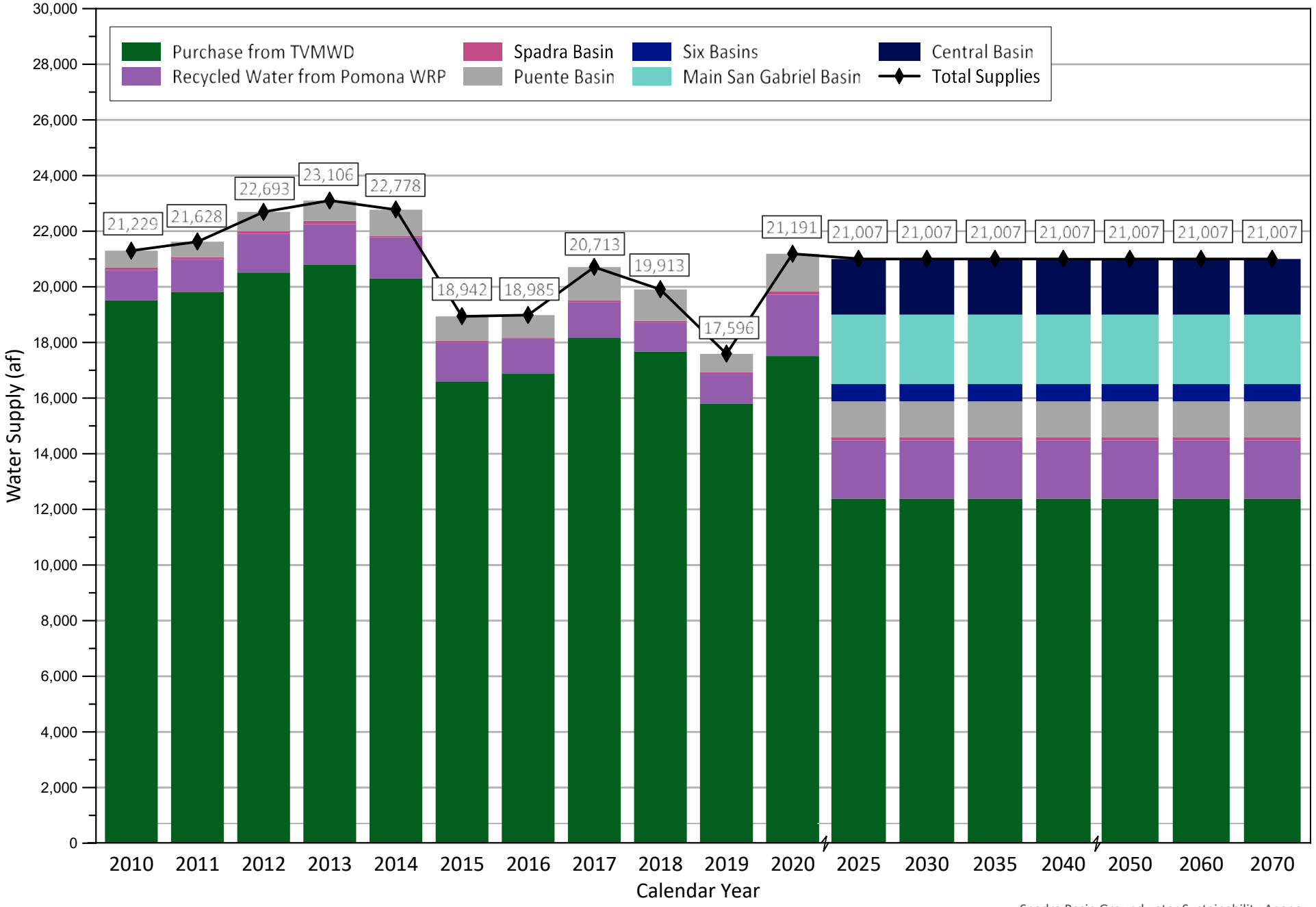
- The Pomona Basin Regional Groundwater Project to deliver groundwater from the Six Basins via the Pomona-Walnut-Rowland Joint feeder line that delivers imported water to the region.
- The La Habra Heights County Water District project to deliver groundwater from Central Basin via a connection to the La Habra Heights County Water District distribution system.
- The California Domestic Water Company Pipeline and Pump Station Project to deliver stored imported water from the Main San Gabriel Basin via a connection to the California Domestic Water Company distribution system. Water delivered from this project comes from water acquired and stored by PBWA in the Main San Gabriel Basin that is extracted by California Domestic Water Company on PBWA's behalf.

Figure 5-4 shows that from 2025-2070, local water supplies are projected to satisfy about 31 percent of the total demand, and that WVWD will pump about 105 afy of groundwater from the Spadra Basin as part of the local supplies.

5.1.3.2.3 California Polytechnic University Pomona

Figure 5-5 is a stacked bar chart showing CPP's historical (2010-2019) and projected (2020-2070) total water demands and water supplies by source. The CPP water demands include the potable and non- potable needs of the university and their agricultural lands on and off campus, and the needs of Forest Lawn Cemetery adjacent to the university. The water-supply sources available to CPP include: imported water purchased from the TVMWD; groundwater from the Spadra Basin; and recycled water from the Pomona WRP.

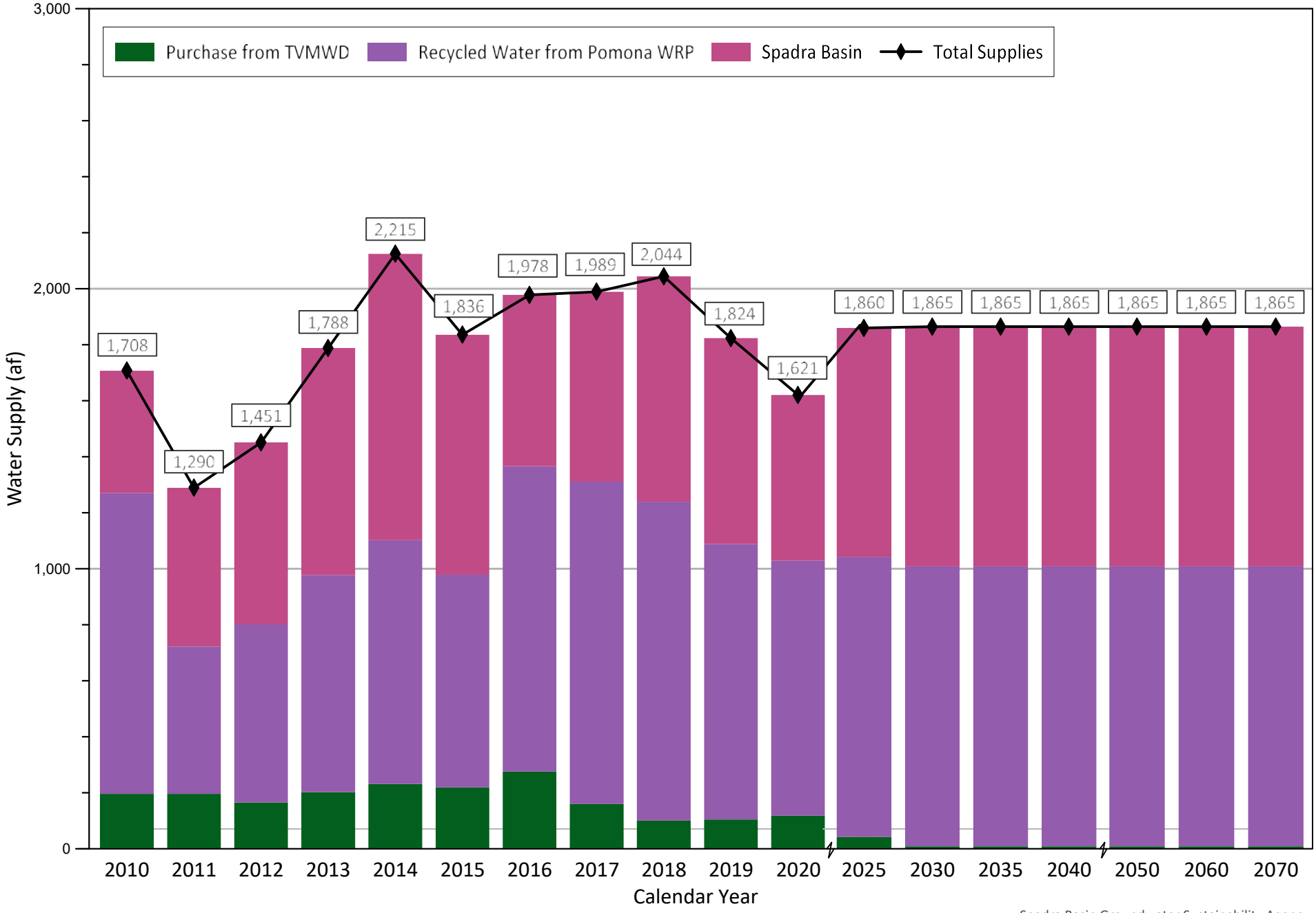
Figure 5-4. Historical and Projected Water Supplies for the City of Pomona for the Walnut Valley Water District



WEST YOST

954-80-20-01 GRAPHER\GRF\GSP\Figure 5-4

Figure 5-5. Historical and Projected Water Supplies for California State Polytechnic University of Pomona



WEST YOST

954-80-20-01 GRAPHER\GRF\GSP\Figure 5-5

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan (GSP)
Last Revised: 1-13-22

CPP's historical water demand from 2010 to 2019 averaged 1,800 afy. CPP expects water demands to remain relatively stable at about 1,800 afy over the planning period.

Historically, CPP's water-supply plan has been to meet non-potable demands with recycled water from Pomona WRP and Spada Basin groundwater. Potable demands have been met with imported water from TVMWD and Spadra Basin groundwater treated at an on-campus reverse osmosis plant. Figure 5-5 shows that from 2010 to 2019, local water supplies satisfied about 90 percent of the total demand, and CPP pumped an average of 700 afy of groundwater from the Spadra Basin as part of the local supplies.

Over the planning period, CPP plans to continue to maximize the use of recycled water and Spadra Basin groundwater and minimize its use of imported water from TVMWD. Figure 5-5 shows that from 2020- 2070, local water supplies are projected to satisfy about 99 percent of the total demand, and that CPP will pump about 850 afy of groundwater from the Spadra Basin as part of the local supplies.

5.1.3.3 Aggregate Water-Supply Plan for the Spadra Basin Pumping

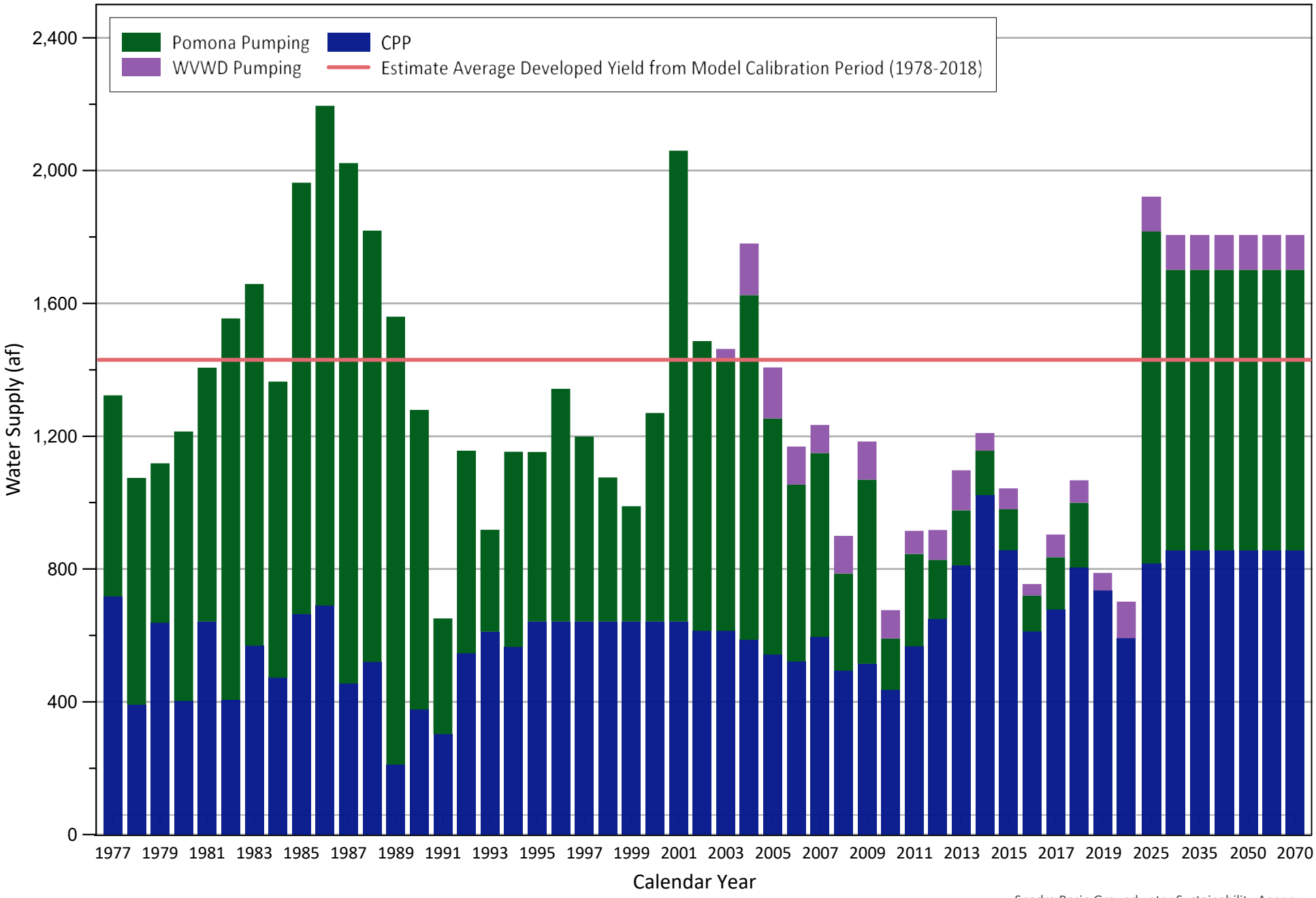
Table 5-1 summarizes the current (2019) and projected (2020 through 2070) total water demands and supplies for the Spadra Basin water purveyors, individually and in aggregate. Collectively, the total water demands of the Spadra Basin purveyors are projected to increase from 39,100 afy in 2019 to about 46,600 afy by 2035 and remain constant thereafter to 2070. The purveyors plan to meet the increase in demands with an increase in groundwater pumping from Spadra Basin and other local groundwater basins (Puente, Chino, Main San Gabriel, Central, and Six Basins). In aggregate, the Spadra Basin water purveyors plan to increase pumping from the Spada Basin from about 800 afy in 2019 to about 1,800 afy by 2030, and that pumping will remain constant through 2070. While all purveyors plan to increase pumping from the Spadra Basin over the planning period, the City of Pomona's planned increase is the greatest because it plans to reactivate two production wells that pumped very little over the last ten years (2010-2019) compared to pumping during 1977-2009.

Figure 5-6 is a stacked bar chart showing the historical (1978-2019) and planned (2020-2070) groundwater pumping from the Spada Basin for the water purveyors in the Spadra Basin. Also shown on this figure is the model-estimated average developed yield of 1,430 afy from 1978 to 2018 determined during calibration of the Spadra Basin groundwater-flow model (Table 2-7 and Appendix I). Pumping during the historical period (1978-2019) was on average about 160 afy less than the developed yield of the Basin. The planned pumping of about 1,800 afy from 2030 to 2070 is about 375 afy greater than the estimated developed yield for the historical period.

5.1.3.4 Groundwater Pumping

Figure 5-6 illustrates that total annual pumping from Spadra Basin during the Baseline Scenario begins at about 700 afy in 2020, increases to about 1,900 afy in 2025, and remains at about 1,800 afy from 2030 to 2070. These pumping projections compare to about 1,280 afy of average-annual pumping in the Spadra Basin that occurred over the long-term historical period of 1977-2018. The distribution of pumping by water purveyor in the Baseline Scenario is about: 50 percent by Pomona; 47 percent by CPP; and 3 percent by WVWD.

Figure 5-6. Historical and Projected Groundwater Pumping from the Spadra Basin - Baseline Scenario



WEST YOST

954-80-20-01 GRAPHER\GRF\GSP\Figure 5-6

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan (GSP)
Last Revised: 1-13-22

The water supply and demand information collected from the Spada Basin water purveyors included information on well utilization rates and schedules and the percentage of total potable and non-potable demands by month. This planning information, along with the planned pumping volumes by purveyor, were used to develop monthly estimates of pumping for the Baseline Scenario for the seven wells presumed active for the planning period.

For active wells outside of the Spadra Basin but within the CVM domain, the most recent planning projections for pumping in the Chino Basin, Six Basins, and Cucamonga Basin that was used in the 2020 recalculation of Safe Yield in the Chino Basin were assumed for the Baseline Scenario (WEI, 2020).

5.1.3.5 Artificial Recharge

There are no plans for artificial recharge in the Spada Basin, and therefore, there is no artificial recharge included in the Baseline Scenario.

For artificial recharge that is planned to occur outside of the Spadra Basin but within the CVM domain, the most recent planning projections for artificial recharge in the Chino Basin, Six Basins, and Cucamonga Basin that were used in the 2020 recalculation of Safe Yield in the Chino Basin were assumed for the Baseline Scenario (WEI, 2020).

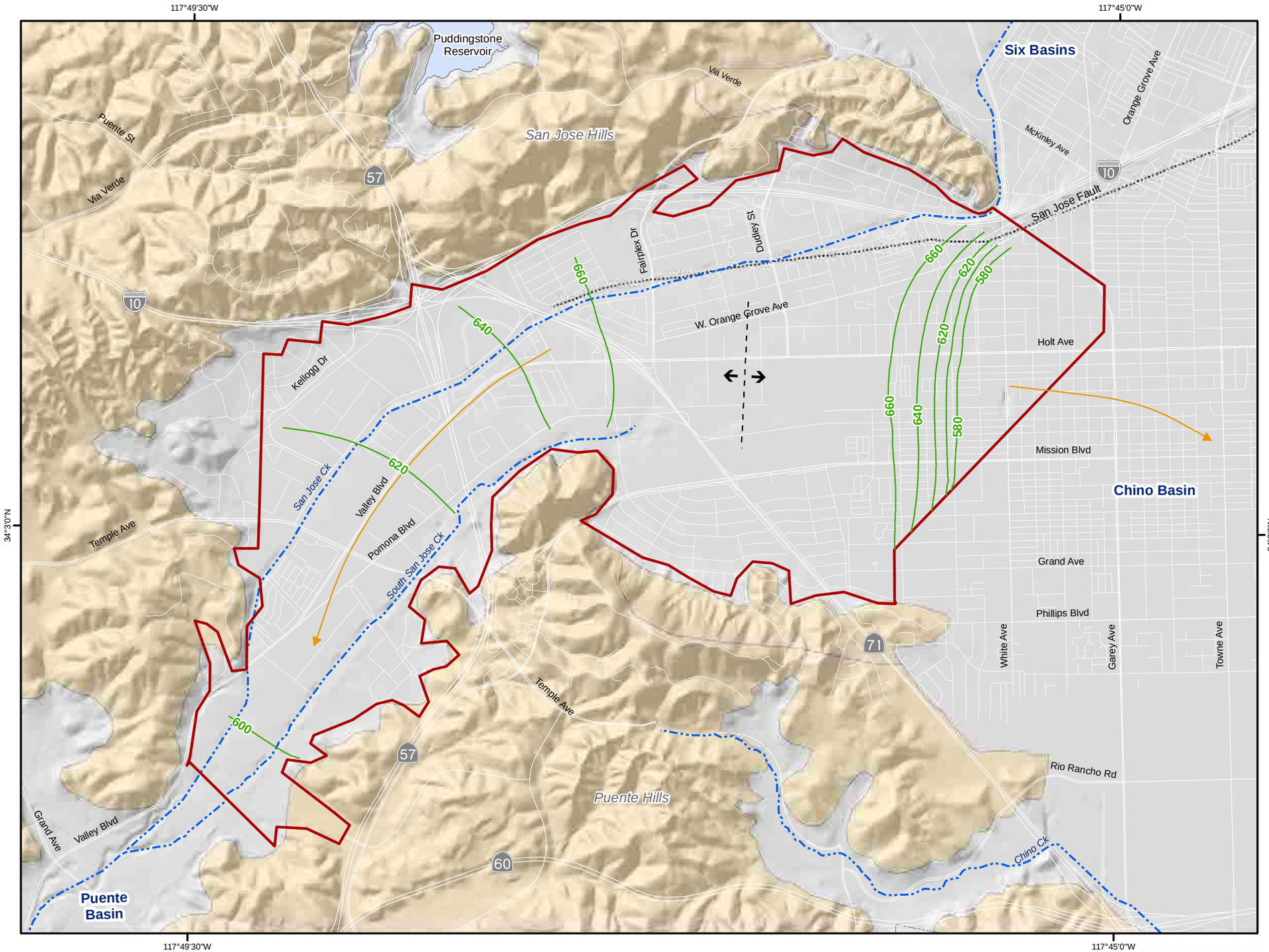
5.2 EVALUATION OF THE BASELINE SCENARIO

The Spadra Basin Groundwater Model was used to simulate the Baseline Scenario and estimate the response of the groundwater basin over the planning period, including: groundwater elevation and flow directions; pumping sustainability at wells; the water budget; basin storage; land subsidence; and the developed yield of the basin. The groundwater level Minimum Thresholds established for wells throughout the Basin in *Section 3 Sustainable Management Criteria* are used as a metric to assess the sustainability of the Baseline Scenario for the Sustainability Indicators of chronic lowering of groundwater levels, reduction of groundwater storage, and land subsidence.

5.2.1 Groundwater-Level Response

5.2.1.1 Groundwater Elevations and Groundwater-Flow Directions

Figure 5-7 is a map showing model-predicted groundwater-elevation contours for July 2018, which represents the initial condition for groundwater elevations at the start of the planning period. The arrows on the map depict the general groundwater-flow directions across the Spadra Basin. There is a groundwater divide in the eastern portion of the basin where groundwater either flows east towards the Chino Basin or west towards the center of the Basin then to the southwest towards the Puente Basin. The location of the groundwater divide is transient and can shift depending on changes in groundwater levels in the Spadra Basin and/or the Chino Basin.



Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 12/22/2020
File: Figure 5-7_GWE_201807.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

600 Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain
Location Concealed
Location Approximate
Location Uncertain

Groundwater Elevation for Initial Conditions - July 2018

Figure 5-7

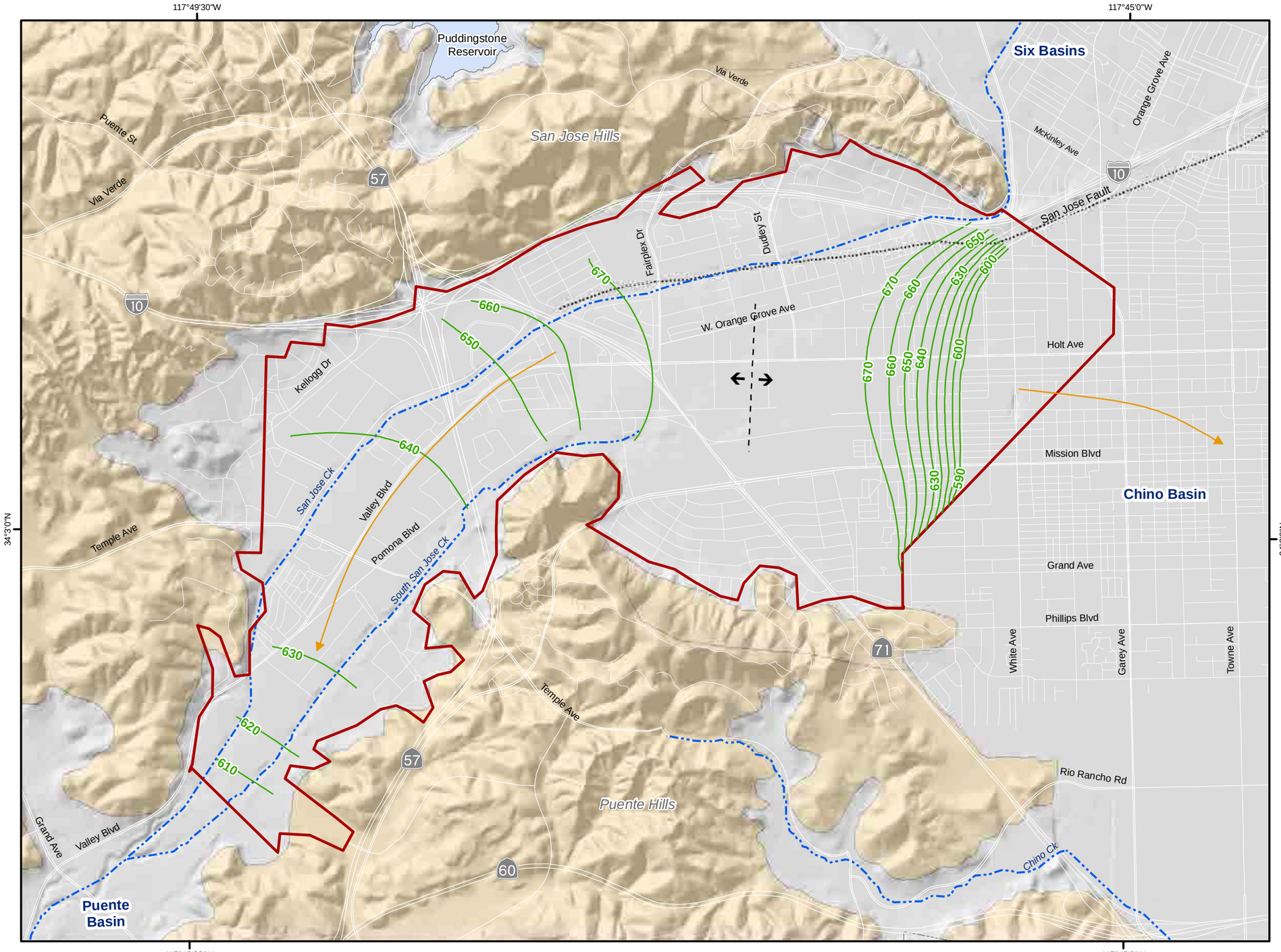
Model-predicted groundwater elevations were also mapped for the following years/conditions during the planning period for the Baseline Scenario:

- July 2024 (Figure 5-8). The groundwater elevations shown in this figure represent the time during the planning period of the highest groundwater elevations across the Spadra Basin. Groundwater elevations across most of the Spadra Basin are about 15 ft higher compared to the initial condition (2018).
- June 2079 (Figure 5-9). The groundwater elevations shown in this figure represent the time during the planning period of lowest groundwater elevations in the Spadra Basin. This occurs at the end of the planning period. Groundwater elevations across the Spadra Basin are about 20 ft lower compared to the initial condition (2018).

These figures show that in general, groundwater elevations are projected to change across the Spada Basin over the planning period, but the shape and orientation of the groundwater-elevation contours and the location of the groundwater divide will not change, which indicates that the groundwater-flow patterns within the Spadra Basin are expected to remain consistent over time in the Baseline Scenario.

Figures 5-10 and 5-11 are maps that show the model-predicted change in groundwater elevations for the Baseline Scenario over two time periods:

- Figure 5-10 shows the model-predicted change in groundwater elevations for the initial condition (July 2018) to the time of highest groundwater elevations (July 2024). The map shows that groundwater elevations increased from 5-20 ft across most of the Spadra Basin.
- Figure 5-11 shows the model-projected change in groundwater elevations for the initial condition (July 2018) to the time of lowest groundwater elevations at the end of the planning period (July 2079). This figure shows that groundwater elevations declined during the planning period by about 20-25 ft across most of the basin.



600 Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 12/22/2020
File: Figure 5-8_GWE_202407.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

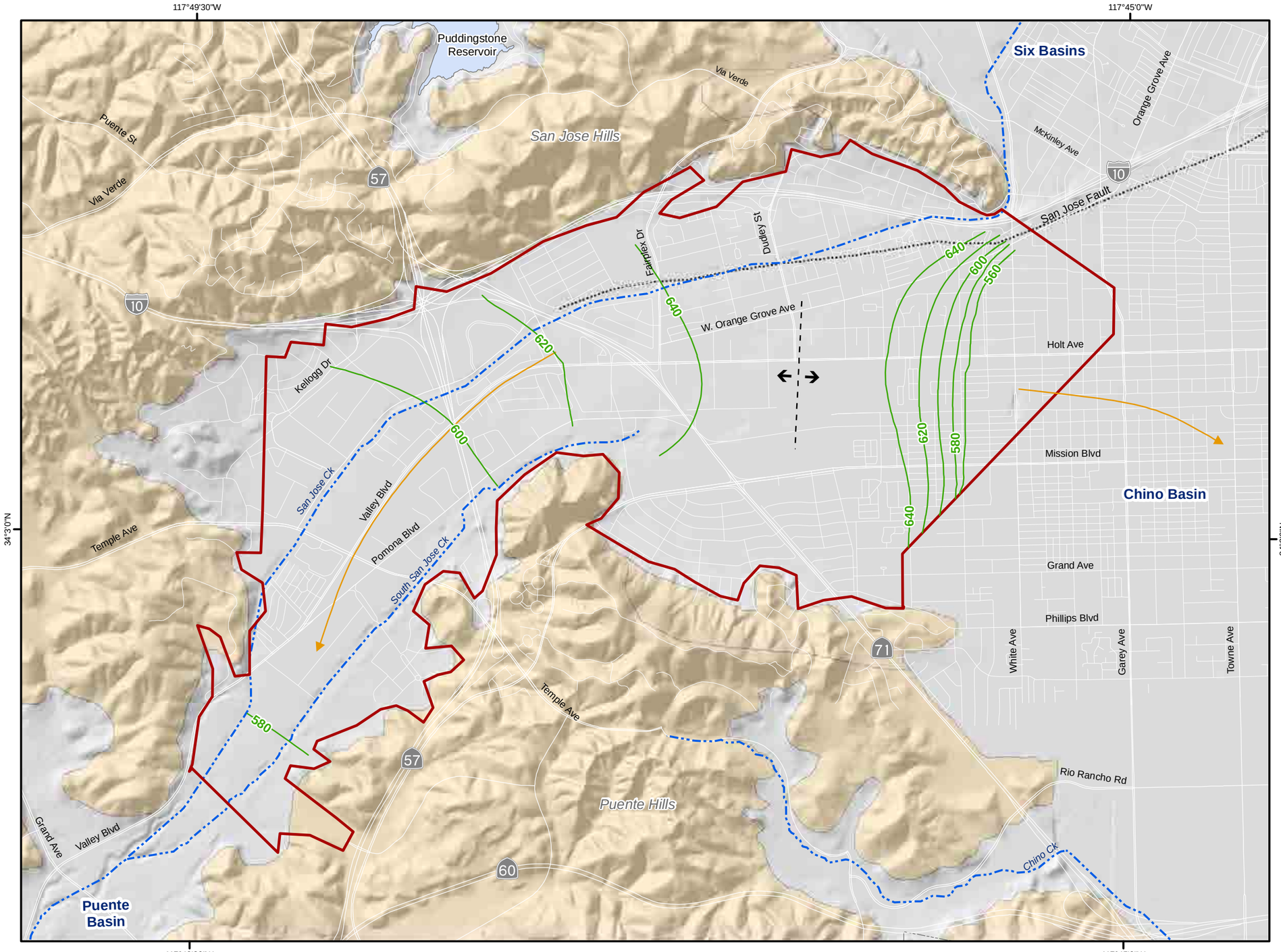
Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Groundwater Elevation for the Period of Highest Groundwater Levels for the Baseline Scenario - June 2024

Figure 5-8



600 — Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 12/22/2020
File: Figure 5-9_GWE_207906.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

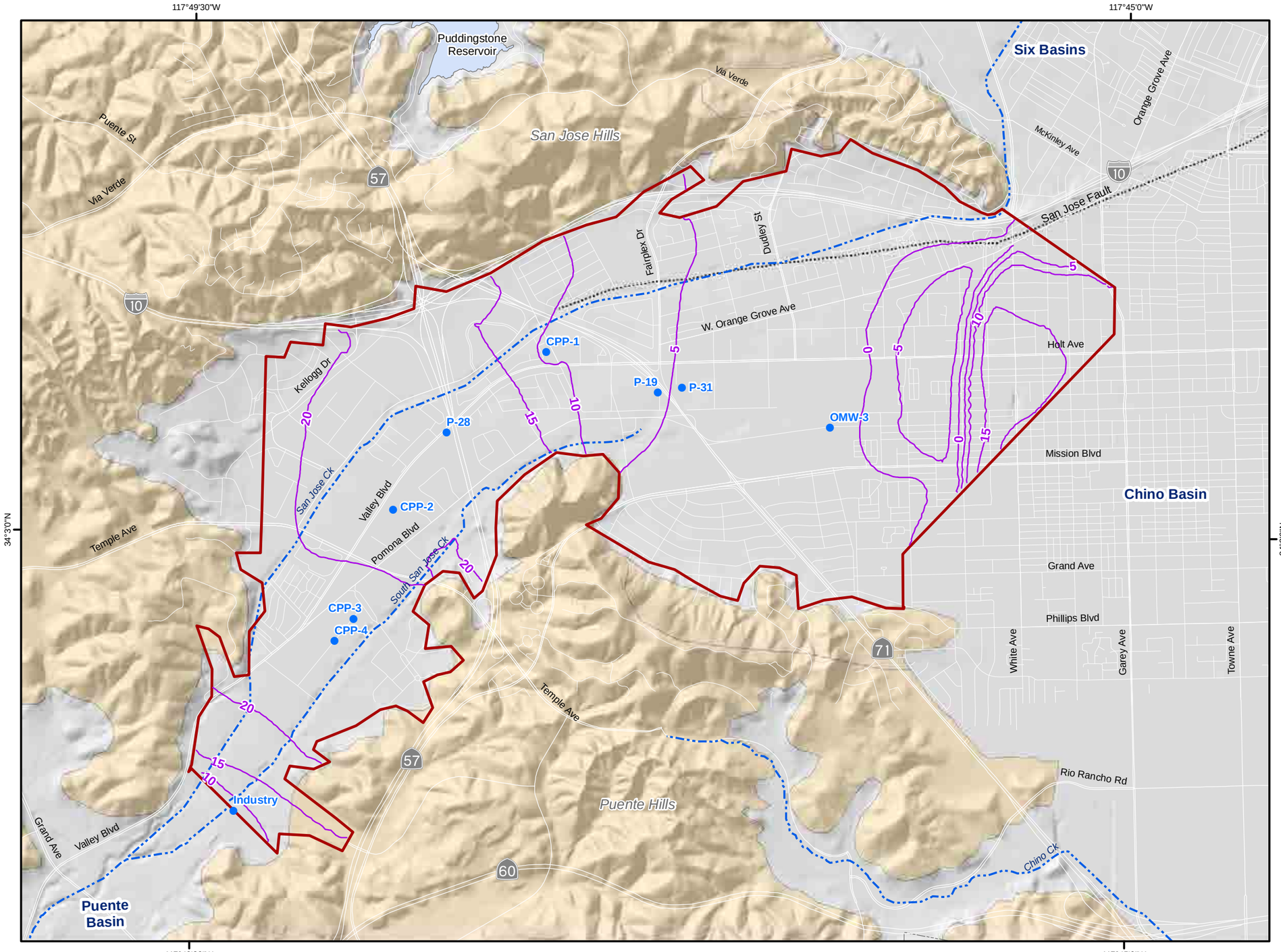
Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Groundwater Elevation for the Period of Lowest Groundwater Levels for the Baseline Scenario - June 2079

Figure 5-9



—20— Groundwater-Elevation Change Contours (ft)

Well with Projected Water-Level Time Series

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 12/22/2020
File: Figure 5-10_GWE_201807-202407.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

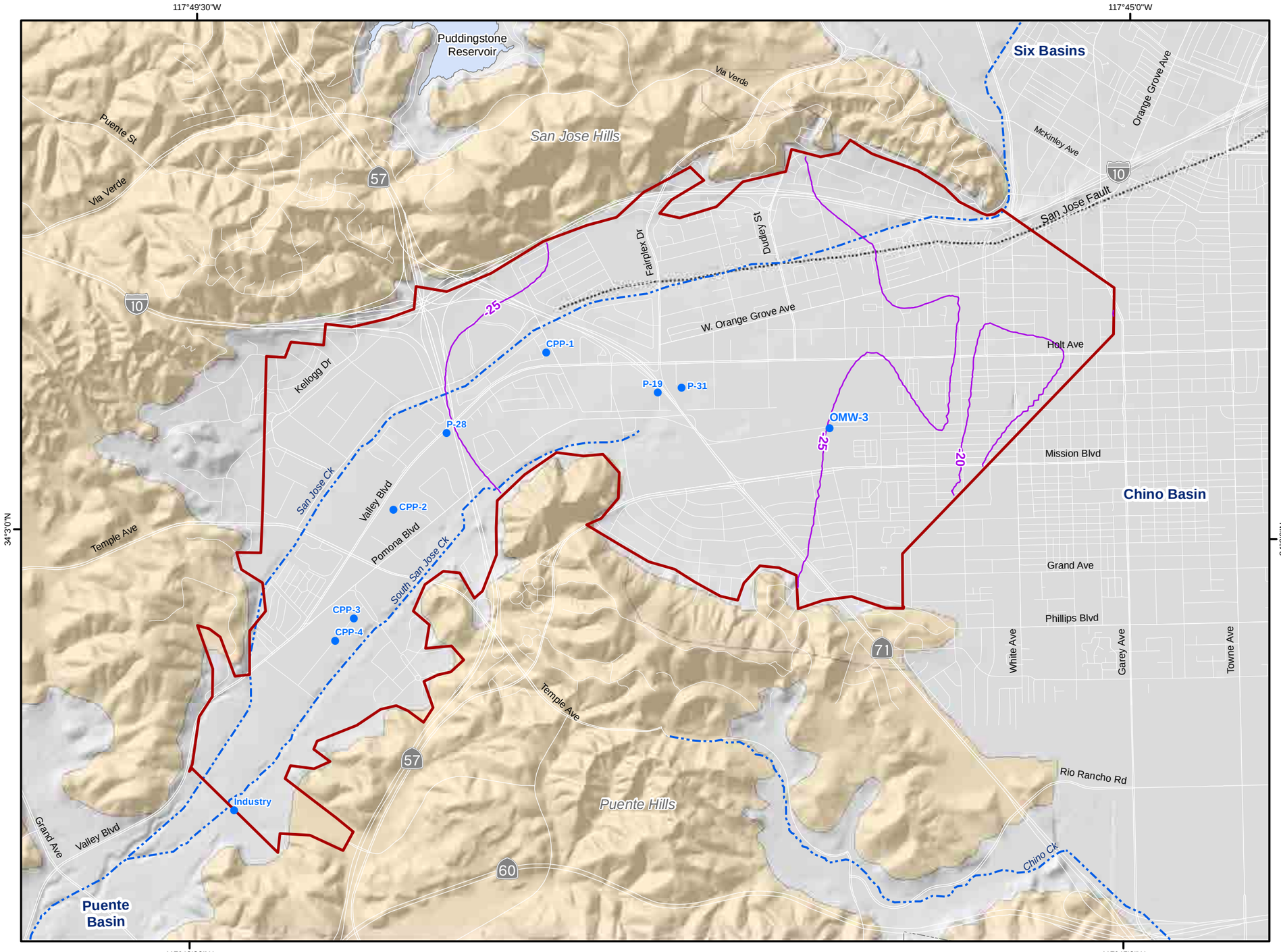
Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Groundwater-Level Change: Initial Condition vs. Highest Groundwater Levels - Baseline Scenario (July 2018 - June 2024)

Figure 5-10



-20- Groundwater-Elevation Change Contours (ft)

Well with Projected Water-Level Time Series

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Groundwater-Level Change: Initial Condition vs. Lowest Groundwater Levels - Baseline Scenario (July 2018 - June 2079)

Figure 5-11

Prepared by:

WEST YOST
Water. Engineered.

Author: AP
Date: 12/22/2020
File: Fig 5-11_GWE_201807-207906.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

5.2.1.2 Groundwater Elevations at Wells

Figures 5-10 and 5-11 also show the location of nine wells where time-series of the model-predicted groundwater elevations are analyzed in this section to evaluate the sustainability of the Baseline Scenario.

Figures 5-12a through 5-12i are time-series charts of projected groundwater elevations for the Baseline Scenario for nine wells in the Spadra Basin (see Figures 2-10 and 2-11). These nine wells are located throughout the Basin and include all active municipal pumping wells and/or representative monitoring wells where Sustainable Management Criteria have been established in *Section 3 Sustainable Management Criteria*. These time-series charts also show the: measured groundwater elevations; model-simulated groundwater elevations for the historical period 1978-2018; the Minimum Thresholds and Measurable Objectives for groundwater levels established in *Section 3 Sustainable Management Criteria* at representative wells; and the elevation of the top of the pump-bowl assembly and the "pumping sustainability metric" if applicable.

Figures 5-12a through 5-12i show that groundwater levels at all wells are predicted to increase from 2019 to 2024, and then decrease at declining rates through 2070. These trends in groundwater levels correspond to the relatively low rates of pumping during 2019-2024 followed by relatively high rates of pumping from 2025 through 2070. The sustainability of groundwater levels at wells is evaluated in two ways: comparison of groundwater elevations to the pumping sustainability metric for active pumping wells; and comparison of groundwater elevations to Minimum Thresholds and Measurable Objectives for groundwater levels for representative monitoring wells identified in *Section 3 Sustainable Management Criteria.*

5.2.1.2.1 Pumping Sustainability

The time-series charts in Figures 5-12a through 5-12i include a "pumping sustainability metric" for the active pumping wells. The pumping sustainability metric is the lowest water-level elevation that enables the well owner to produce groundwater at a desired pumping rate, given the well construction and pumping equipment. Groundwater pumping at a well is presumed to be sustainable if the water level at that well remains above the pumping sustainability metric. Information on the elevation of the pump- bowl assembly and the pumping sustainability metric was provided by the well owners for each well. The active pumping wells where these pumping sustainability metrics have been established include: Industry, CPP-4, CPP-2, P-28, CPP-1, and P-19. The pumping sustainability metric for one active well (CPP- 3) is undetermined at this time.

Figures 5-12a through 5-12i show that groundwater levels for the Baseline Scenario decline to levels below the pumping sustainability metrics at three wells: Industry, CPP-4, and CPP-2. This indicates that pumping sustainability may be a challenge in the western half of the Spadra Basin for the Baseline Scenario.

5.2.1.2.2 Sustainable Management Criteria

Figures 5-12a through 5-12i include the Minimum Thresholds and Measurable Objectives established as Sustainable Management Criteria for groundwater levels at representative monitoring wells throughout the Spada Basin. The Minimum Thresholds represent the groundwater level at a representative monitoring well that, when exceeded individually or in combination with Minimum Thresholds at other monitoring wells, may cause Undesirable Results in the basin. The avoidance of Undesirable Results is key to the success of a GSP. The Measurable Objectives are quantitative goals for the maintenance or improvement of groundwater conditions to achieve or maintain sustainability in the basin. These Minimum Thresholds and Measurable Objectives are also used as a proxy to assess the Sustainability Indicators of groundwater storage and land

subsidence. The wells in Figure 2-12a through 2-12i where The Minimum Thresholds and Measurable Objectives have been established are: Industry, CPP-4, P-28, CPP-1, P-19, and OMW-3.[3]

[3] Well OMW-3 has Minimum Thresholds and Measurable Objectives but has been excluded from this analysis because the model-predicted groundwater elevations cannot be used as this is an area of uncertainty identified during calibration of the Spadra Basin Groundwater Model.

Figure 5-12a. Historical and Projected Groundwater Elevations for the Baseline Scenario at Industry

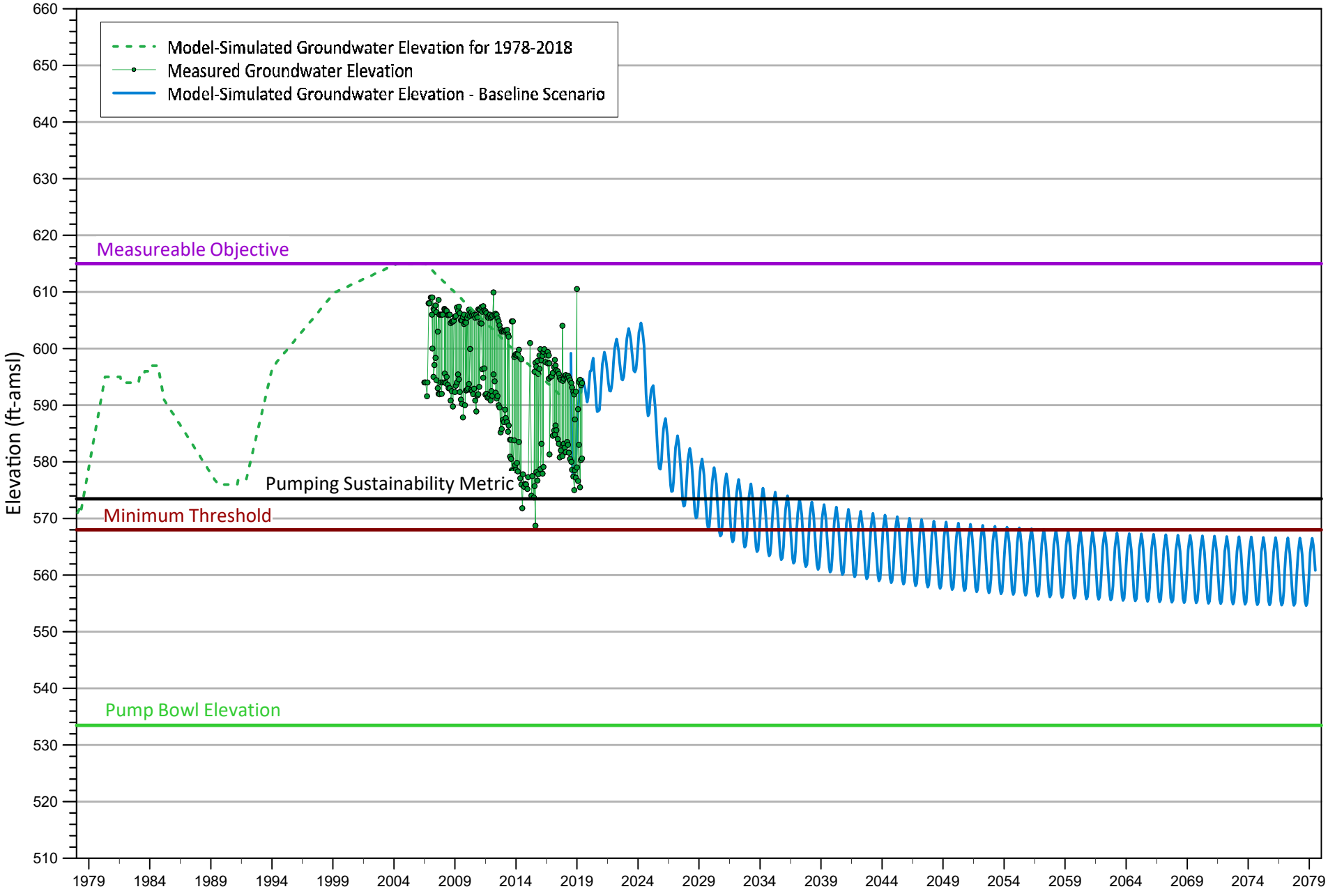


Figure 5-12b. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-4

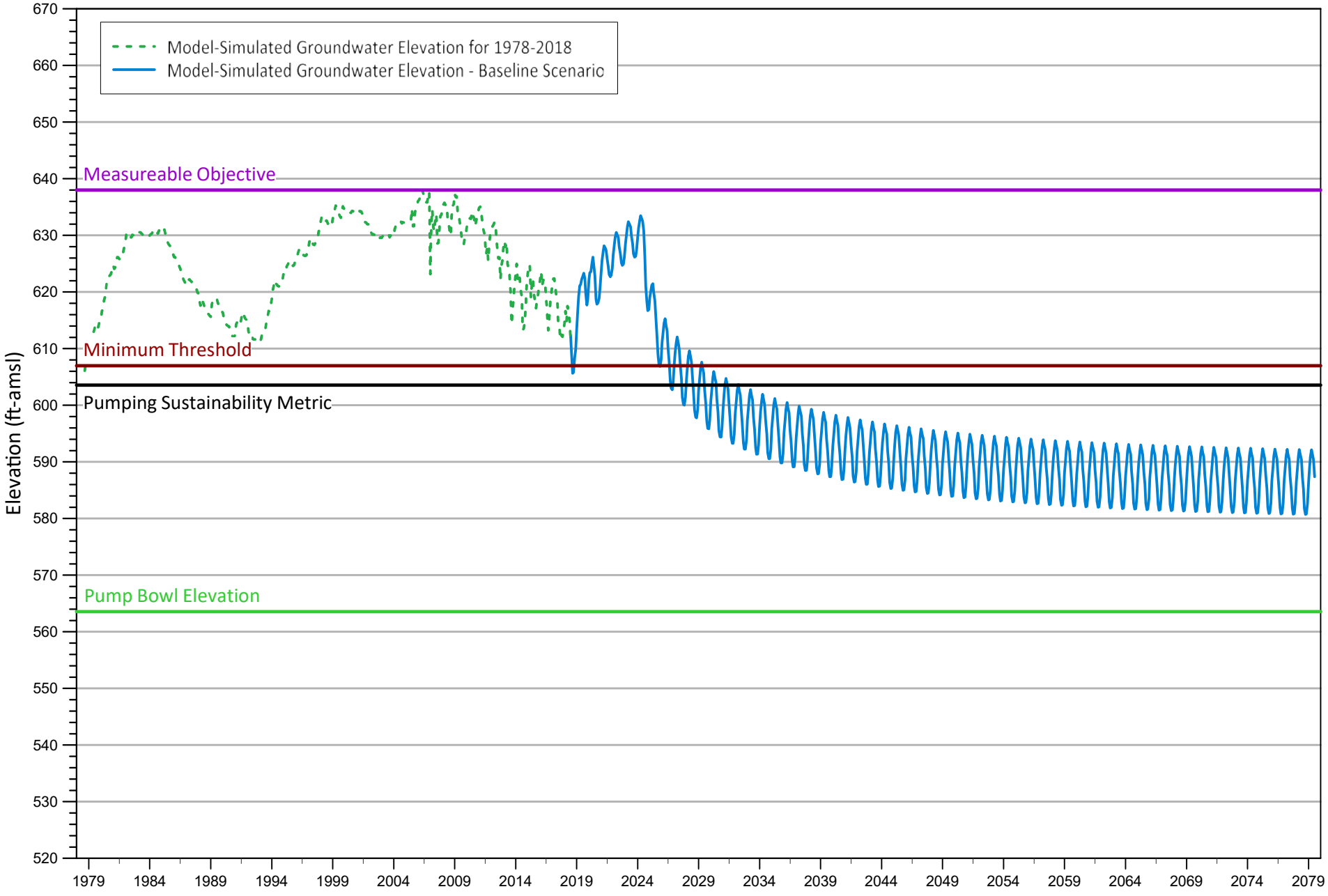


Figure 5-12c. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP- 3

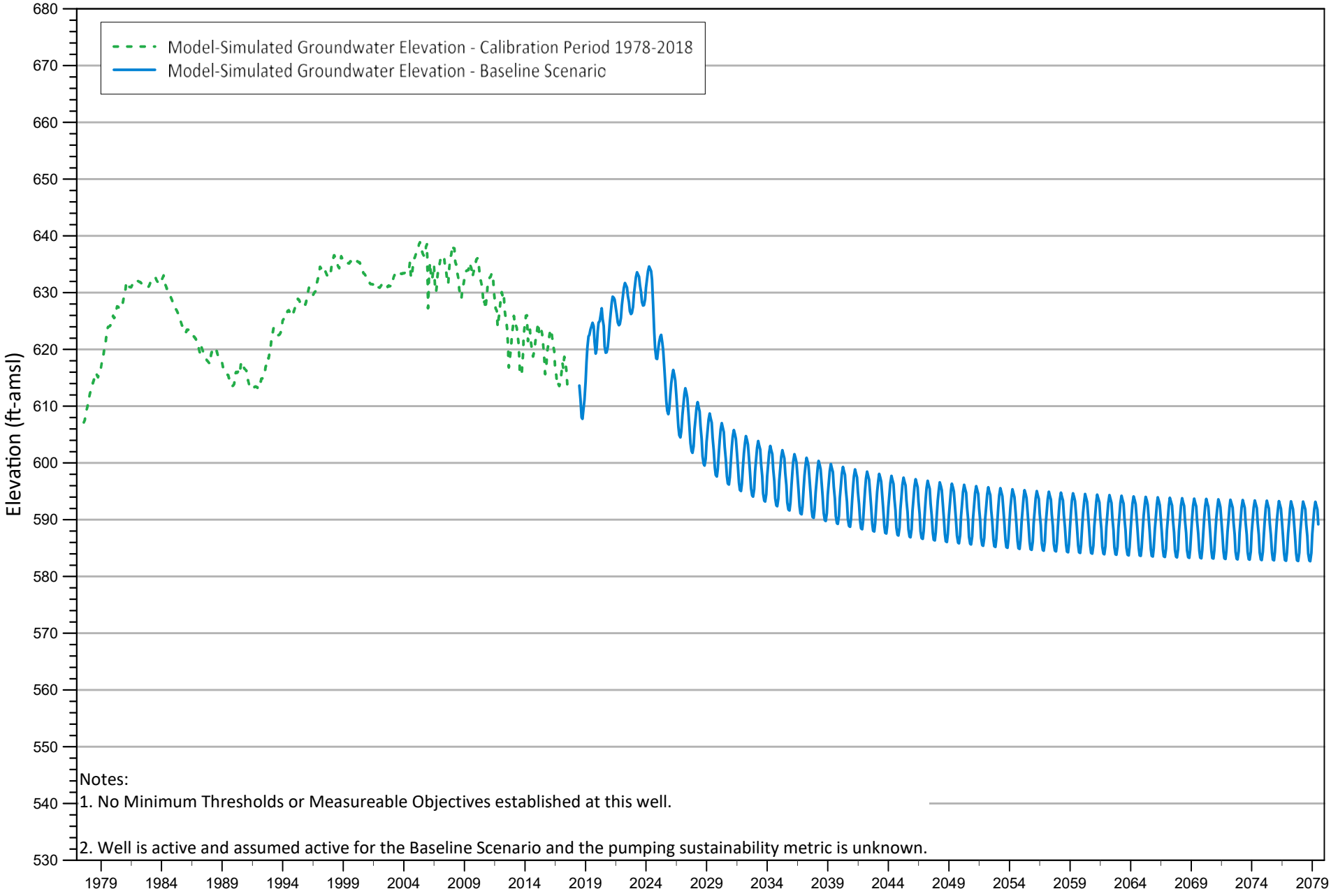


Figure 5-12d. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-2

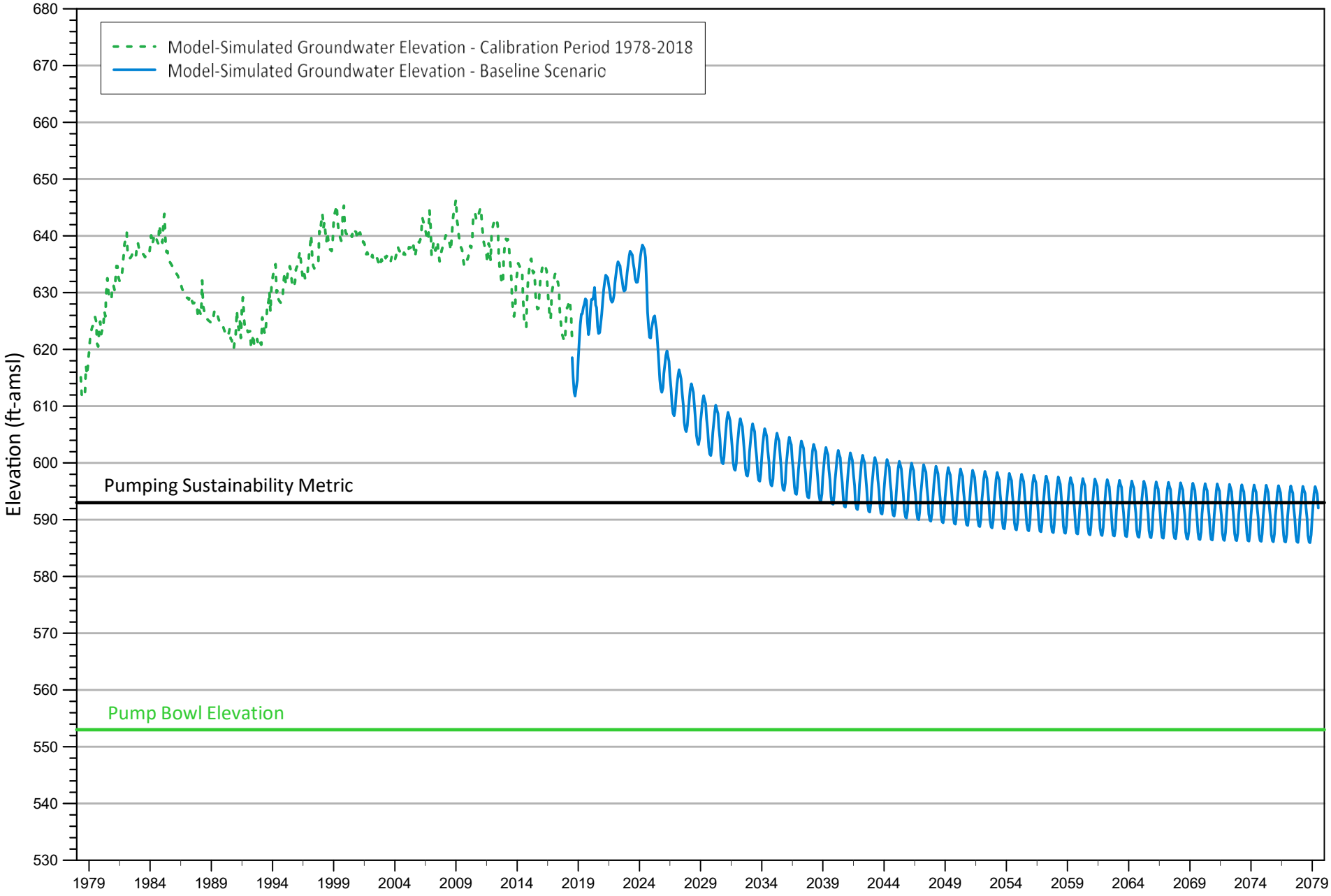


Figure 5-12e. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-28

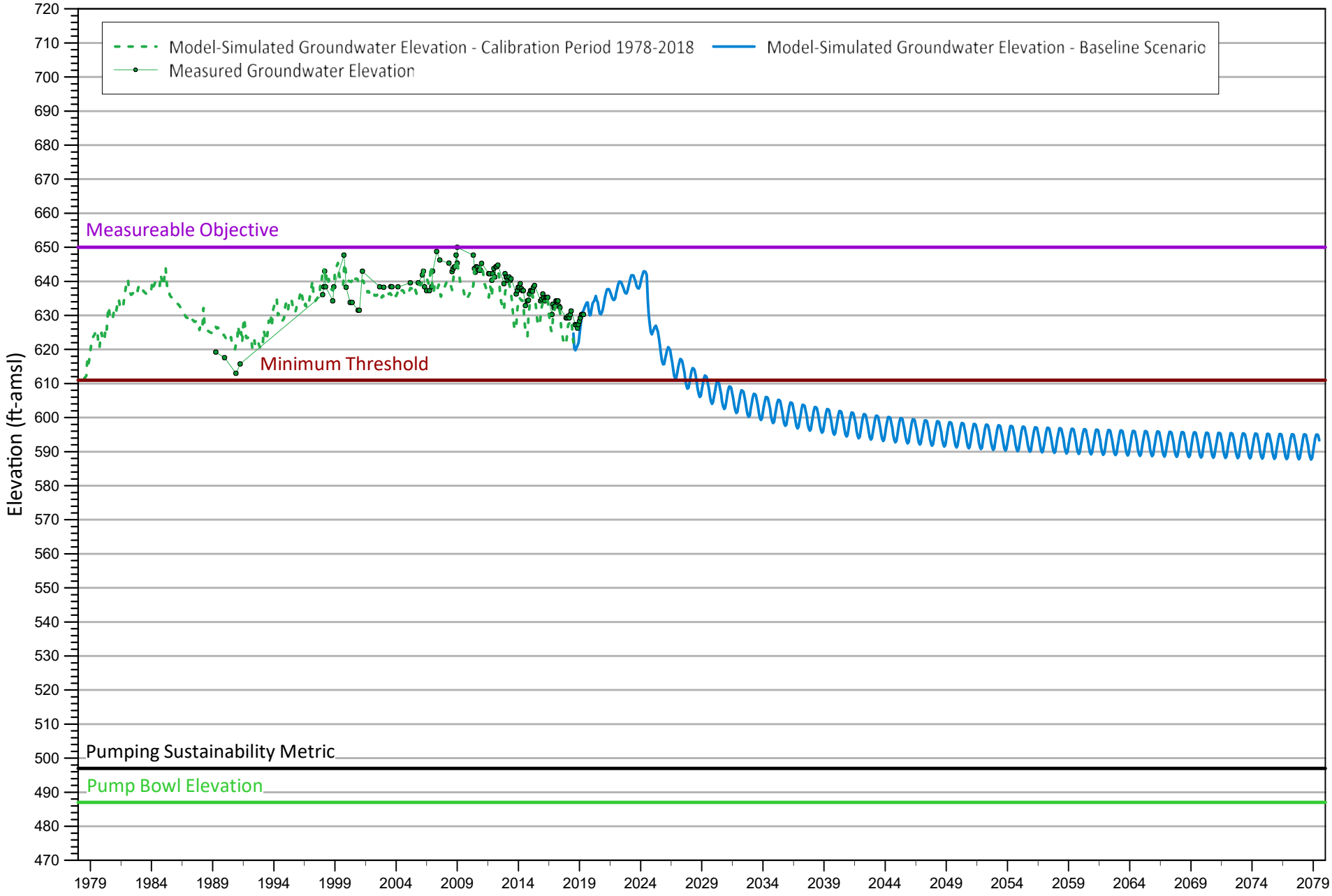


Figure 5-12f. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-1

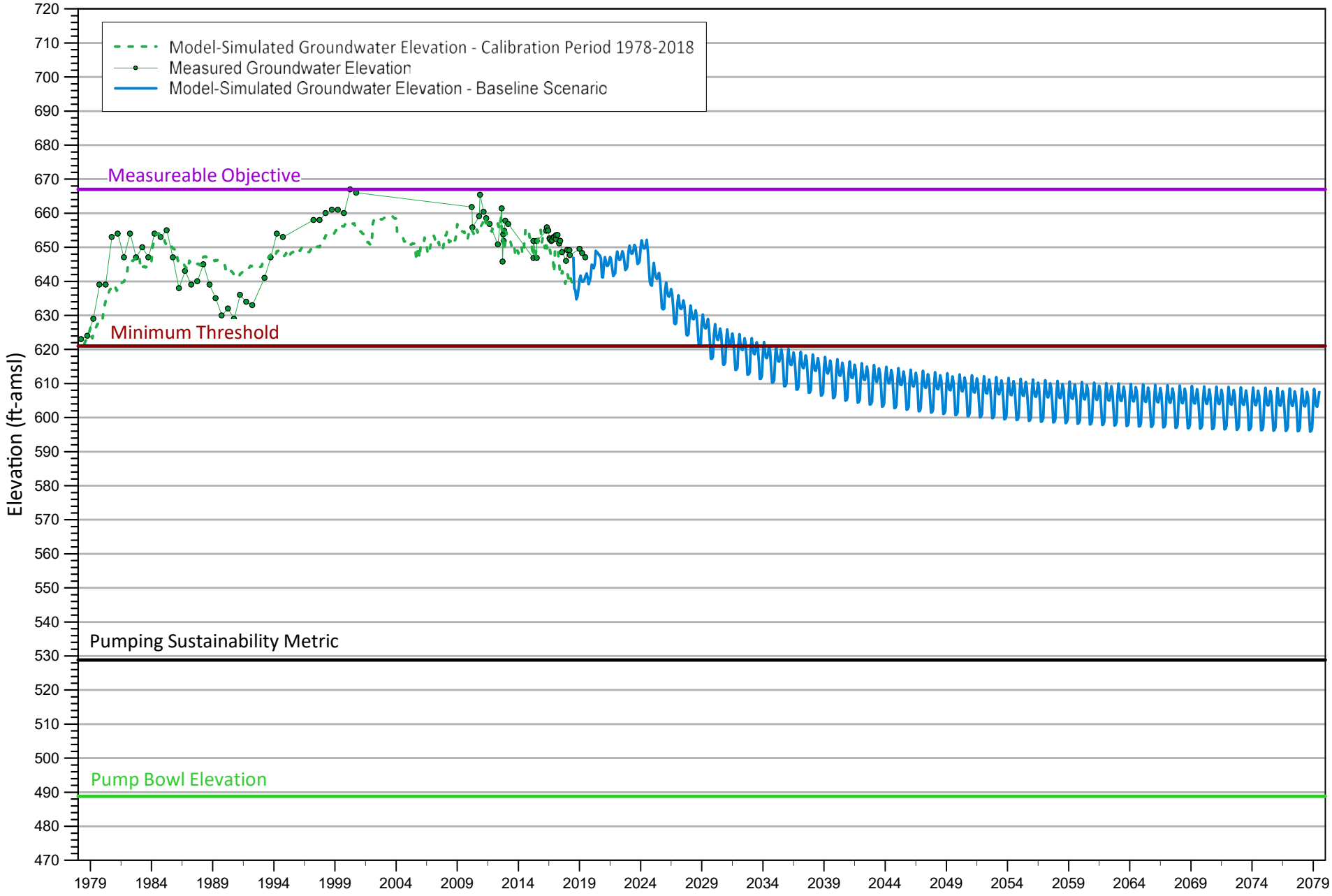


Figure 5-12g. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-19

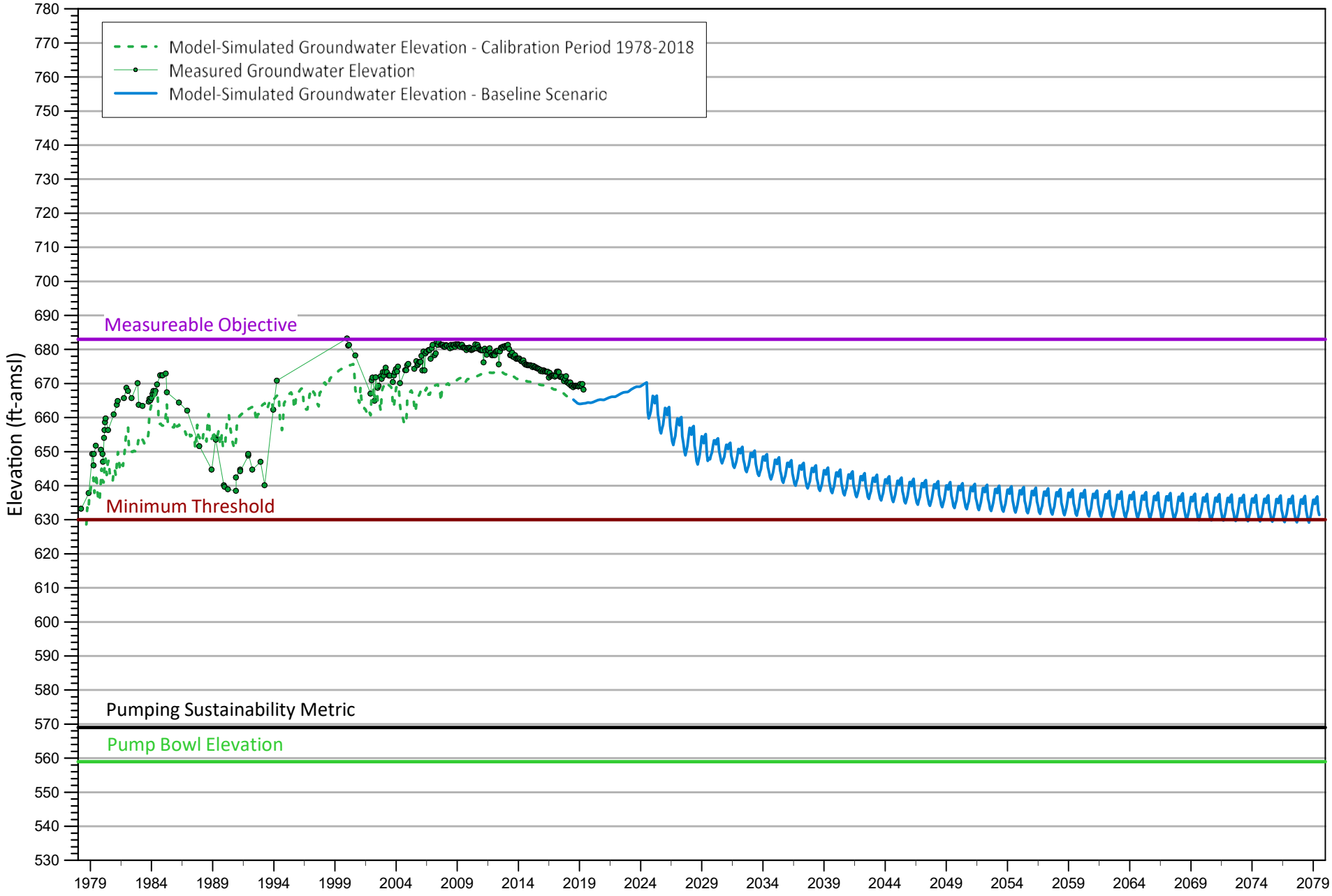


Figure 5-12h. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-31

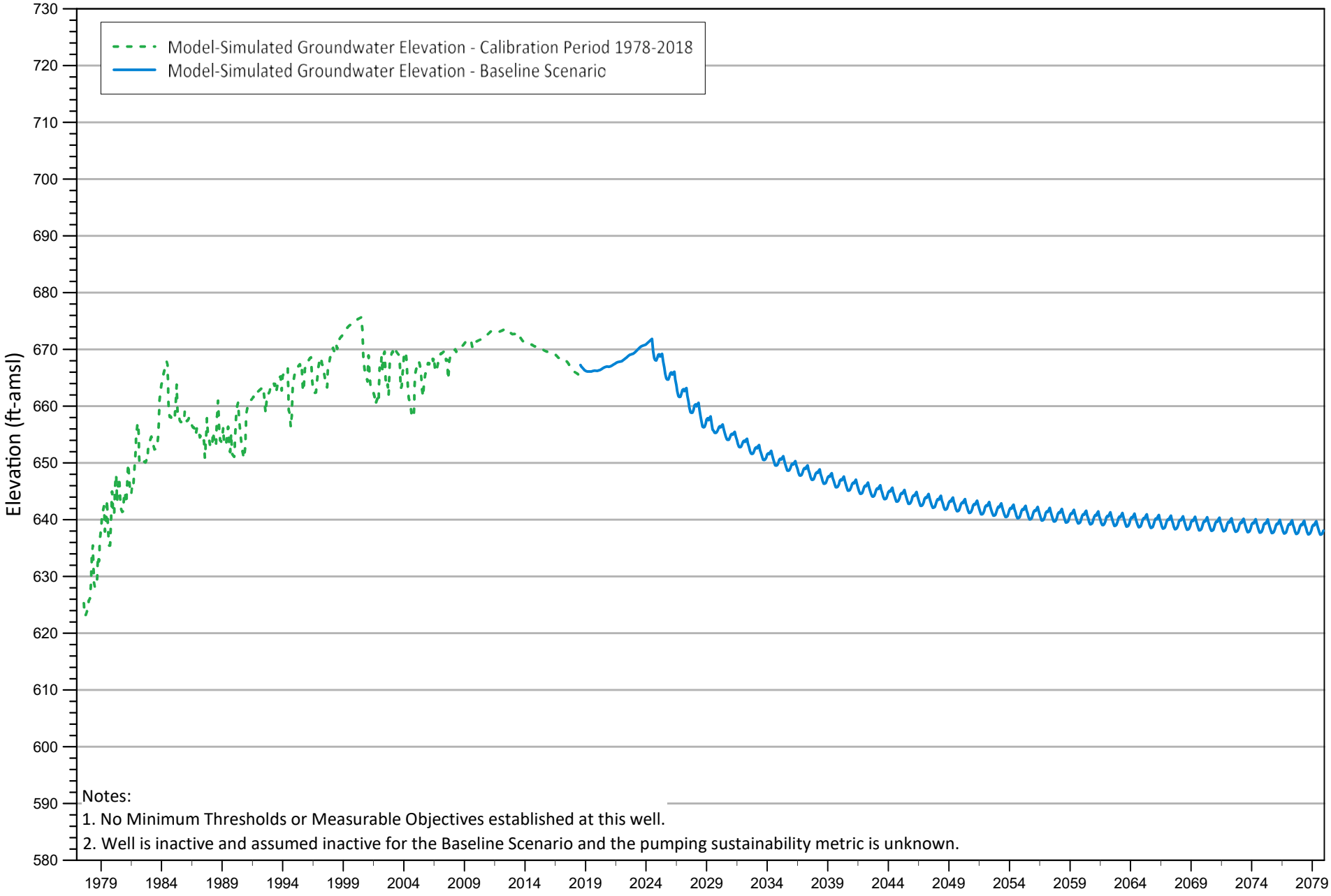
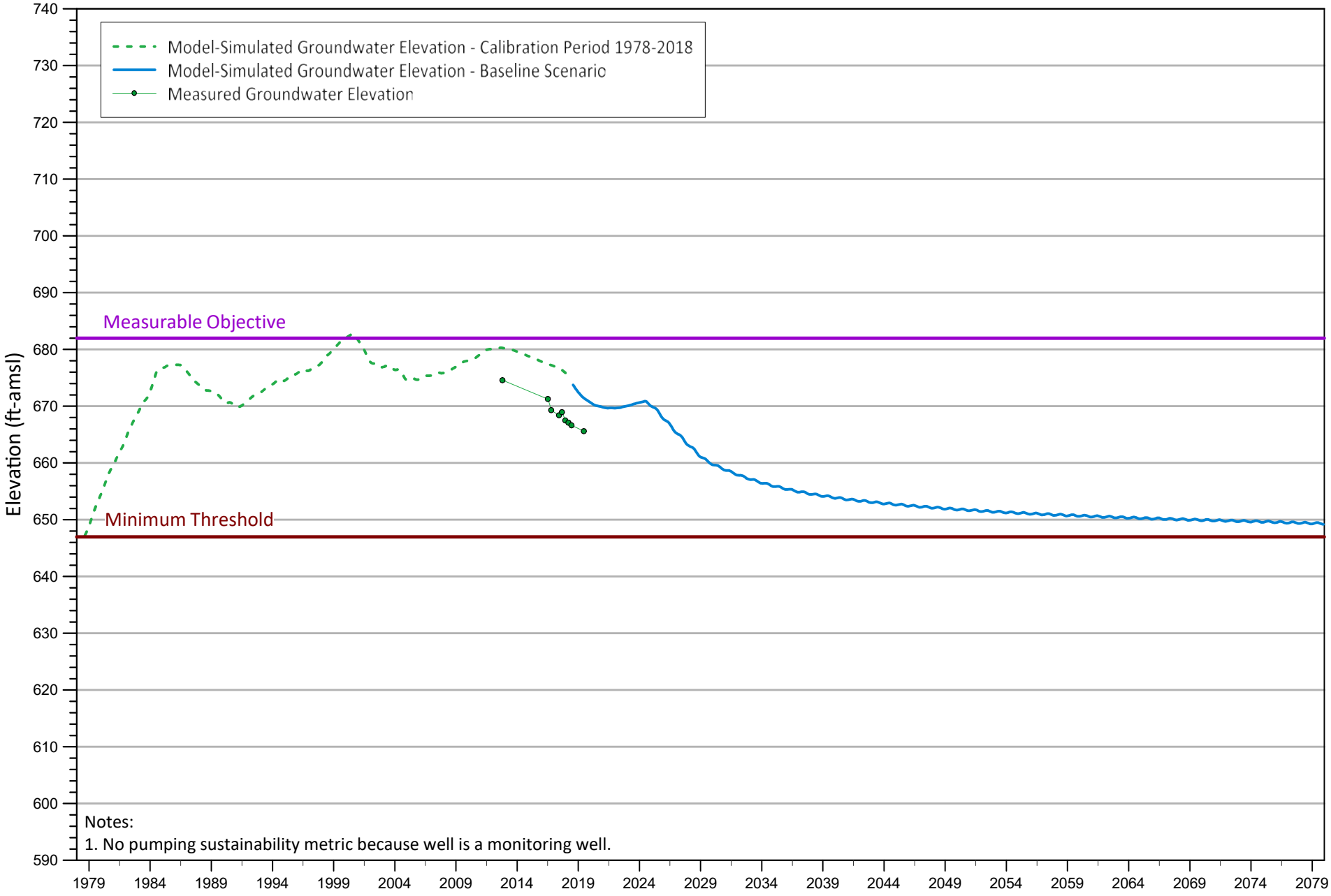


Figure 5-12i. Historical and Projected Groundwater Elevations for the Baseline Scenario at OMW-3



Figures 5-12a through 5-12i show that groundwater levels for the Baseline Scenario decline to levels below the Minimum Thresholds after 2027 and stay below through the end of the planning period in 2079, at five of the six wells: Industry, CPP-4, P-28, CPP-1, and P-19. The decline of groundwater levels below the Minimum Thresholds is predicted to occur around 2027-2030 for the wells in the western portion of the Basin (Industry, CPP-4, P-28, and CPP-1), and around 2060 for the well in the eastern portion of the Basin (OMW-3). This indicates that the Baseline Scenario is not sustainable relative to the Minimum Thresholds defined for these wells in *Section 3 Sustainable Management Criteria.*

5.2.2 Water Budget

Table 5-2 shows the water budget for the Baseline Scenario over the planning period 2019-2079 and contains the components of recharge and discharge, change in storage, and annual developed yield estimates. This water budget fulfills the requirement from Section 354.18 of the GSP Regulations for a projected water budget to estimate future baseline conditions of supply, demand, and aquifer response.

Recharge occurs in the Spadra Basin from DIPAW and subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose and Puente Hills).

- ***Deep infiltration of precipitation and applied water (DIPAW).*** Over the planning period, annual recharge from DIPAW ranged between about 1,600-2,200 afy and averaged 2,167 afy.
- ***Subsurface inflow.*** Annual subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills ranged from about 1,030 to 1,040 afy and averaged 1,036 afy over.
- ***Total recharge.*** Total annual recharge to the Spadra Basin over the planning period averaged about 3,200 afy.

The discharge components for the Spadra Basin are groundwater pumping and subsurface outflow to the Chino Basin and Puente Basin.

- ***Groundwater pumping.*** Over the planning period, annual groundwater pumping ranged from about 700 to 1,900 afy and averaged about 1,700 afy.
- ***Subsurface outflow to the Chino Basin.*** Annual subsurface outflow to the Chino Basin ranged from about 400 to 600 afy and averaged 586 afy.
- ***Subsurface outflow to the Puente Basin.*** Annual subsurface outflow to the Puente Basin ranged from about 900 to 1,500 afy and averaged about 1,000 afy.
- ***Total discharge.*** The annual discharge over the planning period averaged 3,300 afy.

Table 5-2. Water Budget for Spadra Basin - Baseline Scenario Fiscal Year 2019-2079 (acre-feet)

Fiscal Year	Recharge			Discharge				Change in Storage		Annual Developed Yield
	DIPAW	Side Inflows	Total Recharge	Subsurface Outflow to Puente Basin	Groundwater Pumping	Subsurface Outflow to Chino Basin	Total Discharge	Recharge minus Total	Cumulative	
2019	1,581	1,038	2,619	1,310	843	537	2,690	-71	-71	772
2020	1,705	1,035	2,741	1,437	707	389	2,533	207	136	914
2021	1,820	1,039	2,859	1,440	727	446	2,612	247	383	973
2022	1,921	1,039	2,960	1,491	702	492	2,685	275	658	977
2023	2,033	1,039	3,072	1,523	702	535	2,760	313	971	1,015
2024	2,037	1,036	3,073	1,543	702	557	2,802	271	1,241	973
2025	2,164	1,040	3,204	1,388	1,922	580	3,890	-686	556	1,236
2026	2,168	1,040	3,208	1,254	1,922	590	3,766	-558	-2	1,364
2027	2,172	1,040	3,212	1,195	1,922	593	3,710	-498	-500	1,424
2028	2,175	1,038	3,212	1,155	1,922	592	3,669	-457	-957	1,465
2029	2,178	1,041	3,219	1,122	1,922	591	3,635	-416	-1,373	1,506
2030	2,181	1,041	3,222	1,094	1,806	585	3,485	-263	-1,637	1,543
2031	2,185	1,040	3,226	1,073	1,806	579	3,458	-233	-1,870	1,573
2032	2,188	1,037	3,225	1,057	1,806	575	3,438	-212	-2,082	1,594
2033	2,191	1,040	3,231	1,042	1,806	570	3,419	-187	-2,269	1,619
2034	2,194	1,040	3,234	1,029	1,806	565	3,400	-166	-2,435	1,640
2035	2,195	1,040	3,235	1,017	1,806	563	3,386	-151	-2,586	1,655
2036	2,197	1,037	3,234	1,006	1,806	559	3,371	-137	-2,724	1,669
2037	2,197	1,040	3,237	996	1,806	559	3,361	-124	-2,848	1,682
2038	2,198	1,040	3,238	987	1,806	561	3,354	-116	-2,964	1,690
2039	2,199	1,040	3,238	979	1,806	563	3,348	-109	-3,073	1,697
2040	2,199	1,037	3,235	971	1,806	565	3,342	-107	-3,180	1,699
2041	2,199	1,039	3,239	964	1,806	570	3,340	-102	-3,281	1,704
2042	2,200	1,039	3,239	958	1,806	577	3,341	-102	-3,383	1,704
2043	2,200	1,039	3,239	952	1,806	581	3,340	-100	-3,483	1,706
2044	2,201	1,036	3,237	946	1,806	584	3,336	-100	-3,583	1,706
2045	2,201	1,039	3,240	942	1,806	586	3,333	-93	-3,676	1,713
2046	2,202	1,038	3,240	937	1,806	587	3,330	-90	-3,766	1,716
2047	2,203	1,038	3,241	933	1,806	587	3,325	-84	-3,850	1,722
2048	2,203	1,035	3,237	929	1,806	586	3,321	-83	-3,934	1,723
2049	2,203	1,038	3,241	925	1,806	586	3,317	-77	-4,010	1,729
2050	2,204	1,037	3,241	922	1,806	586	3,314	-73	-4,083	1,733
2051	2,204	1,037	3,241	918	1,806	586	3,310	-69	-4,152	1,737
2052	2,204	1,034	3,238	915	1,806	586	3,307	-69	-4,221	1,737
2053	2,205	1,037	3,241	912	1,806	586	3,305	-63	-4,285	1,743
2054	2,205	1,036	3,242	910	1,806	586	3,302	-61	-4,345	1,745
2055	2,206	1,036	3,242	907	1,806	586	3,300	-58	-4,403	1,748
2056	2,206	1,033	3,239	905	1,806	586	3,297	-59	-4,462	1,747
2057	2,206	1,036	3,242	903	1,806	587	3,295	-53	-4,515	1,753
2058	2,207	1,035	3,242	901	1,806	587	3,294	-51	-4,567	1,755
2059	2,207	1,035	3,243	899	1,806	587	3,292	-49	-4,616	1,757
2060	2,208	1,032	3,239	897	1,806	587	3,290	-50	-4,666	1,756
2061	2,208	1,035	3,243	895	1,806	587	3,288	-46	-4,712	1,760
2062	2,208	1,034	3,243	894	1,806	587	3,287	-44	-4,756	1,762
2063	2,209	1,034	3,243	892	1,806	587	3,286	-42	-4,798	1,764
2064	2,209	1,031	3,240	890	1,806	587	3,284	-44	-4,842	1,762
2065	2,210	1,034	3,244	889	1,806	587	3,283	-39	-4,881	1,767
2066	2,210	1,034	3,244	888	1,806	587	3,281	-38	-4,919	1,768
2067	2,211	1,033	3,244	887	1,806	588	3,280	-36	-4,955	1,770
2068	2,211	1,030	3,241	885	1,806	588	3,279	-38	-4,994	1,768
2069	2,211	1,033	3,244	884	1,806	588	3,278	-34	-5,028	1,772
2070	2,212	1,033	3,244	883	1,806	588	3,277	-33	-5,061	1,773
2071	2,212	1,033	3,244	882	1,806	588	3,276	-32	-5,092	1,774
2072	2,212	1,029	3,242	881	1,806	591	3,278	-37	-5,129	1,769
2073	2,212	1,033	3,245	880	1,806	597	3,284	-39	-5,168	1,767
2074	2,213	1,033	3,245	880	1,806	600	3,286	-41	-5,208	1,765
2075	2,213	1,033	3,245	879	1,806	601	3,286	-41	-5,249	1,765
2076	2,213	1,029	3,242	878	1,806	602	3,285	-43	-5,293	1,763
2077	2,213	1,033	3,245	877	1,806	600	3,283	-38	-5,330	1,768
2078	2,213	1,033	3,245	876	1,806	587	3,270	-24	-5,355	1,782
2079	2,213	1,033	3,245	876	1,806	567	3,249	-4	-5,358	1,802
Statistics for the Calibration Period 2019 through 2079										
Total	**132,163**	**63,203**	**195,366**	**61,382**	**104,293**	**35,050**	**200,724**	**-5,358**		**98,934**
Average	2,167	1,036	3,203	1,006	1,710	575	3,291	-88		1,622
Median	2,203	1,036	3,240	925	1,806	586	3,300	-61		1,729
Maximum	2,213	1,041	3,245	1,543	1,922	602	3,890	313		1,802
Minimum	1,581	1,029	2,619	876	702	389	2,533	-686		772

5.2.3 Storage

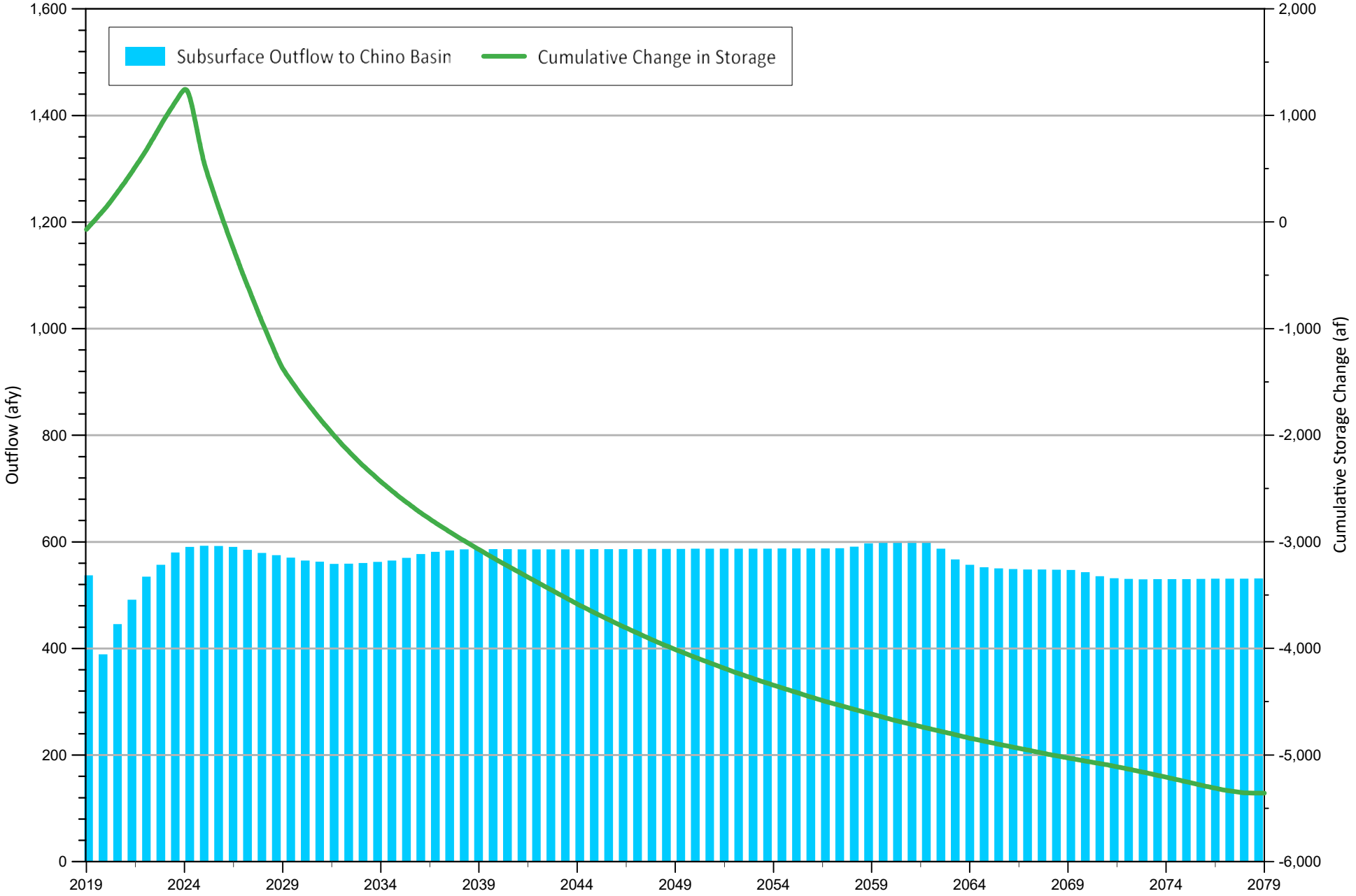
Table 5-2 includes the model estimates of the annual change in storage over the Baseline Scenario planning period which ranged from about -700 to +300 afy and averaged about -90 afy. The cumulative change in storage over the planning period is about -5,400 af. The decline in storage over the planning period appears to be due to the higher rates of groundwater pumping in the Baseline Scenario (~1,700 afy) compared to the average annual rates of pumping during the historical period 1978-2018 (~1,300 afy).

Figures 3-1 and 3-2 are time series charts that show the relationship between the groundwater storage and subsurface outflow to the neighboring Chino Basin and Puente Basin over the planning period for the Baseline Scenario. These time series charts are plotting the cumulative change in storage for the Baseline Scenario planning period as shown the water budget in Table 5-2. Changes in groundwater storage can be used as a proxy for groundwater levels. The cumulative change in groundwater storage of the Spada Basin increases about 1,300 af from 2019 to 2024, then continuously decreases from 2025 through 2079 by about -5,000 af, following the same trend in model-projected groundwater levels at wells in Figure 5-12a through 5-12i. The Minimum Thresholds for lowering of groundwater levels can be used as a proxy for groundwater storage. Groundwater levels for the Baseline Scenario are predicted to decline to levels below the Minimum Thresholds set at five of the six wells analyzed (Figures 5-12a through 5-12i) after 2027 and remain below these thresholds through the end of the planning period in 2079. Hence, this indicates that the Baseline Scenario is likely not sustainable for groundwater storage in the Basin.

Figure 5-13 shows the cumulative change in groundwater storage versus subsurface outflow to the Chino Basin for the Baseline Scenario. Subsurface outflow to the Chino Basin occurs within the saturated sediments across the eastern boundary of the Spadra Basin. This figure shows that subsurface outflow to Chino Basin is predicted to be relatively stable during the planning period, even as groundwater storage declines through 2079. This is because the calibration of the Spadra Basin Groundwater Model indicated the existence of an unmapped hydraulic barrier along the boundary with the Chino Basin, and this area is simulated as having very low hydraulic conductivity (see *Section 2.2.7 Data Gaps*). The low hydraulic conductivity in this area of the model domain appears to govern the subsurface outflow to Chino Basin, keeping it relatively constant even as storage declines across the Spadra Basin.

Figure 5-14 shows the cumulative change in groundwater storage versus subsurface outflow to the Puente Basin for the Baseline Scenario. Subsurface outflow to Puente Basin occurs within the saturated sediments through the bedrock narrows at the western boundary of Spadra Basin. This figure shows that subsurface outflow to the Puente Basin is directly related to storage in the Spadra Basin. As storage decreases in the Spadra Basin over the planning period, the subsurface outflow to Puente Basin follows the same trend and rate of change from about 1,500 afy to 875 afy. The rate of change in storage and subsurface outflow to the Puente Basin gradually decline toward the end of the planning period, which indicates that the water budget of the Spadra Basin is approaching a new level of dynamic equilibrium at the lower rates of subsurface outflow.

Figure 5-13. Cumulative Change in Storage and Subsurface Outflow to Chino Basin - Baseline Alternative

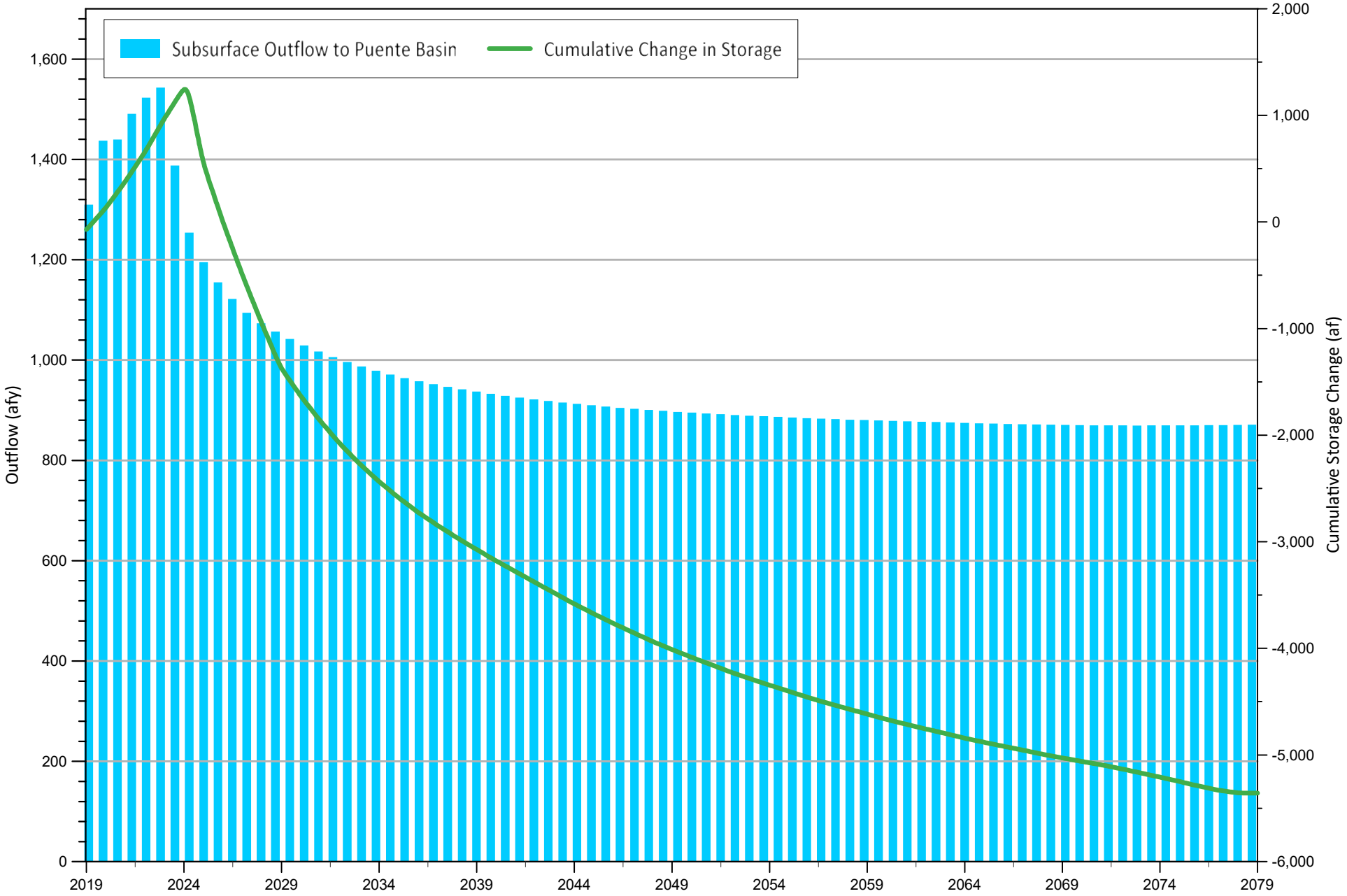


WEST YOST

954-80-20-01 GRAPHER\GRF\TMs\TM5\Figure 5-13

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan (GSP)
Last Revised: 1-14-22

Figure 5-14. Cumulative Change in Storage and Subsurface Outflow to Puente Basin - Baseline Alternative



5.2.4 Land Subsidence

Section 2.2 Basin Setting demonstrated that very little permeant land subsidence, if any, has occurred historically within the Spadra Basin. And as described in *Section 3 Sustainable Management Criteria*, maintaining water levels above the Minimum Thresholds established at representative monitoring wells that are based on the lowest water levels historically is likely to protect against the occurrence of Undesirable Results for land subsidence in the Basin. Therefore, the Minimum Thresholds for lowering of groundwater levels can be used as a proxy for land subsidence. The groundwater levels for the Baseline Scenario are predicted to decline to levels below these Minimum Thresholds set at five of the six wells analyzed (Figures 5-12a through 5-12i) after 2027 and remain below these thresholds through the end of the planning period in 2079. Hence, this indicates that the Baseline Scenario is likely not sustainable for land subsidence in the Basin.

5.2.5 Developed Yield

The "annual developed yield" is the annual volume of groundwater pumping from the Spadra Basin plus the annual change in storage volume calculated in the water budget. Table 5-2 shows that the annual developed yield increased over the planning period from 772 af in 2019 to 1,802 af in 2079, and averaged 1,622 af, which is 190 af more than the estimated annual developed yield of 1,430 afy for the historical 1978 to 2018 period.

The increasing trend in developed yield is caused by increased pumping and declining groundwater levels, which in turn, reduces subsurface outflow to the Puente Basin. As shown in Figures 5-12a through 5-12i, 5-13, and 5-14, the rate of decline in groundwater levels and storage approaches zero toward the end of the planning period. This indicates that the water budget of the Basin is establishing a new dynamic equilibrium at these lower groundwater levels, where recharge and discharge are approximately equal. This observation demonstrates that the Spadra Basin can be operated at these lower groundwater and storage levels to increase the developed yield of the basin; however, the adverse effects are projected to be exceedances of groundwater level Minimum Thresholds, pumping sustainability challenges at some wells, the potential for land subsidence, and reduced subsurface outflow to the Puente Basin.

5.2.6 Conclusions and Recommendations

The following are the main conclusions and recommendations derived from the evaluation of the Baseline Scenario.

Conclusions:

- The model results of the Baseline Scenario indicate that groundwater levels are projected to decline over the planning period by 20-25 ft throughout the Basin to levels below the groundwater level Minimum Thresholds at most of the representative monitoring wells. The Minimum Thresholds for groundwater levels were set to protect against the occurrence of Undesirable Results including chronic lowering of groundwater levels, significant depletions in storage, land subsidence, and impacts to the beneficial uses of downgradient groundwater basins. This indicates that the Baseline Scenario is not sustainable over the planning period, and projects and programs are needed to achieve long-term sustainability and avoid Undesirable Results.

- The groundwater levels are predicted to decline to levels below the pumping sustainability metrics at three of the pumping wells in the western portion of the Basin. This indicates that the Baseline Scenario may cause pumping sustainability challenges for some water purveyors.
- The model results of the Baseline Scenario indicate that the annual developed yield of the Basin can be increased with more pumping and lower groundwater levels in the Basin. Under these conditions, the Basin appears to reach a new dynamic equilibrium with less subsurface outflow to the Puente Basin. However, the effects of operating at these lower groundwater levels are, groundwater elevations below Minimum Thresholds; pumping sustainability challenges at wells in the western portion of the Basin; and decreased subsurface outflow to Puente Basin.

Recommendations:

- Develop and evaluate up to four Basin Optimization Scenarios. These scenarios will represent potential plans and projects to: (i) achieve sustainability in the Spadra Basin over the planning period and (ii) maximize the beneficial use of the Basin.
- The Basin Optimization Scenarios should include projects that increase recharge to the basin, such as artificial recharge of storm water and/or supplemental waters. Increased recharge will have the effect of increasing groundwater levels, which could avoid exceedances of Minimum Thresholds and the occurrence of Undesirable Results.
- The projects and plans in the Basin Optimization Scenarios could be implemented in a coordinated fashion to conduct a conjunctive use program—the coordinated use and management of all surface water and groundwater resources available to the water purveyors to enhance basin yield and improve water-supply reliability. The operational concept is to use and/or store surface waters in the Spadra Basin during wet periods when these supplies are more available, so that Spadra Basin groundwater is more available for use during dry periods.

5.3 DEVELOPMENT OF THE BASIN OPTIMIZATION SCENARIOS

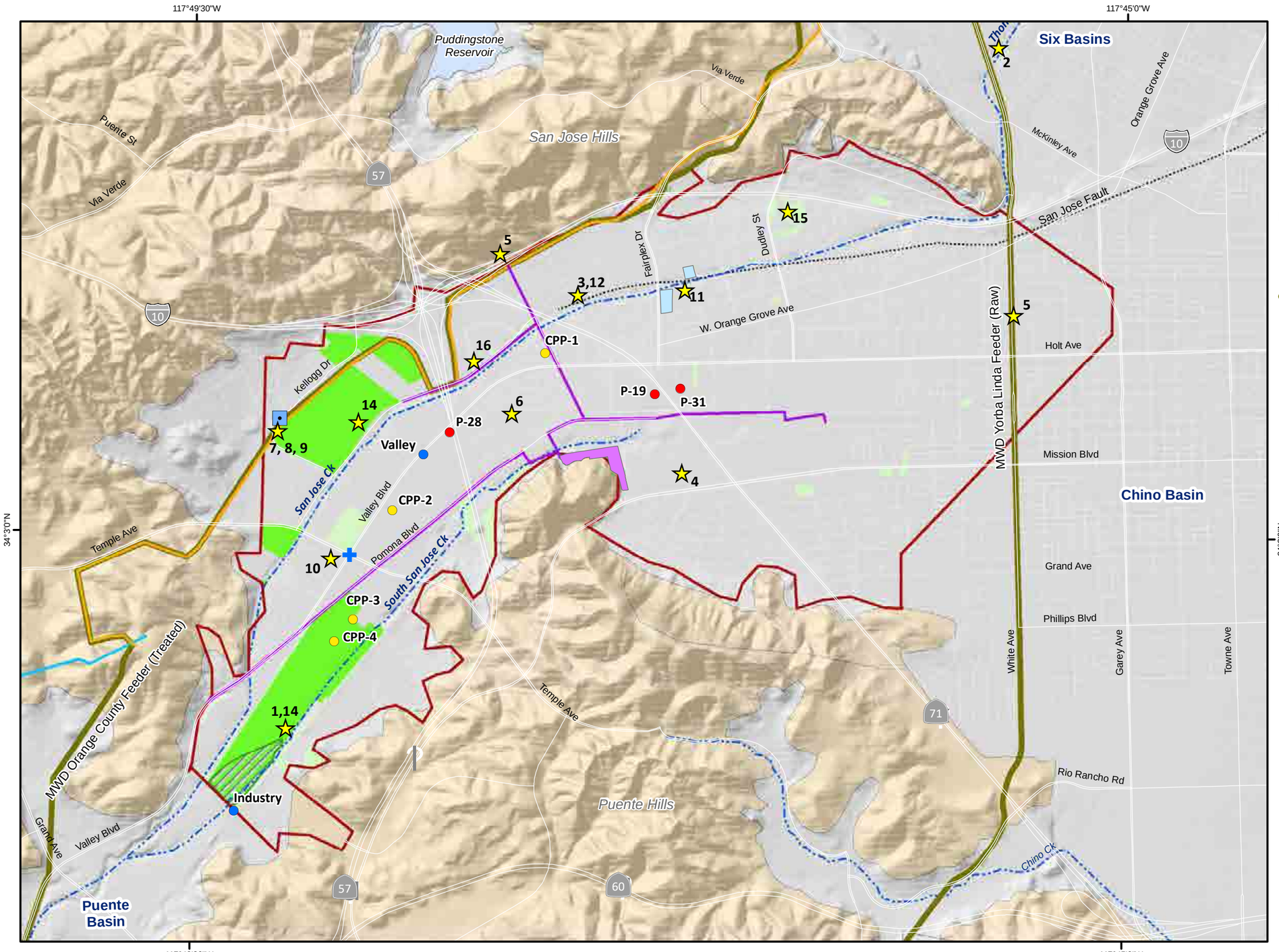
This section describes the accumulation of data and information from Spadra Basin stakeholders on potential projects and management actions in the Spadra Basin, and the combination of some of these projects and management actions into Basin Optimization Scenarios that are intended to achieve long-term sustainability and maximize the beneficial use of the Spadra Basin.

5.3.1 Potential Projects and Management Plan Concepts

The GSA conducted a call for projects from all Spadra Basin stakeholders via email in January 2021. Feedback on potential projects and management actions was received from California State Polytechnic University, Pomona (CPP), WVWD, City of Pomona (Pomona), and Forest Lawn Memorial Parks. This feedback was compiled and presented at a Spadra Basin Advisory Committee meeting on February25, 2021 for discussion amongst the stakeholders and to solicit additional feedback. Table 5-3 lists the various projects and plans with stakeholder attribution. Figure 5-15 is a map that shows the locations of the projects in the Spadra Basin.

Table 5-3 . Proposed Projects and Management Actions for the Spadra Basin

Map ID	Project Description	Proposing Agency
Recharge Projects		
1	Convert CPP agricultural land at the confluence of San Jose Creek and South San Jose Creek into spreading grounds	CPP, Pomona
2	Develop a spreading connection off of the MWD Foothill Feeder - Rialto Pipeline at Thompson Creek Channel	CPP, WVWD
3	Redirect storm water flows in the area to new spreading grounds	CPP, Forest Lawn
4	Recharge surplus recycled water from the Pomona WRP after contractual obligations are met, via spreading or injection	CPP, Pomona, Forest Lawn, WVWD
5	Utilize three large diameter pipelines for imported water that run through the Spadra Basin as sources for artificial recharge; 1) The MWD's Orange County Feeder treated water pipeline, 2) The Pomona Walnut Rowland Joint Water Line (JWL) treated water pipeline, and 3) The MWD's Yorba Linda Feeder raw water pipeline.	WVWD
11	Selecting recharge locations where there is easy connection to different types of recharge waters (storm water, recycled water, and imported water) - Example shown in map for Map ID 11	Feb 2021 Advisory Committee Meeting
12	Construction of rubber dams in the San Jose Creek to divert storm water for recharge;	Feb 2021 Advisory Committee Meeting
13	Construction of underground infiltration galleries under sports fields at John Marshall Middle School or other schools/parks for recharge of recycled water and other waters	Feb 2021 Advisory Committee Meeting
14	Recharge storm water and recycled water through flood irrigation at Cal Poly Pomona agricultural lands when land is fallow	Feb 2021 Advisory Committee Meeting
15	Potential recharge location south east of the intersection of the 10 Freeway and Dudley Street.	Feb 2021 Advisory Committee Meeting
16	Potential recharge location at University Corporate Center Drive, however previous studies have indicated that the soil is potentially not conducive for recharge	Feb 2021 Advisory Committee Meeting
Pump and/or Treat Projects		
6	Construct a new production well	CPP
7	Connect all wells to the Reverse Osmosis Plant	CPP
8	Operate Reverse Osmosis Plant at maximum capacity 24/7 with surplus potable water going to Pomona, Walnut and Rowland	CPP, Pomona, WVWD
9	Expand treatment capacity at the CPP Reverse Osmosis Plant	CPP, Forest Lawn
10	Utilizing an existing intertie at the intersection of Temple and Valley between WVWD and the City of Pomona, to facilitate use of Spadra Basin water by WVWD by leveraging Pomona's existing pumping capacity in the basin.	WVWD
Management Strategies		
	Replace recycled water going to Forest Lawn with groundwater	CPP
	Conjunctive Water Management to maximize the use of all water resources available to the parties, including storm, recycled, imported, and groundwaters, and the storage capacity of the groundwater basin.	Forest Lawn
	Maximize recharge and pumping to assist in groundwater cleanup and characterize impacts to neighboring basins	Forest Lawn
	Increase reliability of irrigation water with an increase in the use of recycled water	Forest Lawn
	Inventory all existing and adjacent (public and private) water facilities to optimize the basin	Forest Lawn
	Leverage existing infrastructure to move surplus water around between parties	WVWD
	Increase and maximize groundwater pumping with increased artificial recharge	Forest Lawn, WVWD
	Implementing treatment and leveraging cleanup of point sources in the basin	Feb 2021 Advisory Committee Meeting
	Design a management plan to optimally manage and use the basin for local reliable sources without a storage a recovery program	Feb 2021 Advisory Committee Meeting
	Implement recharge programs with a steady and reliable source of water with matched increased pumping.	Feb 2021 Advisory Committee Meeting



4 Location of Proposed Project (labeled by ID in Table 2-1)

Existing Facilities

Existing Production Wells (Symbolized by Well Owner)

- Cal Poly Pomona (CPP)
- City of Pomona (Pomona)
- Walnut Valley Water District (WVWD)

Imported Water Pipelines

- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
- Badillo Grand Pipeline, Treated
- MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)

- Pomona Water Reclamation Plant (WRP)
- Pomona WRP Recycled Water Pipelines
- CPP Reverse Osmosis (RO) Plant
- Intertie between WVWD and Pomona

Other

- CPP Agricultural Lands
- Agricultural Land at Confluence of San Jose and South San Jose Creeks
- Vacant Land
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 11/8/2021
File: Figure 5-15 projects.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Map of Proposed Locations for New Projects for the Spadra Basin

Figure 5-15

The primary project concepts of interest to the stakeholders were: artificial recharge projects that will support groundwater levels and augment the yield of the basin; the use of surplus recycled water from the Pomona WRP that otherwise is discharged to South San Jose Creek and exits the Spadra Basin; and groundwater treatment projects to increase the potable use of the Spadra Basin. These project concepts and other feedback were used to develop three Basin Optimization Scenarios, described below.

5.3.2 Basin Optimization Scenarios

Three Basin Optimization Scenarios have been developed over the 60-year planning period: Basin Optimization Scenario 1 – Sustainability through Substitution; Basin Optimization Scenario 2 - Sustainability through Recharge; and Basin Optimization Scenario 3 – Maximum Beneficial Use. All three scenarios are intended to achieve long-term sustainability in the Basin, and Basin Optimization Scenario 3 – is intended to maximize its beneficial use. The scenarios will be evaluated using the Spadra Basin Groundwater Model for the same 60- year planning period of 2019-2079 that was used to evaluate the Baseline Scenario. The hydrologic response of the Spadra Basin to the Basin Optimization Scenarios will be compared to the Sustainable Management Criteria set in the Spadra Basin for groundwater levels, and by proxy groundwater storage and land subsidence. Additionally, cost estimates will be prepared for each Basin Optimization Scenario and compared to each other and the cost of the Baseline Scenario.

The primary cause of the projected decline in groundwater levels in the Baseline Scenario is an increase in projected groundwater pumping by 526 afy from the long-term average pumping for the 1978 to 2018 historical period. This observation was used to set the assumption that about 500 afy of recharge or decreased pumping is needed to support groundwater levels and achieve long-term sustainability in the Spadra Basin for the Basin Optimization Scenarios.

All three Basin Optimization Scenarios include the use of surplus recycled water from the Pomona WRP to achieve the objectives of the scenarios. Surplus recycled water is tertiary-treated effluent from the Pomona WRP that is not delivered for direct reuse to existing customers in the Spadra Basin for irrigation or commercial purposes.

Currently, this surplus recycled water is discharged to the South San Jose Creek where it exits the Spadra Basin and either evaporates, is recharged about 15 miles downstream at the Montebello Forebay, or is consumed by riparian vegetation at the Montebello Forebay. The LACSD filed for a wastewater change petition (WW 0104) with the State of California Water Resources Control Board (State Water Board) in October 2019 to reduce the discharge of treated recycled water to the South San Jose Creek from the Pomona WRP to zero for all months of the year (State Water Board, 2019) and be redirected for other uses. The wastewater change petition described the surplus recycled water as 3.2 mgd based on the average discharge that occurred from 2014 to 2018, which is about 3,500 afy. The change petition was approved in October 2020 allowing for the potential utilization of this surplus recycled water in the Spadra Basin (State Water Board and California EPA, 2020).

The LACSD completed a final Environmental Impact Report (FEIR) for the reduced discharge to the San Gabriel River Watershed envisioned in the wastewater change petition for the Pomona WRP and three other treatment plants in the watershed (ESA, 2019). The FEIR includes a mitigation measure for the LACSD to implement an Adaptive Monitoring Plan (AMP) in coordination with the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) to ensure the quantity and quality of the riparian and wetland habitat downstream is maintained during reduced flow from the upstream treatment plants. A draft AMP was developed and included as an attachment to the FEIR (Wood, 2019) and includes the monitoring of various vegetation parameters and trigger levels to implement

responsive measures that could include resumed discharges to the river and tributary channels in sufficient volumes to support the habitat sustained by historical discharges.

Recycled water is considered the primary source of recharge for the Basin Optimization Scenarios 2 and 3 because of the stakeholder interest to utilize this local available source of water that is currently not being used in the Spadra Basin. Basin Optimization Scenarios 2 and 3 contemplate the use of recycled water for artificial recharge ranging from 500 afy to 3,500 afy at locations that are conceptual at this time. However, there is potential the recycled water available for recharge could be less in the future than the assumed maximum of 3,500 afy in the scenarios. Conditions where less recycled water would be available in the future could include: if the LACSD's AMP implements a response measure to resume some discharge to support the downstream habitat; a decrease in influent and production at the Pomona WRP; or new reuse and storage projects are implemented. The GSP implementation includes planning phases for project implementation to take the conceptual projects described in the GSP to design and construction (Section 6.1.5). The planning phases include the identification and characterization of project alternatives, which could include less recycled water recharge, other sources or combinations of water for recharge, projects to increase recycled water availability, among others.

Each Basin Optimization Scenario is summarized below. Figure 5-16 is a map of the Spadra Basin that shows the locations of all existing wells, potential new wells, and potential new recharge facilities included in the three Basin Optimization Scenarios.

5.3.2.1 Basin Optimization Scenario 1 – Sustainability through Substitution

Objective. Support groundwater levels and achieve sustainability in the Spadra Basin by decreasing groundwater pumping.

Description. Scenario 1 eliminates groundwater pumping at Cal Poly wells CPP-2, CPP-3, and CPP-4 (wells currently used for non-potable supply for irrigation) and replaces it with surplus tertiary-treated recycled water from the Pomona WRP. The combined planned pumping in the Baseline Scenario for CPP- 2, CPP-3, and CPP-3 is 430 afy. Therefore, the 430 afy of groundwater supply will be replaced with 430 afy of recycled water from the Pomona WRP. This substitution is viable because the monthly surplus recycled water is greater than the monthly planned pumping at the CPP-2, CPP-3, and CPP-4 wells combined, even during the peak demand months in the summer. Additionally, the sites that are irrigated with groundwater pumped from these CPP wells are near the main recycled water pipelines where turnouts and extensions could be added for irrigation at these sites.

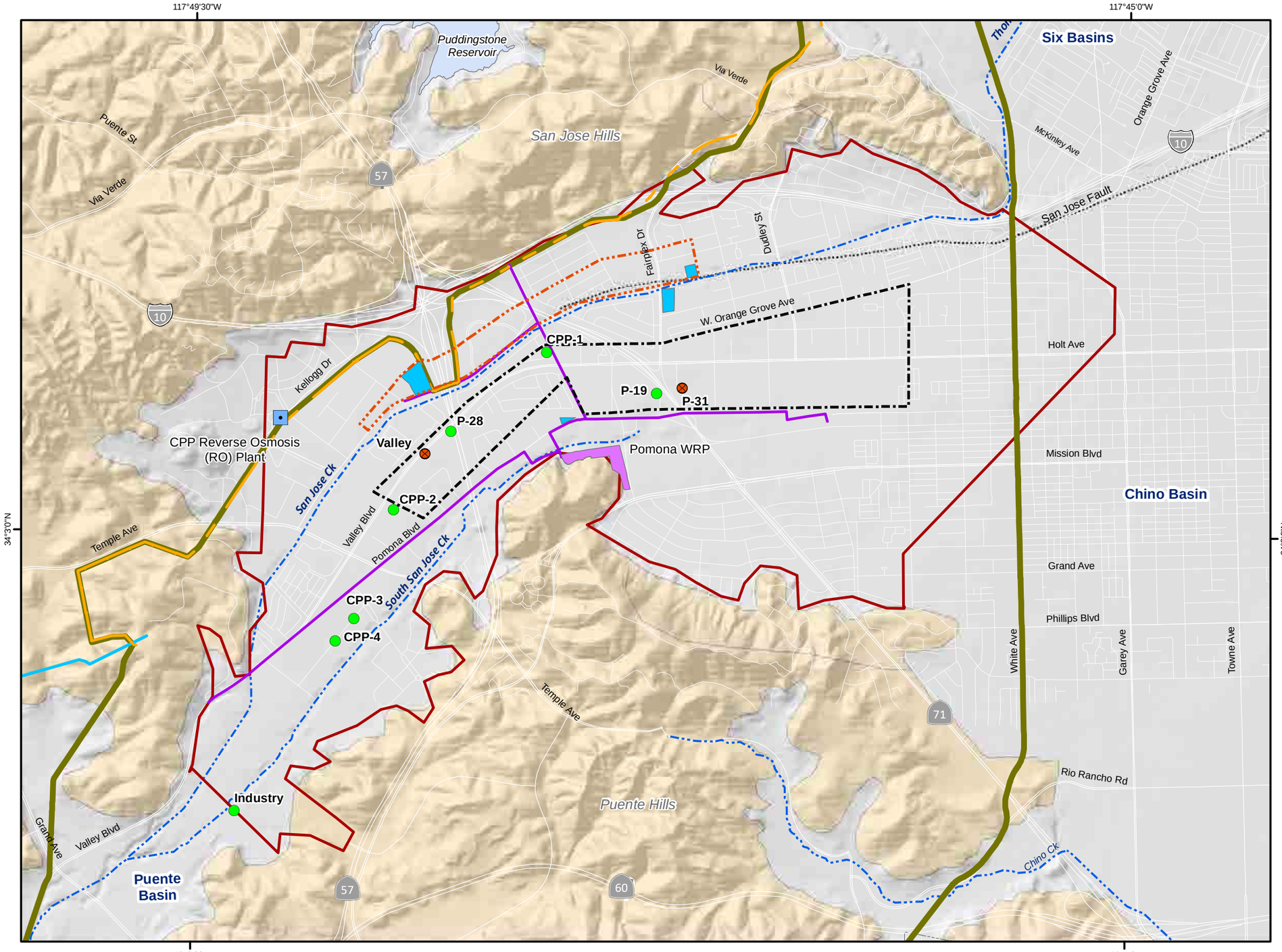
Permitting: Already permitted under existing WRRs for LACSD Order No. 97-072, and potentially the development of a SNMP for the Spadra Basin.

Groundwater Pumping. In Scenario 1, a total of 1,376 afy is pumped from wells CPP-1, P-28, P-19, and Industry. This is 430 afy less than groundwater pumping in the Baseline Scenario.

Managed Aquifer Recharge. There is no artificial recharge included in Scenario 1.

Treatment. There is no additional groundwater treatment included in Scenario 1.

New Wells/Facilities. Additional recycled water pipeline and connections will be necessary to enable irrigation with recycled water at the sites currently irrigated with groundwater.



Exsisting Wells

- Well Planned to be Active in Baseline Scenario
- Well Planned to be Inactive in Baseline Scenario

Exsisting Facilities

- Pomona WRP Recycled Water Pipelines
- Pomona Water Reclamation Plant (WRP)
- CPP Reverse Osmosis (RO) Plant

Imported Water Pipelines

- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
- Badillo Grand Pipeline (Treated)
- MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)

New Wells and Facilities

- Potential Location for Underground Recharge Gallery
- Target Area for New Injection Wells
- Target Area for New Production Wells

- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 11/8/2021
File: Figure 5-16_BOS_Wells_Facilities_New.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Map of Potential Locations for New Wells and Facilities for Basin Optimization Scenarios

Figure 5-16

5.3.2.2 Basin Optimization Scenario 2 – Sustainability through Recharge

Objective. Support groundwater levels and achieve sustainability in the Spadra Basin via managed aquifer recharge of recycled water from Pomona WRP.

Description. Scenario 2 increases artificial recharge to the Spadra Basin from 0 afy to 500 afy via the construction of new recharge facilities for the recharge of recycled water from the Pomona WRP. Two different types of recharge facilities will be constructed for the recharge of 500 afy: an underground recharge gallery with an estimated capacity of 200 - 890 afy (dependent on the selected site's surface area) and an injection well with an estimated recharge capacity of 450 afy. The two types of recharge facilities provide for operational flexibility and reliability, and the option to increase recharge above 500 afy. The two recharge facilities can also act as a pilot program to test the functionality and success of the two types of facilities.

Permitting. The recharge of recycled water will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin, or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). The current regulatory permitting framework of the recycled water recharge via injection (subsurface application) requires the advance treatment of water prior to recharge. This scenario does not include advance treatment prior to injection. Permitting will be a regulatory challenge that will need to be addressed with the Regional Board and State Water Board during the planning stages of project implementation as described in Section 6.1.5 of the GSP.

Groundwater Pumping. In Scenario 2, a total of 1,806 afy is pumped from wells CPP-1, CPP-2, CPP-3, CPP- 4, P-28, P-19, and Industry. This is equal to the planned pumping in the Baseline Scenario.

Managed Aquifer Recharge. In Scenario 2, a total of 500 afy of recycled water is artificially recharged in the Spadra Basin, an increase of 500 afy compared to the Baseline Scenario.

Treatment. There is no additional groundwater treatment included in Scenario 2.

New Wells/Facilities.

- One underground recharge gallery and associated recycled water pipeline. Figure 5-16 shows potential locations for an underground recharge gallery. These locations were identified because they are along and/or near the main Pomona WRP recycled water pipeline in the northern central portion of the Basin and not near existing production wells. The potential locations to the east of Highway 71 will require the construction of new recycled water pipeline, but this new pipeline could be utilized to irrigate the schools and parks in this area and to supply recharge to any new injection wells in this area.

- One injection well and associated recycled water pipeline and connections. The location of the injection well will be within the target area shown in Figure 5-16. This target area was identified as an area along and/or near the main Pomona WRP recycled water pipeline and not nearby or upgradient from existing production wells.

5.3.2.3 Basin Optimization Scenario 3 – Maximum Beneficial Use

Objective. Support groundwater levels, achieve sustainability, and maximize the beneficial use of the Spadra Basin by utilizing all available surplus recycled water from the Pomona WRP for artificial recharge, increasing groundwater production, and increasing groundwater treatment capacity to produce a new potable water supply from the Spadra Basin.

Description. Scenario 3 increases artificial recharge to the Spadra Basin from 0 afy to 3,500 afy via the construction of new recharge facilities for the recharge of recycled water from the Pomona WRP. Two different types of recharge facilities will be constructed for the recharge of 3,500 afy: one underground recharge gallery with an estimated capacity of 200 - 890 afy (dependent on the selected site's surface area) and seven injection wells with a combined recharge capacity of 3,150 afy. The two types of recharge facilities provide for operational flexibility and reliability.

The increase in recharge will be accompanied by an increase in pumping of 3,000 afy to recapture recharge over the 500 afy needed to achieve sustainability. This increase in production will be achieved by increasing production at wells P-19, P-28, and CPP-1 to 90 percent of the design capacity, and the construction and operation of five new production wells with an average pumping capacity of 525 afy each. Two inactive wells (Walnut and P-31) could be rehabilitated to help achieve the increase in pumping instead of constructing some of the new production wells.

Scenario 3 also includes expanding the Reverse Osmosis (RO) Plant owned and operated by CPP to increase the potable use of Spadra Basin groundwater. Currently, the RO Plant treats groundwater pumped from well CPP-1 with a design influent capacity of 538 afy. Scenario 3 assumes 4,304 afy of groundwater pumped from wells CPP-1, P-28, P-19, and five new production wells will be conveyed to an expanded RO Plant for treatment with an influent capacity of about 4,400 afy.

Permitting: Like Scenario 2, the recharge of recycled water in Scenario 3 will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin, or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). Scenario 3 will also require a permit from the State Water Board DDW for water treatment. The current regulatory permitting framework of the recycled water recharge via injection (subsurface application) requires the advance treatment of water prior to recharge. This scenario does not include advance treatment prior to injection, but instead, includes advance treatment after groundwater extraction. Permitting will be a regulatory challenge that will need to be addressed with the Regional Board and State Water Board and DDW during the planning stages of project implementation as described in Section 6.1.5 of the GSP.

Groundwater Pumping. In Scenario 3, a total of 4,864 afy is pumped from wells CPP-1, CPP-2, CPP-3, CPP-4, P-28, P-19, Industry, and five new production wells. This is an increase of about 3,000 afy from the planned pumping in the Baseline Scenario.

Managed Aquifer Recharge. In Scenario 3, a total of 3,500 afy of recycled water is artificially recharged in the Spadra Basin, an increase of 3,500 afy compared to the Baseline Scenario.

Treatment. In Scenario 3, the CPP RO Plant influent capacity is expanded from 538 afy to 4,300 afy for potable supply for the Spadra Basin water purveyors.

New Wells/Facilities.

- One underground recharge gallery and associated recycled water pipeline. Figure 5-16 shows potential locations for an underground recharge gallery. These locations were identified because they are along and/or near the main Pomona WRP recycled water pipeline and not near existing production wells. The potential locations to the east of Highway 71 will require the construction of new recycled water pipeline, but this new pipeline could be utilized to irrigate the schools and parks in this area and to supply recharge to any new injection wells in this area.
- Seven injection wells and associated recycled water pipeline. The location of the injection wells will be within the target area shown in Figure 5-16. This target area was identified as an area along and/or near the main Pomona WRP recycled water pipeline and not nearby or upgradient from existing production wells and the proposed target area for new production wells.

- Five new production wells and conveyance pipelines to the RO Plant. The location of the wells will be in the target area shown in Figure 5-16. This target area was identified because it is the along the central axis and deepest portion of the basin. The inactive wells (Valley and P-31) could be put back into use and conveyed to CPP RO Plant in lieu of constructing two of the new production wells.
- Expansion of the treatment capacity at the CPP RO Plant and conveyance pipelines to and from the RO plant.

The Table 5-4 summarizes the Baseline and Basin Optimization Scenarios.

Table 5-4. Summary of Basin Optimization Scenarios vs. Baseline Scenario

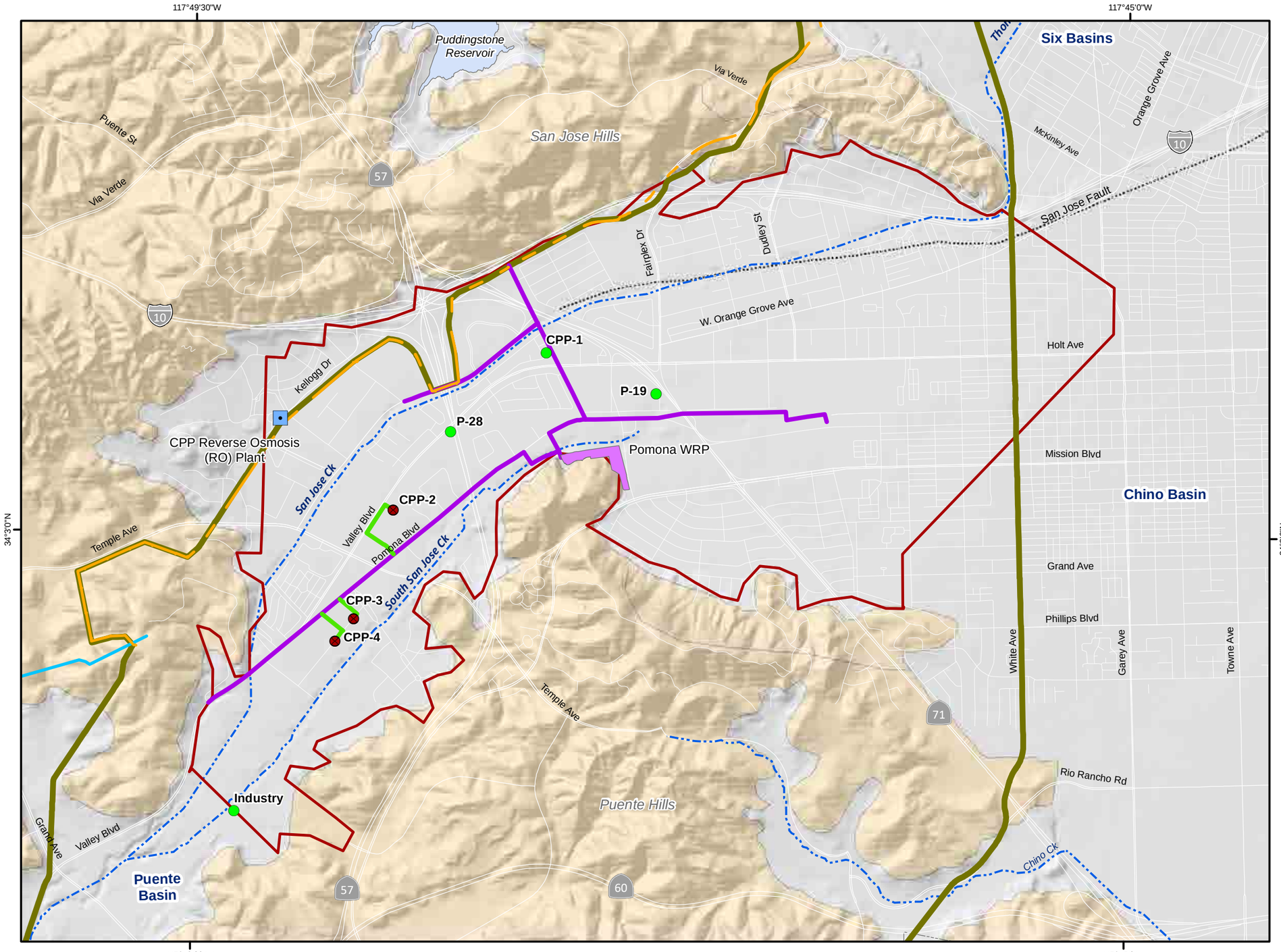
Scenario	Pumping, afy	Pumping from Baseline, afy	Recharge, afy	Recharge from Baseline, afy	New Facilities
Baseline	1,806	—	0	—	—
Scenario 1	1,376	-430	0	0	• Additional recycled water pipeline and connections
Scenario 2	1,806	0	500	500	• Underground recharge gallery and pipeline • Injection well and pipeline
Scenario 3	4,800	2,994	3,500	3,500	• Underground recharge gallery and pipeline • Seven Injection wells and pipeline • Five production wells and pipeline • Expansion of CPP RO Plant and pipeline

5.4 EVALUATION OF THE BASIN OPTIMIZATION SCENARIOS

The objective of this section is to describe the predicted hydrologic responses of the three Basin Optimization Scenarios described in *Section 5.3* above over the 60-year planning period of 2019 to 2079. The hydrologic responses were predicted with the Spadra Basin Groundwater Model and are compared against each other and the hydrologic response of the Baseline Scenario.

Figures 5-17a, 5-17b, and 5-17c show the locations of the existing and planned facilities that are included in Basin Optimization Scenarios 1, 2, and 3, respectively. Table 5-5 summarizes the facilities and operations for the Basin Optimization Scenarios. Tables 5-6a, 5-6b, 5-6c are the model-estimated annual water budgets of the Spadra Basin for the three Basin Optimization Scenarios over the planning period of 2019-2079.

The hydrologic responses are described in the sub-sections below, including groundwater levels, comparison of the groundwater levels to sustainability metrics set in *Section 3 Sustainable Management Criteria*, pumping sustainability, change in storage, subsurface outflow to the Chino and Puente Basins, and sustainable yield.



Existing Facilities

- Production Well Active in Scenario1
- Production Well Inactive in Scenario1
- Pomona Water Reclamation Plant (WRP)
- Pomona WRP Recycled Water Pipeline
- CPP Reverse Osmosis (RO) Plant

Planned New Facilities for Scenario 1

- Recycled Water Pipeline

Imported Water Pipelines

- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
- Badillo Grand Pipeline (Treated)
- MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 10/8/2021
File: Figure 5-17a Facilities_Sc1.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

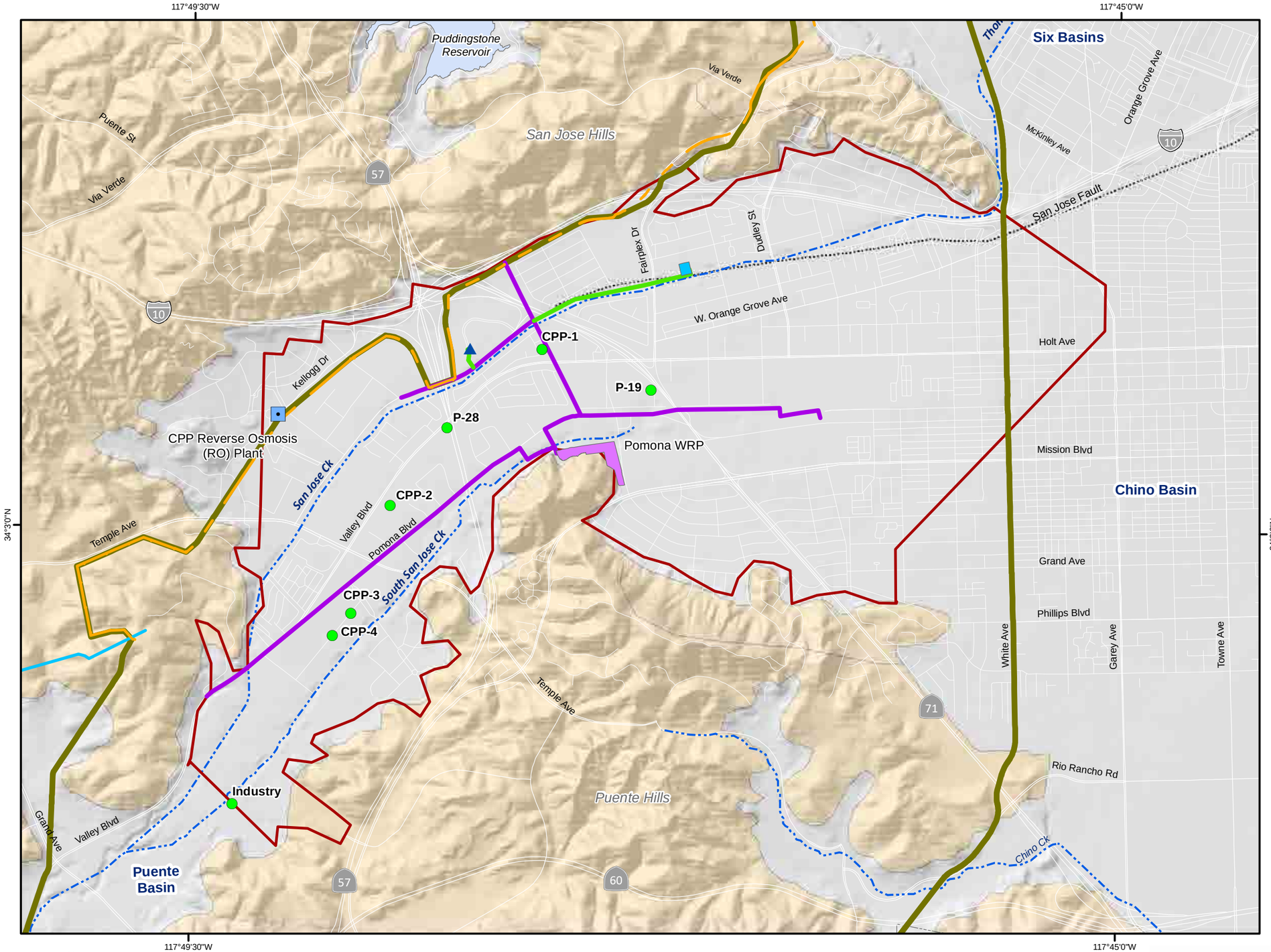
Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Location Map of Facilities for Basin Optimization Scenario 1

Figure 5-17a



Existing Facilities

- Production Well Active in Scenario 2
- Pomona Water Reclamation Plant (WRP)
- Pomona WRP Recycled Water Pipeline
- CPP Reverse Osmosis (RO) Plant

Planned New Facilities for Scenario 2

- Underground Recharge Gallery
- Injection Well
- Recycled Water Pipeline

Imported Water Pipelines

- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
- Badillo Grand Pipeline (Treated)
- MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)

- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 10/8/2021
File: Figure 5-17b Facilities_Sc2.mxd

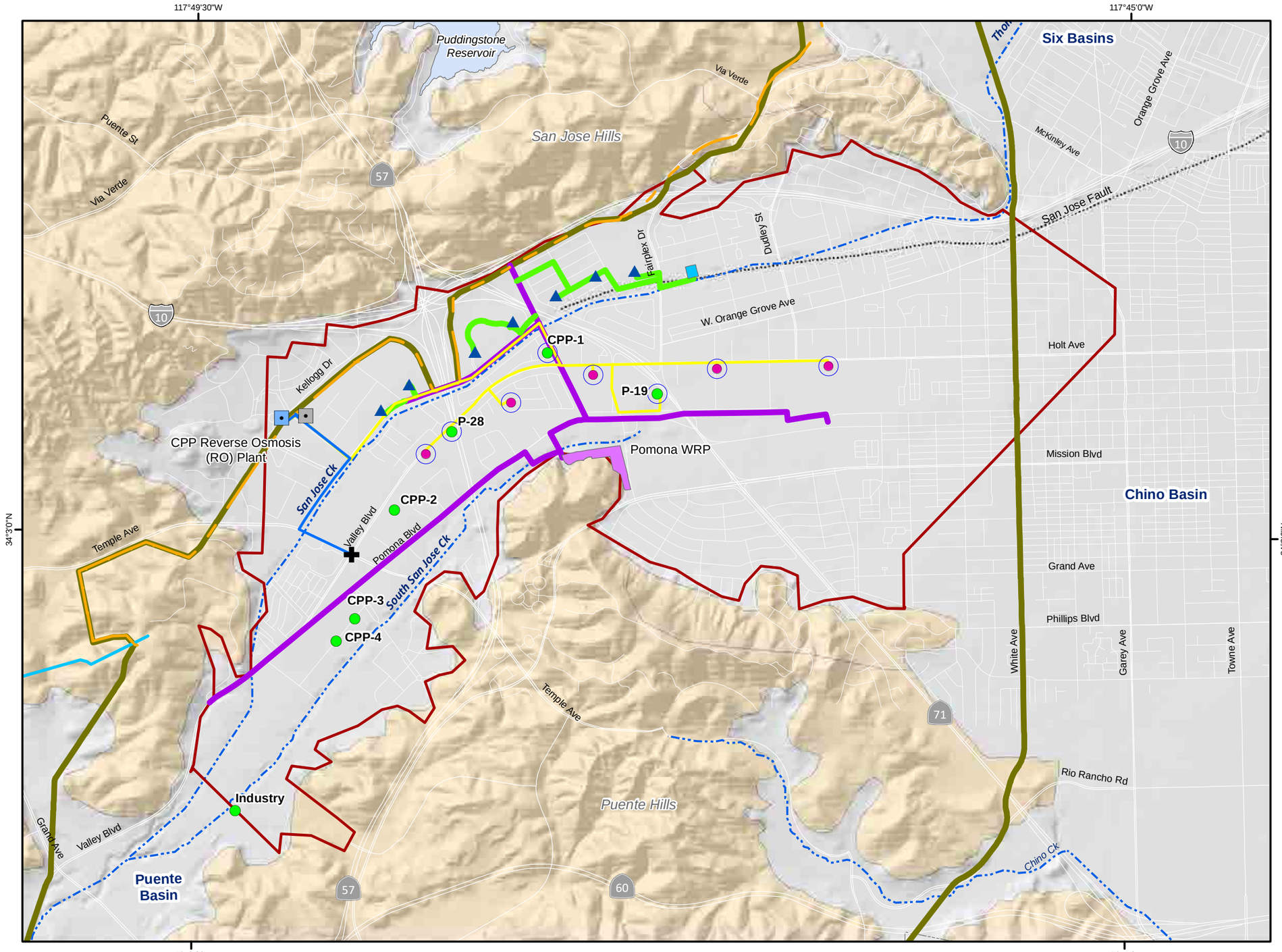
0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Location Map of Facilities for Basin Optimization Scenario 2

Figure 5-17b



Existing Facilities

- Production Well Active in Scenario 3
- Pomona Water Reclamation Plant (WRP)
- Pomona WRP Recycled Water Pipeline
- CPP Reverse Osmosis (RO) Plant
- Intertie between WVWD and Pomona

Planned New Facilities for Scenario 3

- Underground Recharge Gallery
- Injection Well
- Production Well
- Well - Groundwater is Conveyed to RO Plant
- New Expanded RO Plant
- Recycled Water Pipeline
- RO Plant Influent Pipeline
- RO Effluent Pipeline to Intertie

Imported Water Pipelines

- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
- Badillo Grand Pipeline (Treated)
- MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 10/8/2021
File: Figure 5-17c Facilities_Sc3.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Location Map of Facilities for Basin Optimization Scenario 3

Figure 5-17c

Table 5-5. Summary of Operational Assumptions for the Basin Optimization Scenarios and Facilities

Facility	Capacity (afy)	Volume Assumed in Scenario (afy)			
		Baseline	Scenario 1	Scenario 2	Scenario 3
Assumed Startup Year for Operation of Planned Facilities:			FY 2027	FY 2027	FY 2030
Pumping					
P-19	646	295	295	295	581
P-28	565	550	550	550	550
Industry Well	210	105	105	105	105
CPP-1	662	426	426	426	430
CPP-2	525	200	--	200	200
CPP-3	404	10	--	10	10
CPP-4	807	220	--	220	220
New Well 1	602	--	--	--	542
New Well 2	602	--	--	--	542
New Well 3	602	--	--	--	542
New Well 4	602	--	--	--	542
New Well 5	602	--	--	--	542
Total:	**6,829**	**1,806**	**1,376**	**1,806**	**4,806**
Direct Reuse of Recycled Water					
Artificial Recharge					
Underground Recharge Gallery	410	--	--	250	350
Injection Well 1	450	--	--	250	450
Injection Well 2	450	--	--	--	450
Injection Well 3	450	--	--	--	450
Injection Well 4	450	--	--	--	450
Injection Well 5	450		--	--	450
Injection Well 6	450	--	--	--	450
Injection Well 7	450	--	--	--	450
Total:	**3,560**	**0**	**0**	**500**	**3,500**
Groundwater Treatment					
Wells where groundwater pumped is conveyed to RO Plant:					
CPP-1	662	426	426	426	426
P-19	646	--	--	--	581
P-28	565	--	--	--	550
New Well 1	602	--	--	--	542
New Well 2	602	--	--	--	542
New Well 3	602	--	--	--	542
New Well 4	602	--	--	--	542
New Well 5	602	--	--	--	542
Total:	**4,883**	**426**	**426**	**426**	**4,267**
Cal Poly RO Plant:	550 - 4,300 [2]	426	426	426	4,267

Notes:
1 - Injection Well capacity is estimated as 25% of the average capacity of the existing production wells in the center o the Spadra Basin
2- 550 afy is the current capacity and 4,300 afy is the expansion capacity for Scenario 3

Table 5-6a. Water Budget for Spadra Basin - Basin Optimization Scenario 1 -- Fiscal Year 2019-2079 (acre-feet)

	Recharge					Discharge				Change in Storage	
Fiscal Year	Injection Well	DIPAW	Side Inflows	Vault Recharge	Total Recharge	Groundwater Pumping	Subsurface Outflow to Puente Basin	Subsurface Outflow to Chino Basin	Total Discharge	Total Recharge minus Total Discharge	Cumulative
2019	0	1,581	1,038	0	2,619	843	1,310	537	2,690	(71)	(71)
2020	0	1,705	1,035	0	2,741	707	1,437	389	2,533	207	136
2021	0	1,820	1,039	0	2,859	727	1,440	446	2,612	247	383
2022	0	1,921	1,039	0	2,960	702	1,491	492	2,685	275	658
2023	0	2,033	1,039	0	3,072	702	1,523	535	2,760	313	971
2024	0	2,037	1,036	0	3,073	702	1,543	557	2,802	271	1,242
2025	0	2,164	1,040	0	3,204	1,922	1,388	580	3,890	(686)	556
2026	0	2,168	1,040	0	3,208	1,922	1,254	590	3,766	(558)	(2)
2027	0	2,172	1,040	0	3,212	1,494	1,328	593	3,415	(203)	2,038
2028	0	2,175	1,038	0	3,212	1,494	1,360	593	3,447	(235)	(439)
2029	0	2,178	1,041	0	3,219	1,494	1,354	591	3,439	(221)	(660)
2030	0	2,181	1,041	0	3,222	1,376	1,344	587	3,307	(85)	(745)
2031	0	2,185	1,041	0	3,226	1,376	1,337	582	3,296	(70)	(814)
2032	0	2,188	1,037	0	3,225	1,376	1,332	580	3,288	(63)	(877)
2033	0	2,191	1,040	0	3,231	1,376	1,329	577	3,281	(50)	(927)
2034	0	2,194	1,040	0	3,234	1,376	1,325	573	3,274	(41)	(968)
2035	0	2,195	1,040	0	3,235	1,376	1,322	572	3,271	(36)	(1,003)
2036	0	2,197	1,037	0	3,234	1,376	1,319	570	3,265	(31)	(1,034)
2037	0	2,197	1,040	0	3,237	1,376	1,317	571	3,264	(27)	(1,061)
2038	0	2,198	1,040	0	3,238	1,376	1,314	574	3,264	(27)	(1,088)
2039	0	2,199	1,040	0	3,238	1,376	1,312	577	3,265	(27)	(1,115)
2040	0	2,199	1,037	0	3,235	1,376	1,310	580	3,266	(31)	(1,146)
2041	0	2,199	1,039	0	3,239	1,376	1,309	586	3,271	(32)	(1,178)
2042	0	2,200	1,039	0	3,239	1,376	1,307	594	3,277	(38)	(1,216)
2043	0	2,200	1,039	0	3,239	1,376	1,306	599	3,281	(42)	(1,258)
2044	0	2,201	1,036	0	3,237	1,376	1,304	602	3,283	(46)	(1,304)
2045	0	2,201	1,039	0	3,240	1,376	1,303	605	3,284	(44)	(1,348)
2046	0	2,202	1,038	0	3,240	1,376	1,302	606	3,284	(44)	(1,392)
2047	0	2,203	1,038	0	3,241	1,376	1,301	607	3,284	(43)	(1,435)
2048	0	2,203	1,035	0	3,237	1,376	1,299	607	3,282	(45)	(1,480)
2049	0	2,203	1,038	0	3,241	1,376	1,299	607	3,282	(41)	(1,521)
2050	0	2,204	1,037	0	3,241	1,376	1,298	607	3,281	(40)	(1,562)
2051	0	2,204	1,037	0	3,241	1,376	1,297	608	3,281	(40)	(1,601)
2052	0	2,204	1,034	0	3,238	1,376	1,295	608	3,280	(42)	(1,643)
2053	0	2,205	1,037	0	3,241	1,376	1,295	609	3,280	(38)	(1,681)
2054	0	2,205	1,036	0	3,242	1,376	1,294	609	3,279	(38)	(1,719)
2055	0	2,206	1,036	0	3,242	1,376	1,293	610	3,279	(37)	(1,756)
2056	0	2,206	1,033	0	3,239	1,376	1,292	610	3,278	(39)	(1,795)
2057	0	2,206	1,036	0	3,242	1,376	1,291	610	3,278	(36)	(1,831)
2058	0	2,207	1,035	0	3,242	1,376	1,291	611	3,277	(35)	(1,866)
2059	0	2,207	1,035	0	3,243	1,376	1,290	611	3,277	(34)	(1,900)
2060	0	2,208	1,032	0	3,239	1,376	1,289	611	3,276	(37)	(1,937)
2061	0	2,208	1,035	0	3,243	1,376	1,288	612	3,276	(33)	(1,970)
2062	0	2,208	1,034	0	3,243	1,376	1,288	612	3,276	(33)	(2,003)
2063	0	2,209	1,034	0	3,243	1,376	1,287	612	3,275	(32)	(2,035)
2064	0	2,209	1,031	0	3,240	1,376	1,286	612	3,274	(34)	(2,069)
2065	0	2,210	1,034	0	3,244	1,376	1,285	613	3,274	(31)	(2,100)
2066	0	2,210	1,034	0	3,244	1,376	1,285	613	3,274	(30)	(2,130)
2067	0	2,211	1,033	0	3,244	1,376	1,284	613	3,273	(29)	(2,159)
2068	0	2,211	1,030	0	3,241	1,376	1,283	613	3,272	(32)	(2,191)
2069	0	2,211	1,033	0	3,244	1,376	1,283	613	3,272	(28)	(2,219)
2070	0	2,212	1,033	0	3,244	1,376	1,283	613	3,272	(28)	(2,247)
2071	0	2,212	1,033	0	3,244	1,376	1,282	614	3,272	(27)	(2,274)
2072	0	2,212	1,029	0	3,242	1,376	1,281	617	3,274	(32)	(2,307)
2073	0	2,212	1,033	0	3,245	1,376	1,281	623	3,280	(35)	(2,341)
2074	0	2,213	1,033	0	3,245	1,376	1,280	626	3,282	(37)	(2,379)
2075	0	2,213	1,033	0	3,245	1,376	1,280	627	3,283	(38)	(2,416)
2076	0	2,213	1,029	0	3,242	1,376	1,279	627	3,282	(40)	(2,457)
2077	0	2,213	1,033	0	3,245	1,376	1,279	626	3,281	(35)	(2,492)
2078	0	2,213	1,033	0	3,245	1,376	1,278	613	3,267	(22)	(2,514)
2079	0	2,213	1,033	0	3,245	1,376	1,278	593	3,247	(2)	(2,516)
Statistics for the Calibration Period 2019 through 2079											
Total	0	132,163	63,203	0	195,366	81,509	80,315	36,058	197,882	(2,516)	
Average	0	2,167	1,036	0	3,203	1,336	1,317	591	3,244	(41)	
Median	0	2,203	1,036	0	3,240	1,376	1,298	607	3,277	(36)	
Maximum	0	2,213	1,041	0	3,245	1,922	1,543	627	3,890	313	
Minimum	0	1,581	1,029	0	2,619	702	1,254	389	2,533	(686)	

Table 5-6b. Water Budget for Spadra Basin - Basin Optimization Scenario 2 -- Fiscal Year 2019-2079 (acre-feet)

	Recharge					Discharge				Change in Storage	
Fiscal Year	Injection Well	DIPAW	Side Inflows	Vault Recharge	Total Recharge	Groundwater Pumping	Subsurface Outflow to Puente Basin	Subsurface Outflow to Chino Basin	Total Discharge	Total Recharge minus Total Discharge	Cumulative
2019	0	1,581	1,038	0	2,619	843	1,310	537	2,690	(71)	(71)
2020	0	1,705	1,035	0	2,741	707	1,437	389	2,533	207	136
2021	0	1,820	1,039	0	2,859	727	1,440	446	2,612	247	383
2022	0	1,921	1,039	0	2,960	702	1,491	492	2,685	275	658
2023	0	2,033	1,039	0	3,072	702	1,523	535	2,760	313	971
2024	0	2,037	1,036	0	3,073	702	1,543	557	2,802	271	1,242
2025	0	2,164	1,040	0	3,204	1,922	1,388	580	3,890	(686)	556
2026	0	2,168	1,040	0	3,208	1,922	1,254	590	3,766	(548)	8
2027	250	2,172	1,040	250	3,712	1,922	1,236	593	3,751	(38)	2,038
2028	250	2,175	1,038	250	3,712	1,922	1,253	593	3,768	(56)	(86)
2029	250	2,178	1,041	250	3,719	1,922	1,255	593	3,771	(52)	(138)
2030	250	2,181	1,041	250	3,722	1,806	1,255	590	3,651	71	(67)
2031	250	2,185	1,041	250	3,726	1,806	1,258	587	3,652	74	7
2032	250	2,188	1,037	250	3,725	1,806	1,263	586	3,655	70	77
2033	250	2,191	1,040	250	3,731	1,806	1,268	585	3,659	72	149
2034	250	2,194	1,040	250	3,734	1,806	1,273	583	3,662	72	221
2035	250	2,195	1,040	250	3,735	1,806	1,277	583	3,667	68	289
2036	250	2,197	1,037	250	3,734	1,806	1,281	582	3,669	64	354
2037	250	2,197	1,040	250	3,737	1,806	1,285	585	3,676	62	415
2038	250	2,198	1,040	250	3,738	1,806	1,289	589	3,683	55	470
2039	250	2,199	1,040	250	3,738	1,806	1,292	593	3,691	48	518
2040	250	2,199	1,037	250	3,735	1,806	1,295	597	3,698	38	556
2041	250	2,199	1,039	250	3,739	1,806	1,298	604	3,708	31	587
2042	250	2,200	1,039	250	3,739	1,806	1,300	613	3,719	21	607
2043	250	2,200	1,039	250	3,739	1,806	1,303	618	3,727	13	620
2044	250	2,201	1,036	250	3,737	1,806	1,305	622	3,733	4	624
2045	250	2,201	1,039	250	3,740	1,806	1,307	625	3,738	2	626
2046	250	2,202	1,038	250	3,740	1,806	1,309	627	3,742	(2)	624
2047	250	2,203	1,038	250	3,741	1,806	1,310	628	3,744	(4)	620
2048	250	2,203	1,035	250	3,737	1,806	1,311	629	3,746	(9)	611
2049	250	2,203	1,038	250	3,741	1,806	1,313	630	3,749	(8)	603
2050	250	2,204	1,037	250	3,741	1,806	1,314	630	3,750	(9)	594
2051	250	2,204	1,037	250	3,741	1,806	1,315	631	3,752	(11)	583
2052	250	2,204	1,034	250	3,738	1,806	1,316	632	3,753	(15)	568
2053	250	2,205	1,037	250	3,741	1,806	1,316	633	3,755	(14)	554
2054	250	2,205	1,036	250	3,742	1,806	1,317	633	3,757	(15)	539
2055	250	2,206	1,036	250	3,742	1,806	1,318	634	3,758	(16)	523
2056	250	2,206	1,033	250	3,739	1,806	1,318	635	3,758	(20)	504
2057	250	2,206	1,036	250	3,742	1,806	1,318	635	3,760	(18)	486
2058	250	2,207	1,035	250	3,742	1,806	1,319	636	3,761	(18)	468
2059	250	2,207	1,035	250	3,743	1,806	1,319	636	3,761	(19)	449
2060	250	2,208	1,032	250	3,739	1,806	1,319	637	3,762	(22)	427
2061	250	2,208	1,035	250	3,743	1,806	1,319	637	3,762	(20)	407
2062	250	2,208	1,034	250	3,743	1,806	1,319	638	3,763	(20)	387
2063	250	2,209	1,034	250	3,743	1,806	1,319	638	3,763	(20)	367
2064	250	2,209	1,031	250	3,740	1,806	1,319	638	3,763	(23)	344
2065	250	2,210	1,034	250	3,744	1,806	1,319	639	3,764	(20)	323
2066	250	2,210	1,034	250	3,744	1,806	1,319	639	3,764	(20)	303
2067	250	2,211	1,033	250	3,744	1,806	1,319	639	3,764	(20)	283
2068	250	2,211	1,030	250	3,741	1,806	1,318	640	3,764	(23)	260
2069	250	2,211	1,033	250	3,744	1,806	1,318	640	3,764	(20)	240
2070	250	2,212	1,033	250	3,744	1,806	1,318	640	3,764	(20)	219
2071	250	2,212	1,033	250	3,744	1,806	1,318	641	3,764	(20)	199
2072	250	2,212	1,029	250	3,742	1,806	1,318	644	3,767	(26)	174
2073	250	2,212	1,033	250	3,745	1,806	1,317	650	3,773	(28)	145
2074	250	2,213	1,033	250	3,745	1,806	1,317	653	3,776	(31)	114
2075	250	2,213	1,033	250	3,745	1,806	1,317	654	3,777	(32)	82
2076	250	2,213	1,029	250	3,742	1,806	1,317	655	3,777	(35)	47
2077	250	2,213	1,033	250	3,745	1,806	1,316	653	3,775	(30)	17
2078	250	2,213	1,033	250	3,745	1,806	1,316	640	3,762	(17)	(0)
2079	250	2,213	1,033	250	3,745	1,806	1,316	621	3,742	3	3
Statistics for the Calibration Period 2019 through 2079											
Total	13,250	132,163	63,203	13,250	221,866	104,293	80,448	37,132	221,873	3	
Average	217	2,167	1,036	217	3,637	1,710	1,319	609	3,637	0	
Median	250	2,203	1,036	250	3,740	1,806	1,316	629	3,753	(15)	
Maximum	250	2,213	1,041	250	3,745	1,922	1,543	655	3,890	313	
Minimum	0	1,581	1,029	0	2,619	702	1,236	389	2,533	(686)	

Table 5-6c. Water Budget for Spadra Basin - Basin Optimization Scenario 3 -- Fiscal Year 2019-2079 (acre-feet)

	Recharge					Discharge				Change in Storage	
Fiscal Year	Injection Well	DIPAW	Side Inflows	Vault Recharge	Total Recharge	Groundwater Pumping	Subsurface Outflow to Puente Basin	Subsurface Outflow to Chino Basin	Total Discharge	Total Recharge minus Total Discharge	Cumulative
2019	0	1,581	1,038	0	2,619	843	1,310	537	2,690	(71)	(71)
2020	0	1,705	1,035	0	2,741	707	1,437	389	2,533	207	136
2021	0	1,820	1,039	0	2,859	727	1,440	446	2,612	247	383
2022	0	1,921	1,039	0	2,960	702	1,491	492	2,685	275	658
2023	0	2,033	1,039	0	3,072	702	1,523	535	2,760	313	971
2024	0	2,037	1,036	0	3,073	702	1,543	557	2,802	271	1,242
2025	0	2,164	1,040	0	3,204	1,922	1,388	580	3,890	(686)	556
2026	0	2,168	1,040	0	3,208	1,922	1,254	590	3,766	(558)	(2)
2027	0	2,172	1,040	0	3,212	1,922	1,195	593	3,710	(498)	2,038
2028	0	2,175	1,038	0	3,212	1,922	1,155	593	3,669	(457)	(957)
2029	0	2,178	1,041	0	3,219	1,922	1,122	591	3,635	(412)	(1,369)
2030	3,150	2,181	1,041	350	6,722	4,806	1,123	585	6,513	209	(1,160)
2031	3,150	2,185	1,041	350	6,726	4,806	1,243	576	6,625	101	(1,060)
2032	3,150	2,188	1,037	350	6,725	4,806	1,290	568	6,664	61	(999)
2033	3,150	2,191	1,040	350	6,731	4,806	1,306	561	6,674	58	(941)
2034	3,150	2,194	1,040	350	6,734	4,806	1,313	556	6,675	58	(883)
2035	3,150	2,195	1,040	350	6,735	4,806	1,317	555	6,679	57	(826)
2036	3,150	2,197	1,037	350	6,734	4,806	1,321	553	6,680	54	(772)
2037	3,150	2,197	1,040	350	6,737	4,806	1,324	555	6,685	53	(719)
2038	3,150	2,198	1,040	350	6,738	4,806	1,327	558	6,691	47	(673)
2039	3,150	2,199	1,040	350	6,738	4,806	1,329	562	6,697	41	(632)
2040	3,150	2,199	1,037	350	6,735	4,806	1,332	566	6,704	32	(600)
2041	3,150	2,199	1,039	350	6,739	4,806	1,334	573	6,713	26	(574)
2042	3,150	2,200	1,039	350	6,739	4,806	1,336	581	6,723	16	(558)
2043	3,150	2,200	1,039	350	6,739	4,806	1,338	587	6,731	8	(550)
2044	3,150	2,201	1,036	350	6,737	4,806	1,340	591	6,737	0	(550)
2045	3,150	2,201	1,039	350	6,740	4,806	1,341	594	6,741	(1)	(551)
2046	3,150	2,202	1,038	350	6,740	4,806	1,343	596	6,745	(5)	(556)
2047	3,150	2,203	1,038	350	6,741	4,806	1,344	597	6,747	(6)	(562)
2048	3,150	2,203	1,035	350	6,737	4,806	1,345	597	6,749	(11)	(573)
2049	3,150	2,203	1,038	350	6,741	4,806	1,346	598	6,751	(10)	(583)
2050	3,150	2,204	1,037	350	6,741	4,806	1,347	599	6,752	(11)	(594)
2051	3,150	2,204	1,037	350	6,741	4,806	1,348	599	6,754	(12)	(606)
2052	3,150	2,204	1,034	350	6,738	4,806	1,349	600	6,755	(17)	(623)
2053	3,150	2,205	1,037	350	6,741	4,806	1,349	601	6,756	(15)	(638)
2054	3,150	2,205	1,036	350	6,742	4,806	1,350	602	6,758	(16)	(654)
2055	3,150	2,206	1,036	350	6,742	4,806	1,350	602	6,759	(17)	(671)
2056	3,150	2,206	1,033	350	6,739	4,806	1,350	603	6,759	(21)	(691)
2057	3,150	2,206	1,036	350	6,742	4,806	1,351	604	6,760	(18)	(710)
2058	3,150	2,207	1,035	350	6,742	4,806	1,351	604	6,761	(19)	(729)
2059	3,150	2,207	1,035	350	6,743	4,806	1,351	605	6,762	(19)	(748)
2060	3,150	2,208	1,032	350	6,739	4,806	1,351	605	6,762	(23)	(771)
2061	3,150	2,208	1,035	350	6,743	4,806	1,351	606	6,763	(20)	(791)
2062	3,150	2,208	1,034	350	6,743	4,806	1,351	606	6,763	(20)	(811)
2063	3,150	2,209	1,034	350	6,743	4,806	1,351	606	6,764	(20)	(832)
2064	3,150	2,209	1,031	350	6,740	4,806	1,351	607	6,764	(24)	(856)
2065	3,150	2,210	1,034	350	6,744	4,806	1,351	607	6,764	(21)	(876)
2066	3,150	2,210	1,034	350	6,744	4,806	1,351	607	6,764	(21)	(897)
2067	3,150	2,211	1,033	350	6,744	4,806	1,351	607	6,764	(20)	(918)
2068	3,150	2,211	1,030	350	6,741	4,806	1,351	608	6,764	(24)	(941)
2069	3,150	2,211	1,033	350	6,744	4,806	1,351	608	6,765	(20)	(962)
2070	3,150	2,212	1,033	350	6,744	4,806	1,350	608	6,765	(20)	(982)
2071	3,150	2,212	1,033	350	6,744	4,806	1,350	609	6,765	(20)	(1,002)
2072	3,150	2,212	1,029	350	6,742	4,806	1,350	612	6,768	(26)	(1,028)
2073	3,150	2,212	1,033	350	6,745	4,806	1,350	618	6,774	(29)	(1,057)
2074	3,150	2,213	1,033	350	6,745	4,806	1,350	621	6,776	(31)	(1,088)
2075	3,150	2,213	1,033	350	6,745	4,806	1,349	622	6,777	(32)	(1,121)
2076	3,150	2,213	1,029	350	6,742	4,806	1,349	623	6,777	(35)	(1,156)
2077	3,150	2,213	1,033	350	6,745	4,806	1,349	621	6,776	(31)	(1,187)
2078	3,150	2,213	1,033	350	6,745	4,806	1,348	608	6,763	(17)	(1,204)
2079	3,150	2,213	1,033	350	6,745	4,806	1,348	589	6,742	3	(1,201)
Statistics for the Calibration Period 2019 through 2079											
Total	**157,500**	**132,163**	**63,203**	**17,500**	**370,366**	**254,293**	**81,652**	**35,626**	**371,571**	**(1,201)**	
Average	2,582	2,167	1,036	287	6,072	4,169	1,339	584	6,091	(20)	
Median	3,150	2,203	1,036	350	6,740	4,806	1,349	597	6,749	(17)	
Maximum	3,150	2,213	1,041	350	6,745	4,806	1,543	623	6,777	313	
Minimum	0	1,581	1,029	0	2,619	702	1,122	389	2,533	(686)	

5.4.1 Groundwater Level Response

5.4.1.1 Groundwater Elevation and Groundwater-Flow Directions

Figures 5-18a through 5-18d are maps showing the model-estimated groundwater elevations and flow directions for the Baseline Scenario and the three Basin Optimization Scenarios for the years 2018 (start of the planning period prior to implementation), 2040, 2050, and 2079 (end of the planning period). Also shown on the maps are the pumping and recharge facilities assumed to be operational in the scenarios.

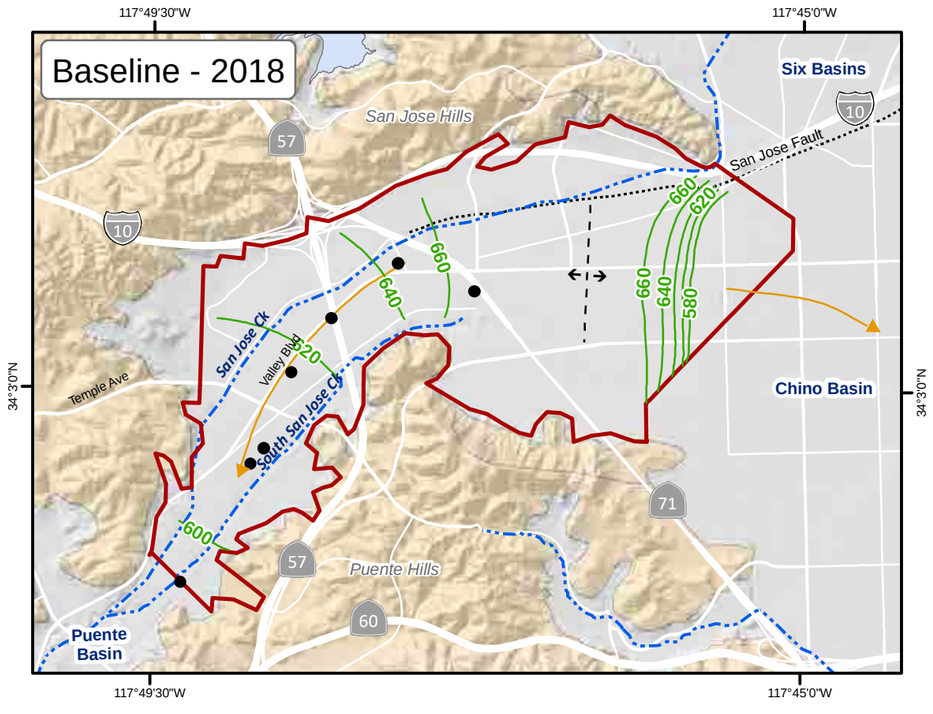
The groundwater-elevation contours are used to analyze and interpret the groundwater-flow directions over the planning period—groundwater flows perpendicular to the contours from higher to lower elevation:

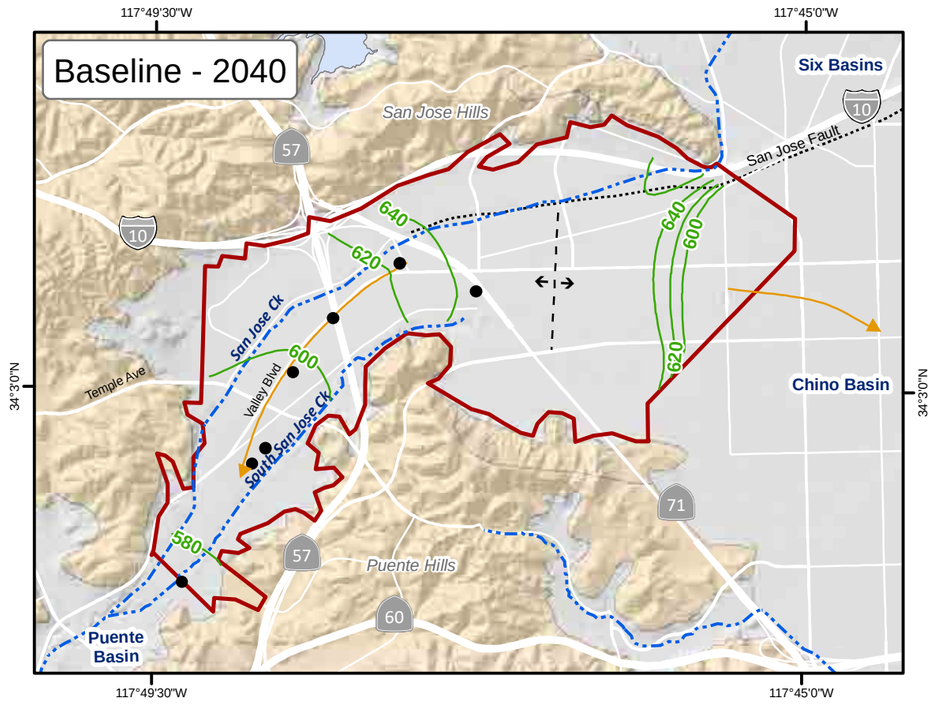
- In the Baseline Scenario, the general groundwater-flow directions remain relatively constant over the planning period and are similar to what was observed historically as described in Section 2.2.2.11 Groundwater Levels and Storage of the Basin Setting. There is a north/south-oriented groundwater divide located in the eastern portion of the basin. In the east, groundwater flows from the groundwater divide towards Chino Basin. West of the groundwater divide, groundwater flows toward Puente Basin. The location of the groundwater divide oscillates slightly in the east/west directions over the planning period.
- In Basin Optimization Scenarios 1 & 2, the groundwater-flow directions are not significantly different than the groundwater-flow directions in the Baseline Scenario.

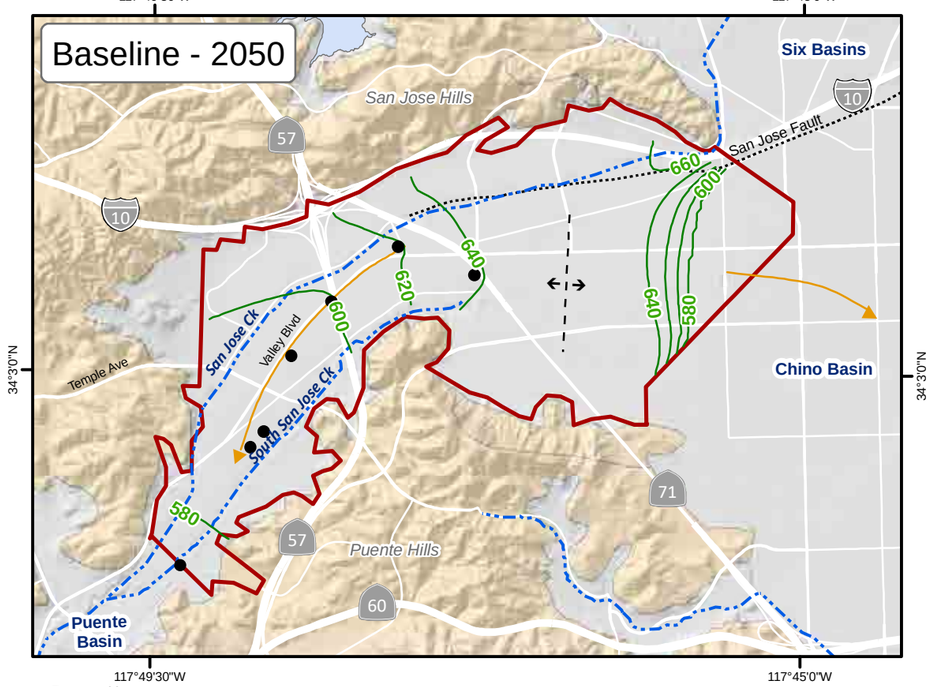
In Basin Optimization Scenario 3, the increases in recharge and pumping cause a change in groundwater- flow directions to a north-to-south direction in the central portion of the basin, and the groundwater divide shifts to the east towards Chino Basin.

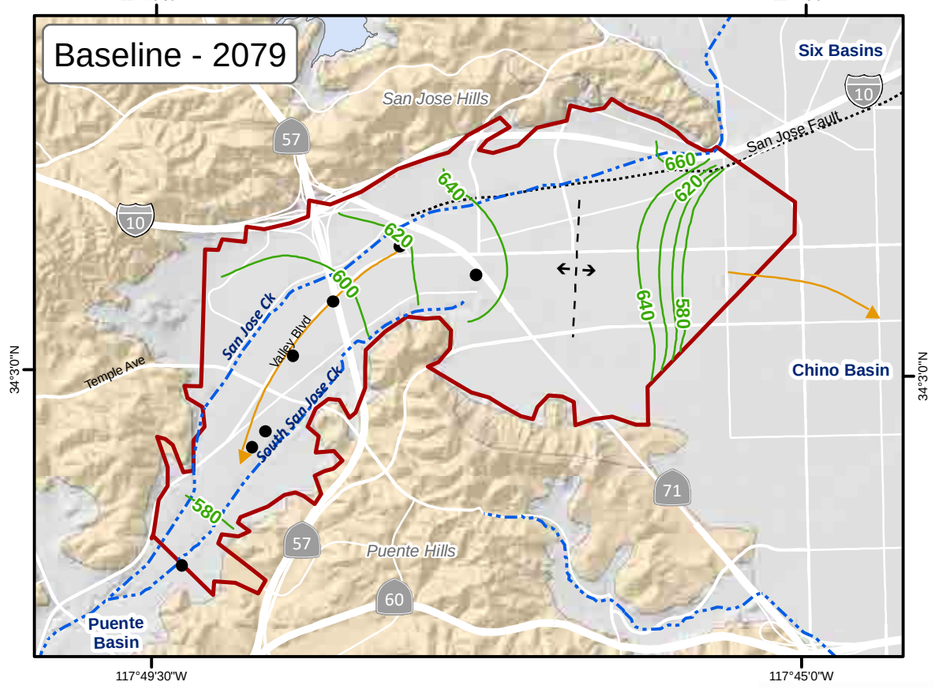
Figures 5-19a through 5-19d are maps showing the model-estimated change in groundwater elevation across the Spadra Basin for the Baseline Scenario and the three Basin Optimization Scenarios for the years: 2030, 2040, 2050, and 2079 (end of planning period). Groundwater elevation change is shown on each map as a color-ramped raster and contours of groundwater-elevation change. The maps also show the existing and planned pumping and recharge facilities included in each scenario.

- **Baseline Scenario**, groundwater elevations are projected to decline across most of the basin by about 25 ft over the planning period.
- **Basin Optimization Scenario 1**, groundwater elevations are projected to increase by up to 10 ft in the west, decrease by up to 10 ft in the center of the basin, and decrease by up to 30 ft in the east over the planning period.
- **Basin Optimization Scenario 2**, groundwater elevations are projected to increase by up to 10 ft in the western and central portions of the basin, and decrease by up to 20 ft in the east over the planning period.
- **Basin Optimization Scenario 3**, groundwater elevations are projected to increase by up to 10 ft in the west, increase by up to 30 ft in the central portion of the basin, and decrease by up to 30 ft in the east over the planning period.









—600— Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Pumping and Recharge Facilities

Production Well Active in Baseline

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-18a_GWEL_Contours_BL.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

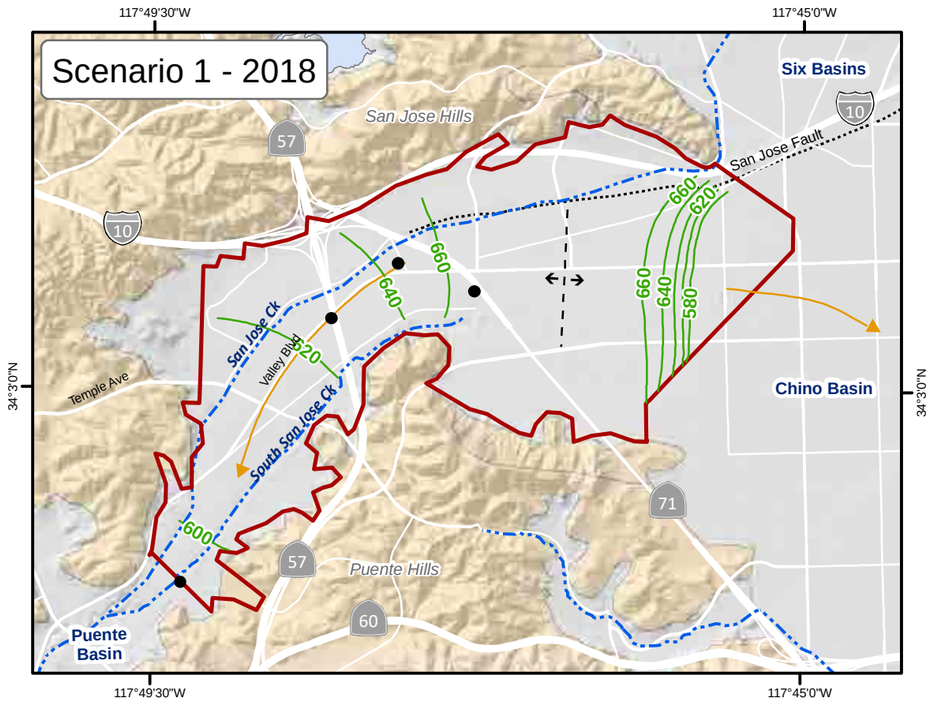
Groundwater Sustainability Plan

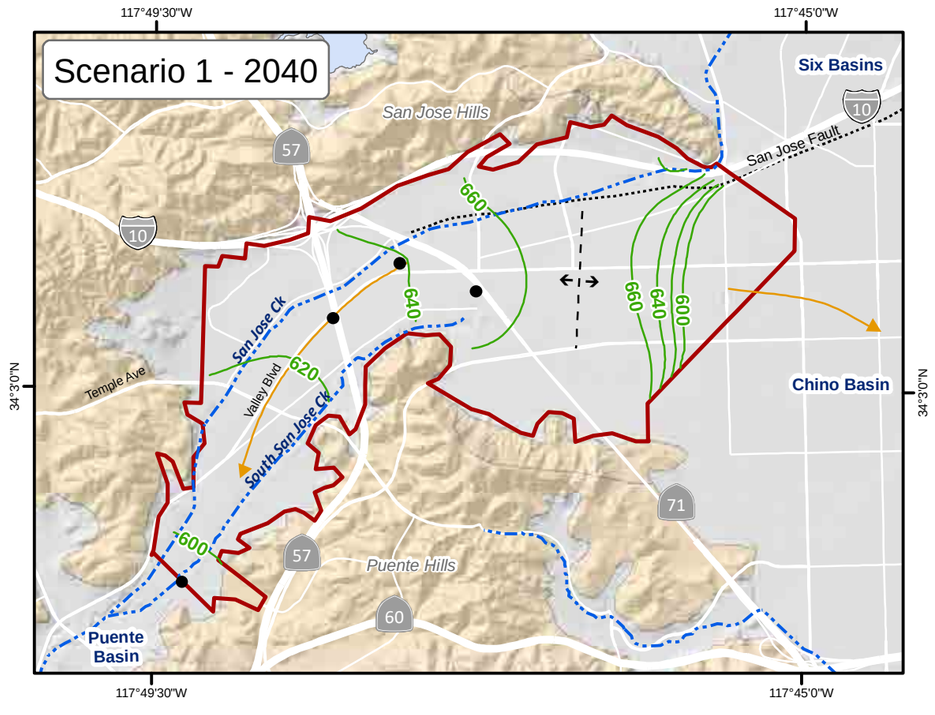
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

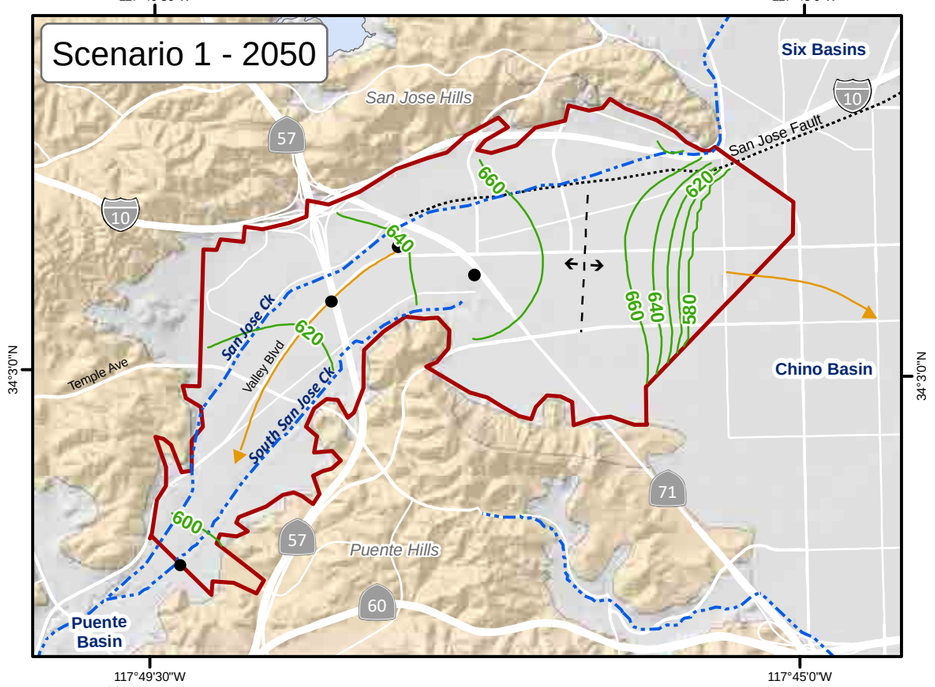
Groundwater Elevation and Flow Direction

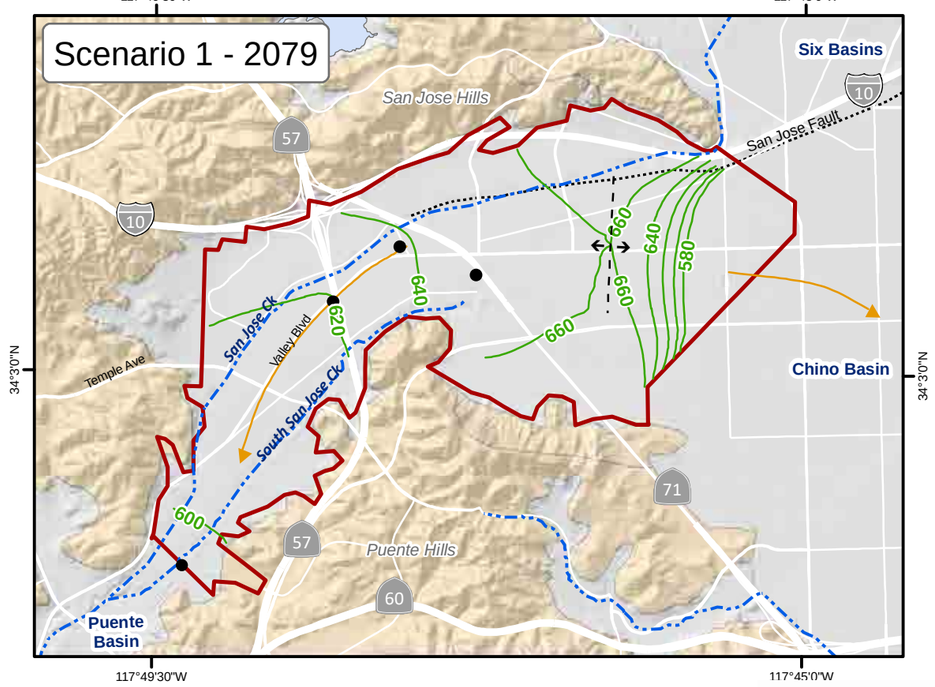
Baseline Scenario

Figure 5-18a









600 — Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Pumping and Recharge Facilities

Production Well Active in Scenario 1

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-18b_GWEL_Contours_S1.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

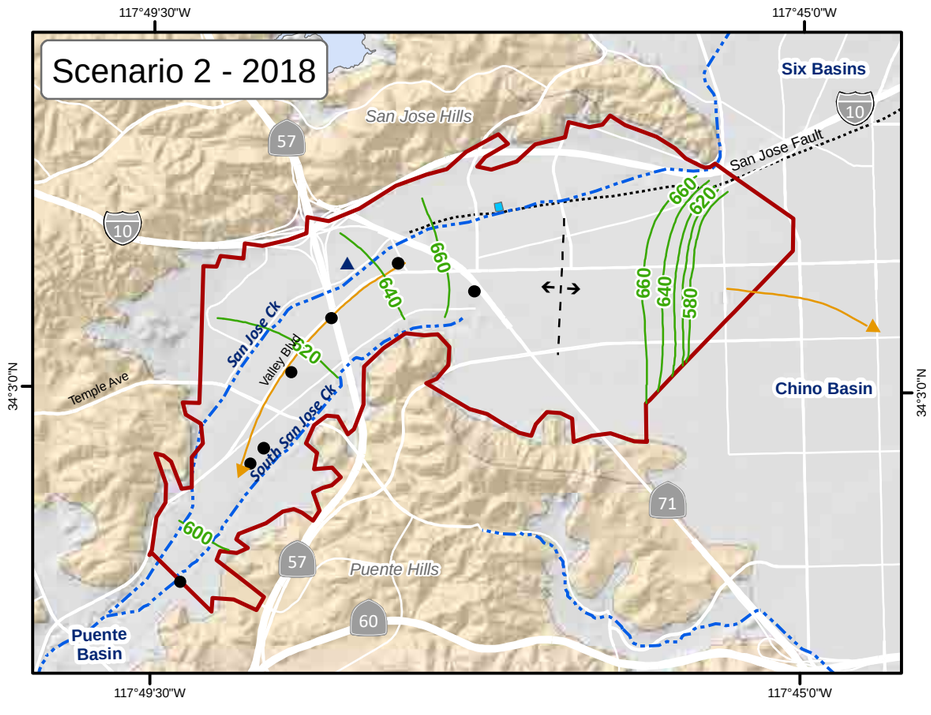
Groundwater Sustainability Plan

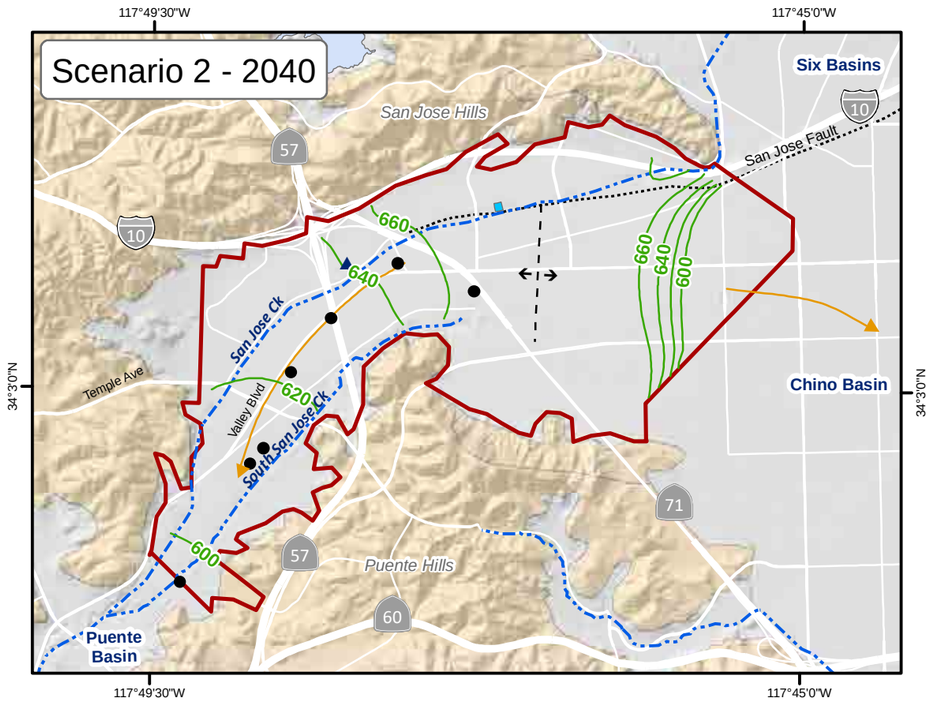
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

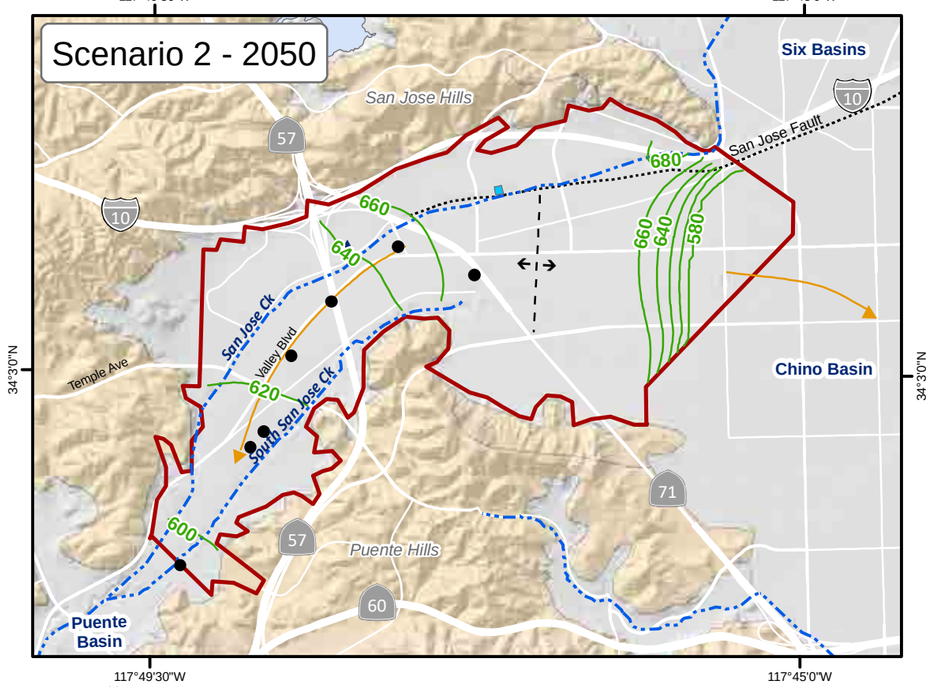
Groundwater Elevation and Flow Direction

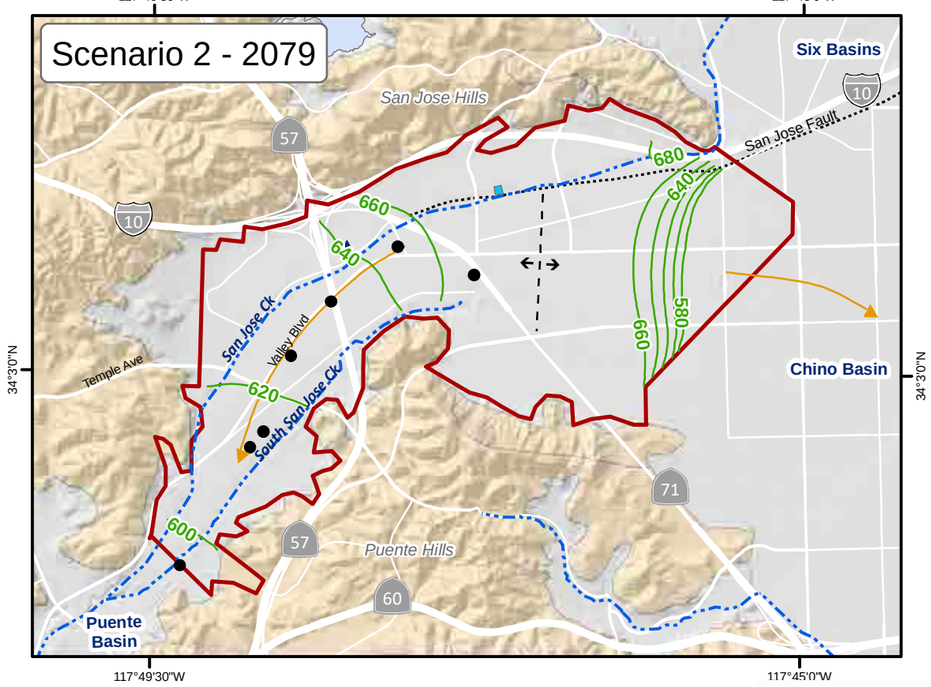
Basin Optimization Scenario 1

Figure 5-18b









600 — Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Pumping and Recharge Facilities

- Production Well Active in Scenario 2
- Underground Recharge Gallery in Scenario 2
- Injection Well in Scenario 2

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-18c_GWEL_Contours_S2.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

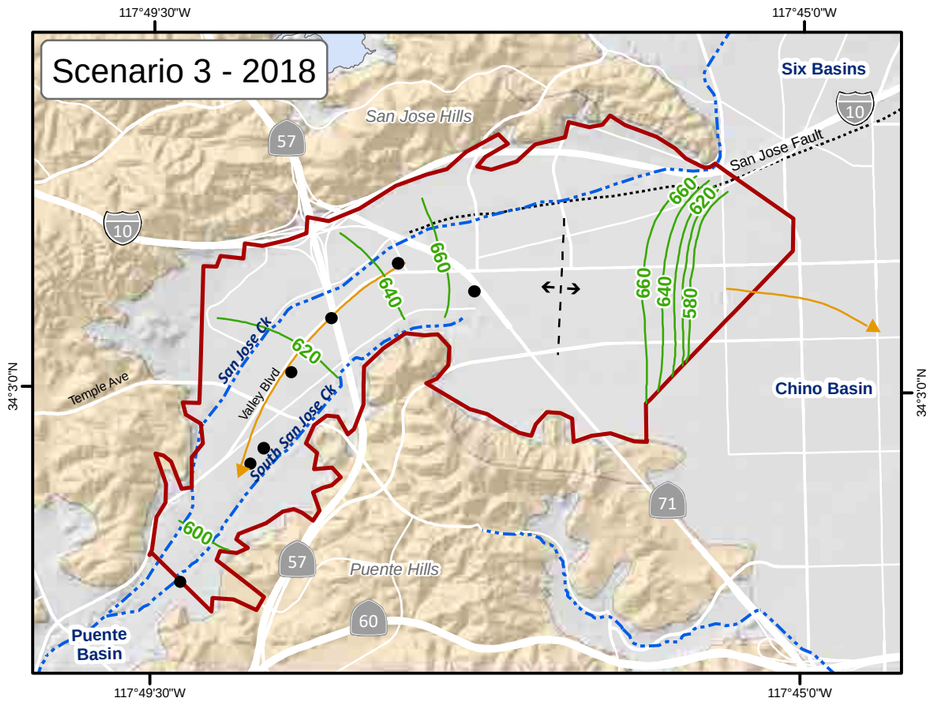
Groundwater Sustainability Plan

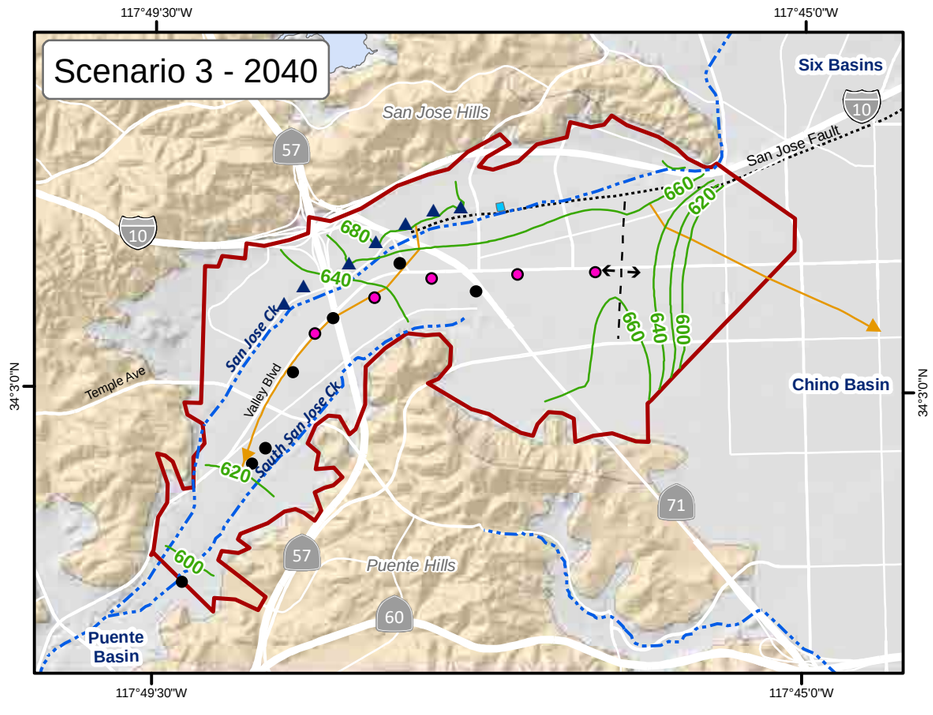
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

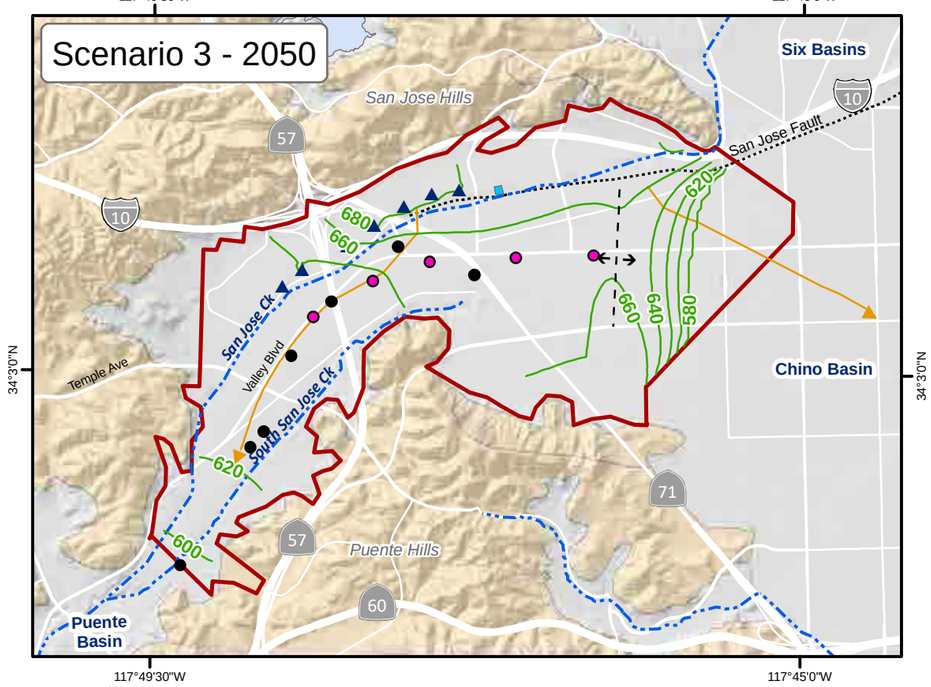
Groundwater Elevation and Flow Direction

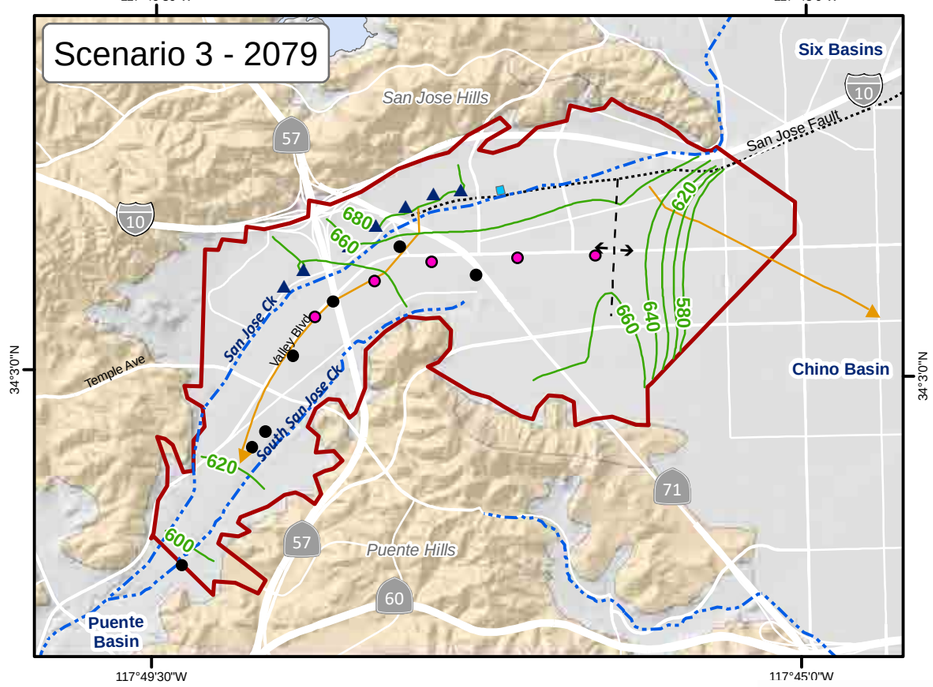
Basin Optimization Scenario 2

Figure 5-18c









600 Groundwater-Elevation Contours (ft-amsl)

General Groundwater-Flow Direction

Groundwater Divide (approximate)

Pumping and Recharge Facilities

- Production Well Active in Scenario 3
- Underground Recharge Gallery in Scenario 3
- Injection Wells in Scenario 3
- New Production Wells in Scenario 3

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-18d_GWEL_Contours_S3.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

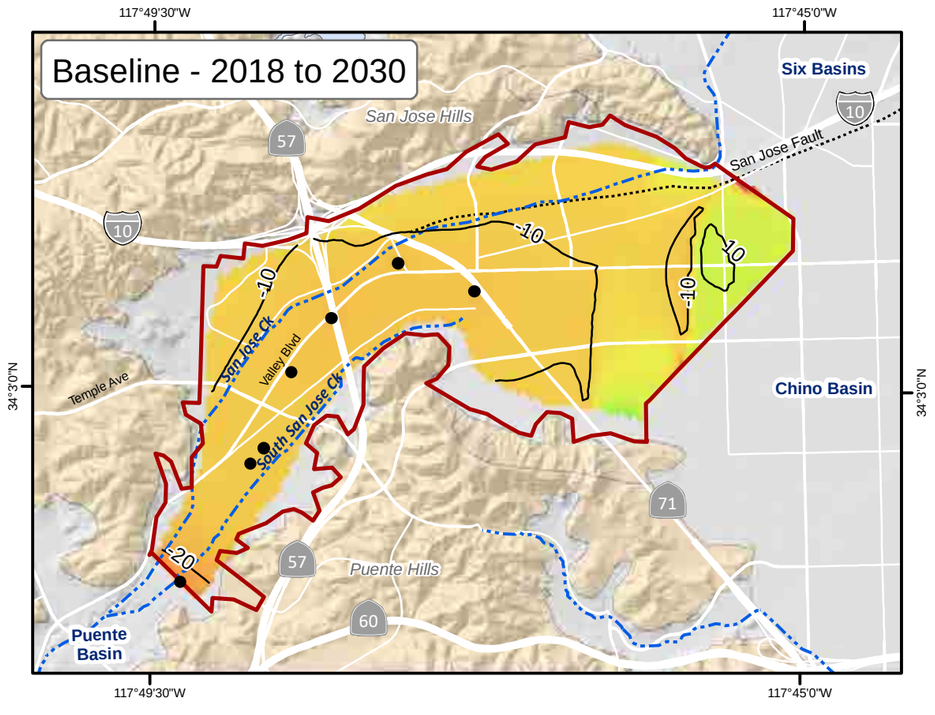
Groundwater Sustainability Plan

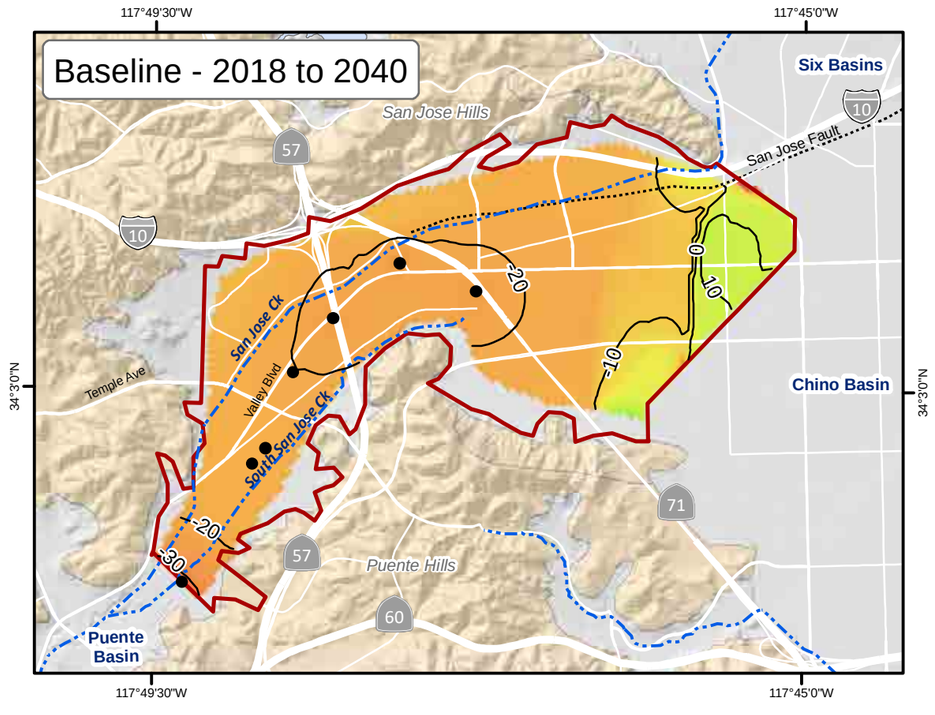
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

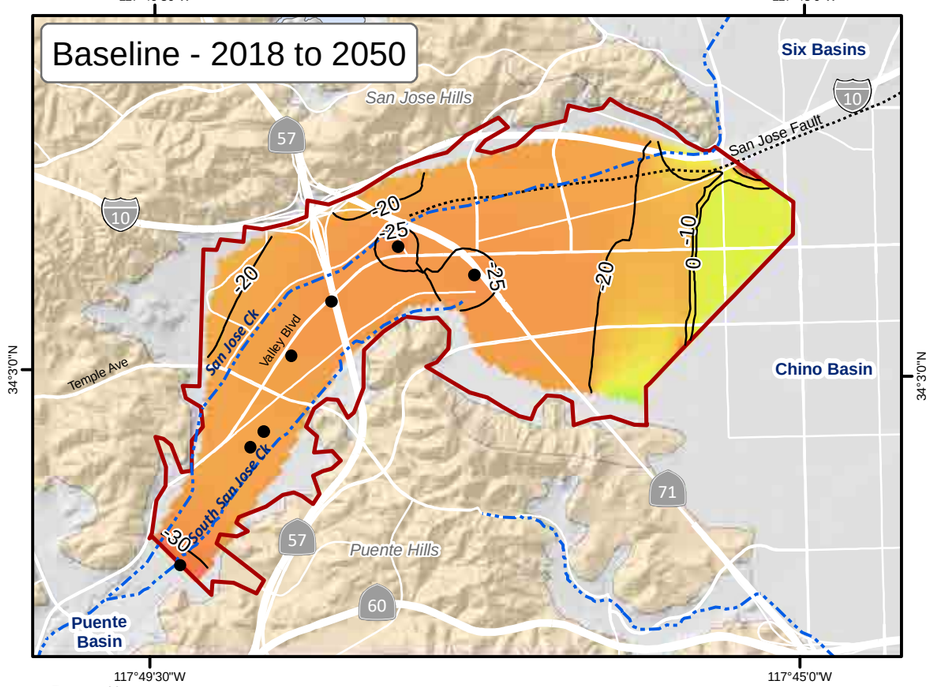
Groundwater Elevation and Flow Direction

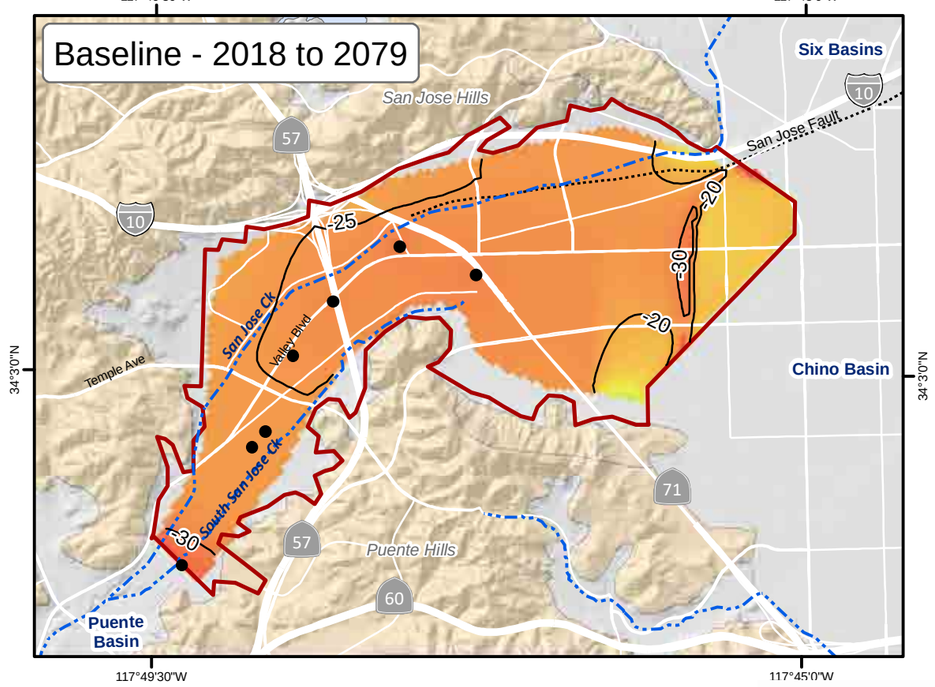
Basin Optimization Scenario 3

Figure 5-18d









Groundwater Elevation Change

40 ft

0

-40 ft

Pumping and Recharge Facilities

- Production Well Active in Baseline

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-19a_GWEL Change_BL.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

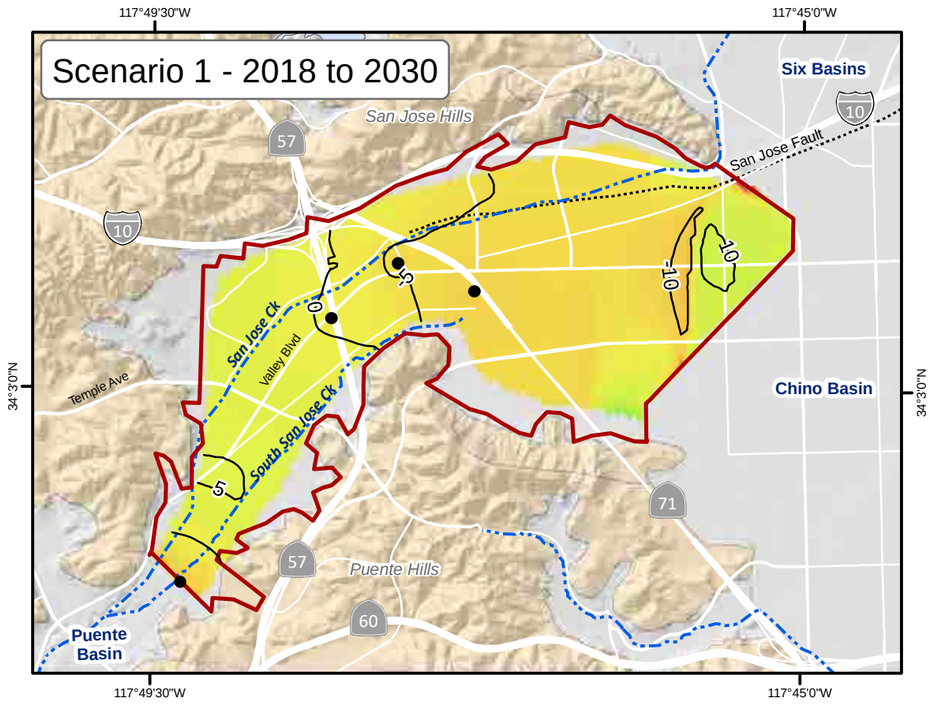
Groundwater Sustainability Plan

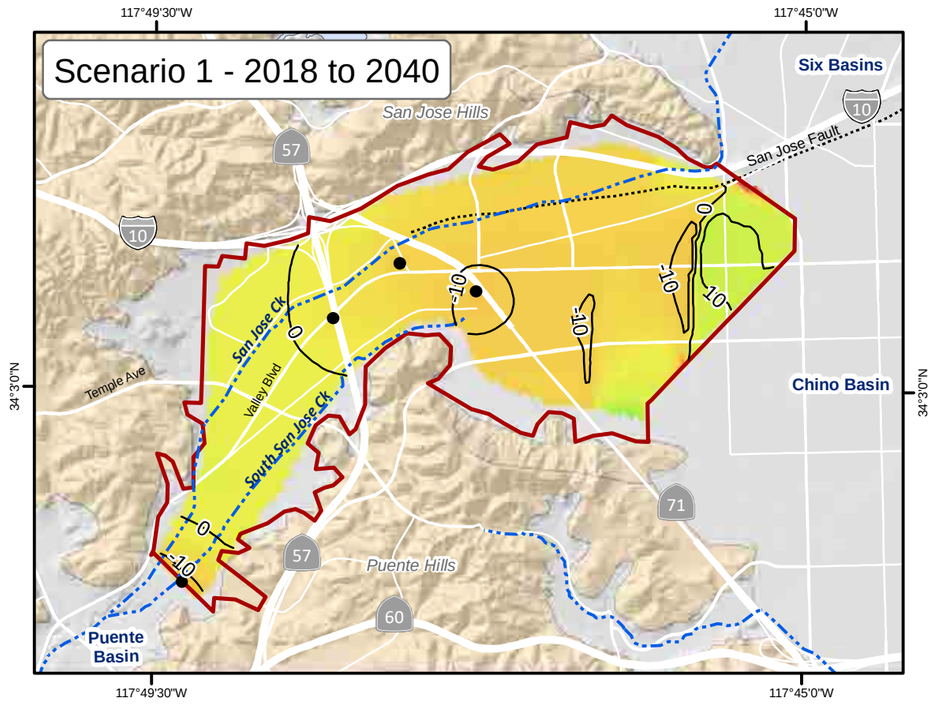
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

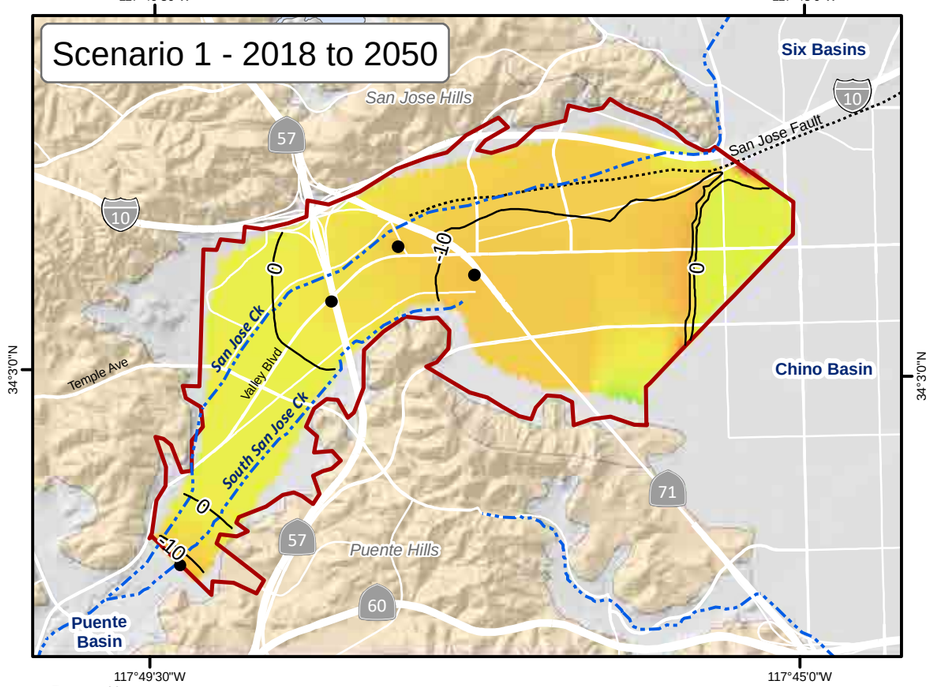
Change in Groundwater Elevation

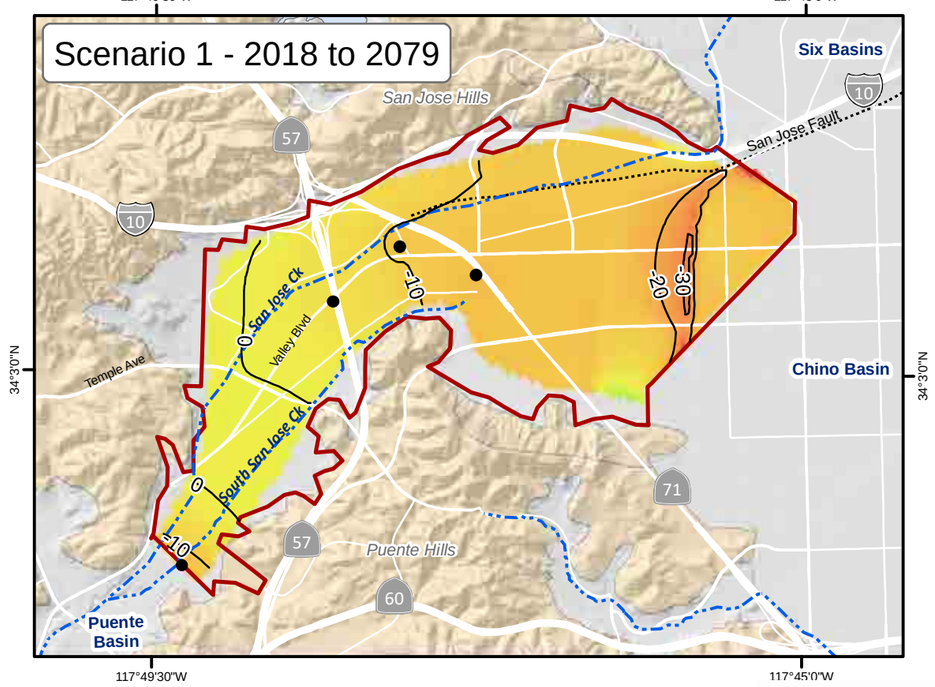
Baseline Scenario

Figure 5-19a









Groundwater Elevation Change

40 ft

0

-40 ft

Pumping and Recharge Facilities

- Production Well Active in Scenario 1

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-19b_GWEL Change_S1.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

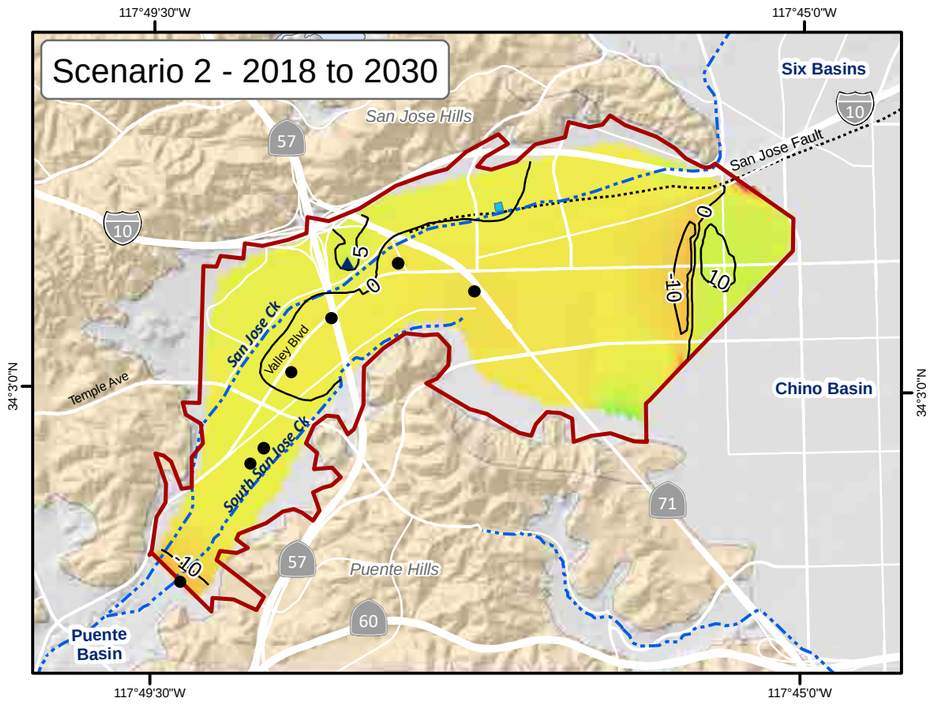
Groundwater Sustainability Plan

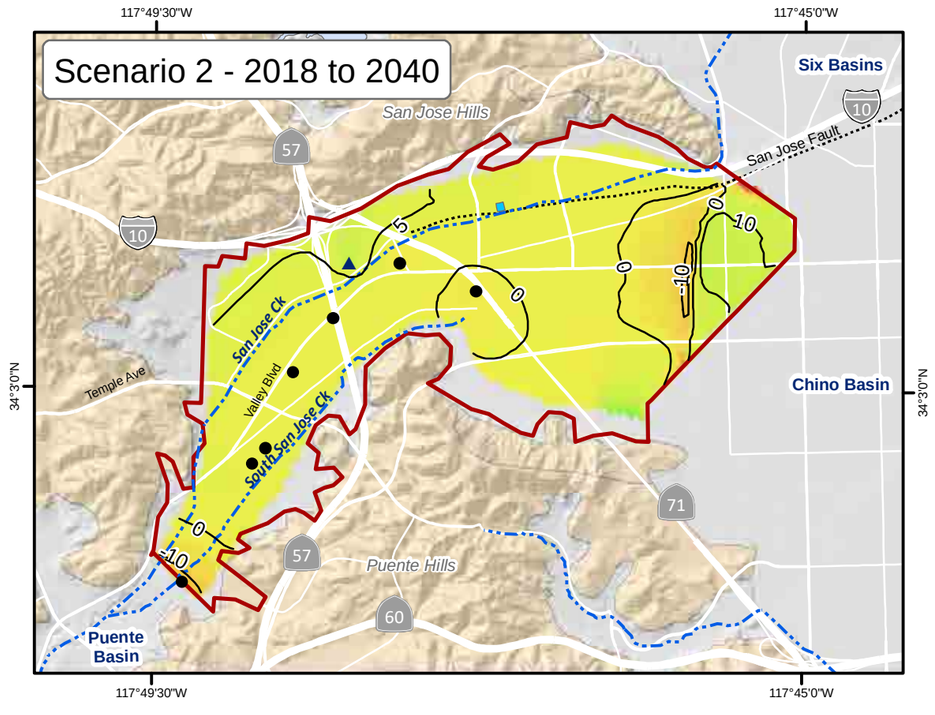
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

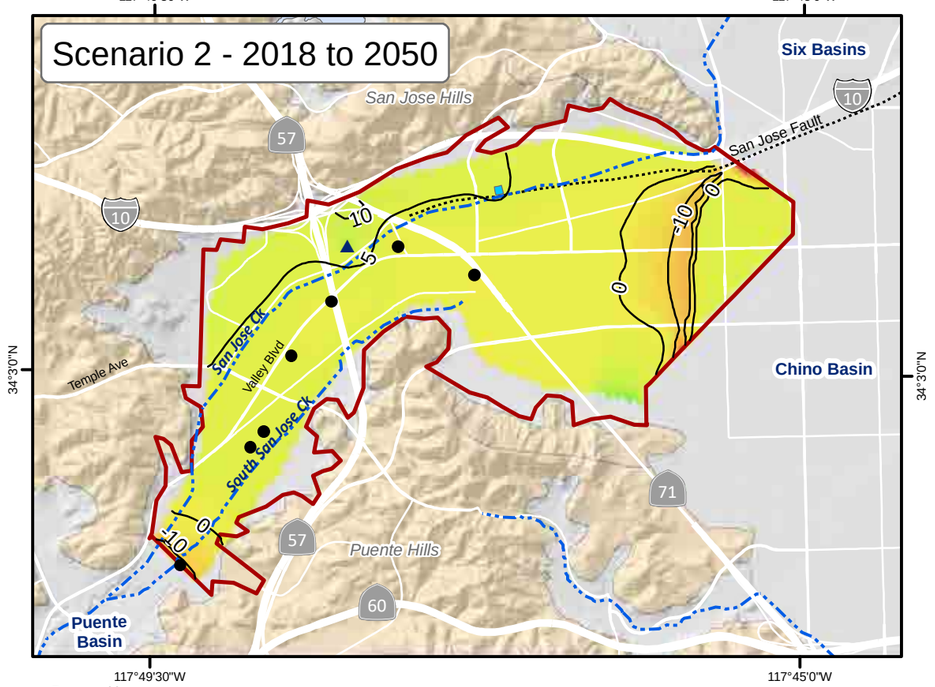
Change in Groundwater Elevation

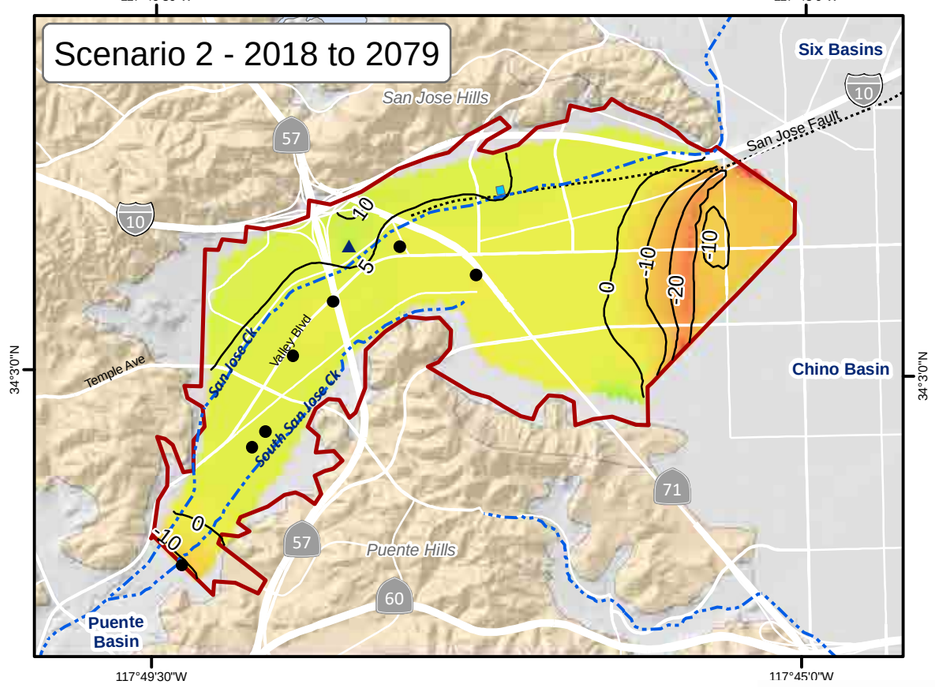
Basin Optimization Scenario 1

Figure 5-19b









Groundwater Elevation Change

40 ft

0

-40 ft

Pumping and Recharge Facilities

- Production Well Active in Scenario 2
- Underground Recharge Gallery in Scenario 2
- Injection Well in Scenario 2
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-19c_GWEL Change_S2.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

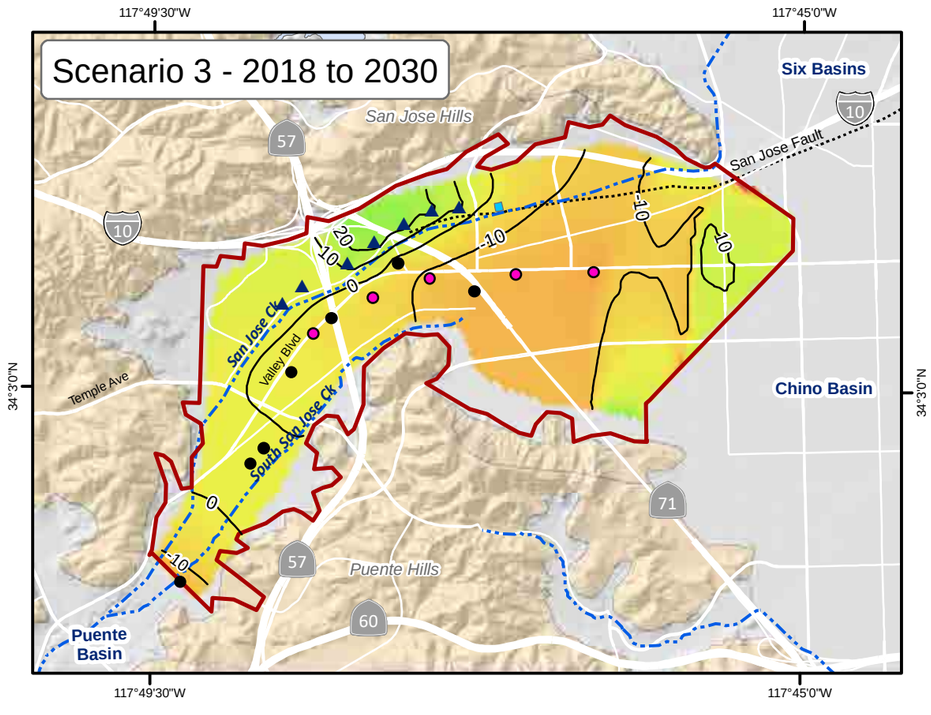
Groundwater Sustainability Plan

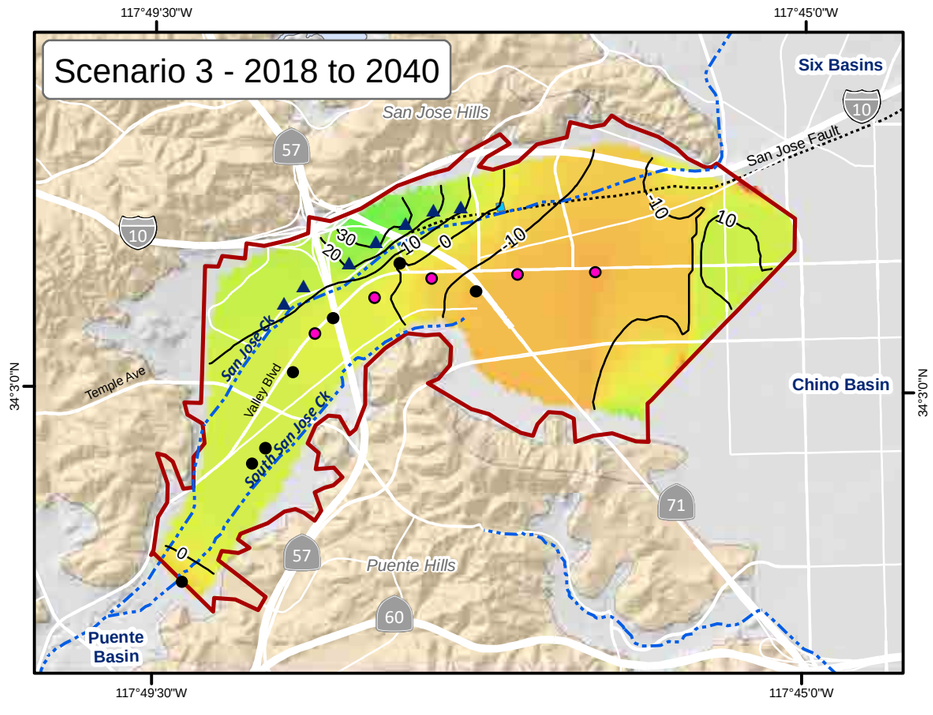
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

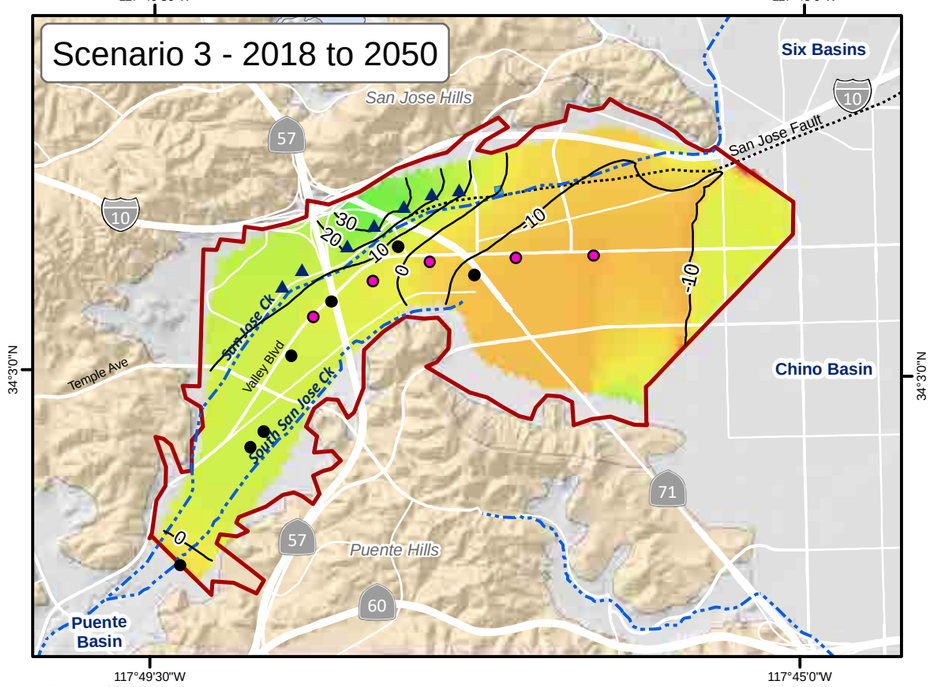
Change in Groundwater Elevation

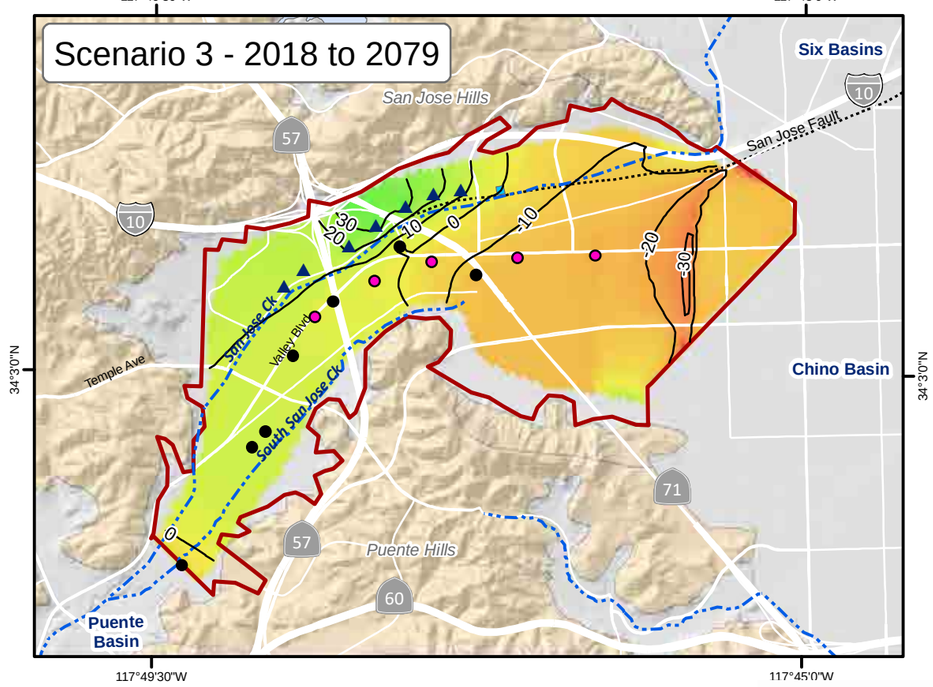
Basin Optimization Scenario 2

Figure 5-19c

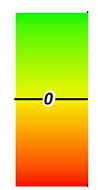








Groundwater Elevation Change



Pumping and Recharge Facilities

- Production Well Active in Scenario 1
- Underground Recharge Gallery in Scenario 3
- Injection Well in Scenario 3
- New Production Well in Scenario 3
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

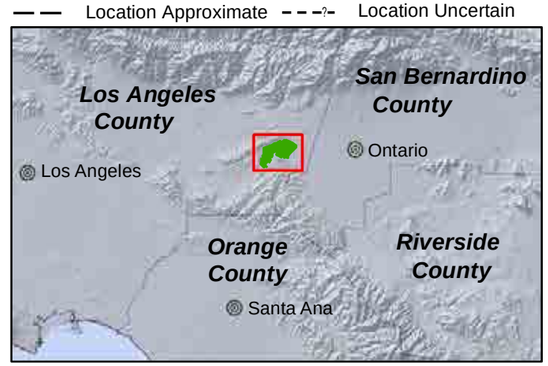
- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain



Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-19d_GWEL Change_S3.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Change in Groundwater Elevation
Basin Optimization Scenario 3

Figure 5-19d

In all three Basin Optimization Scenarios, groundwater levels are projected to decline in the eastern portion of the basin. As described in *Section 2.2.7 Data Gaps,* this is an area of highest uncertainty in the groundwater-flow model of the Spadra Basin, and hence, an area that should be monitored in the future for changes in groundwater levels and potential adverse impacts to the neighboring Chino Basin, such as reduced subsurface outflow. The Spadra Basin GSA is in the process of constructing a new monitoring well within the eastern portion of the basin near the Spadra/Chino Basin boundary. The data that will be collected from the new monitoring well includes borehole lithology, borehole geophysics, depth to bottom of the aquifer, groundwater-quality data, and high-frequency groundwater-level data. The data collected from the new monitoring well, and additional monitoring data collected in the eastern portion of the basin, will be used to detect the potential adverse impacts and Undesirable Results, and also can be used to update and improve the Spadra Basin Groundwater Model in the future.

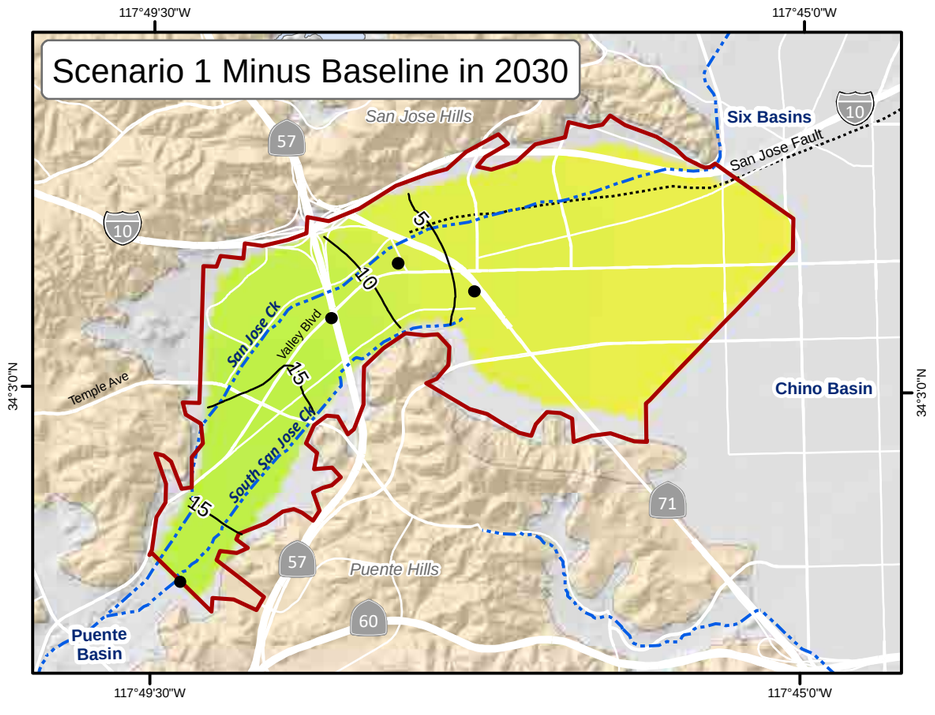
Figures 5-20a through 5-20c show the difference between the model-estimated groundwater elevations for the Baseline Scenario and the three Basin Optimization Scenarios for the years 2030, 2040, 2050, and 2079. The difference in groundwater elevation from the Baseline Scenario is shown on each map as a color-ramped raster and contours of groundwater-elevation difference. These maps show that by 2079 (end of the planning period) groundwater elevations are higher for all Basin Optimization Scenarios compared to the Baseline Scenario:

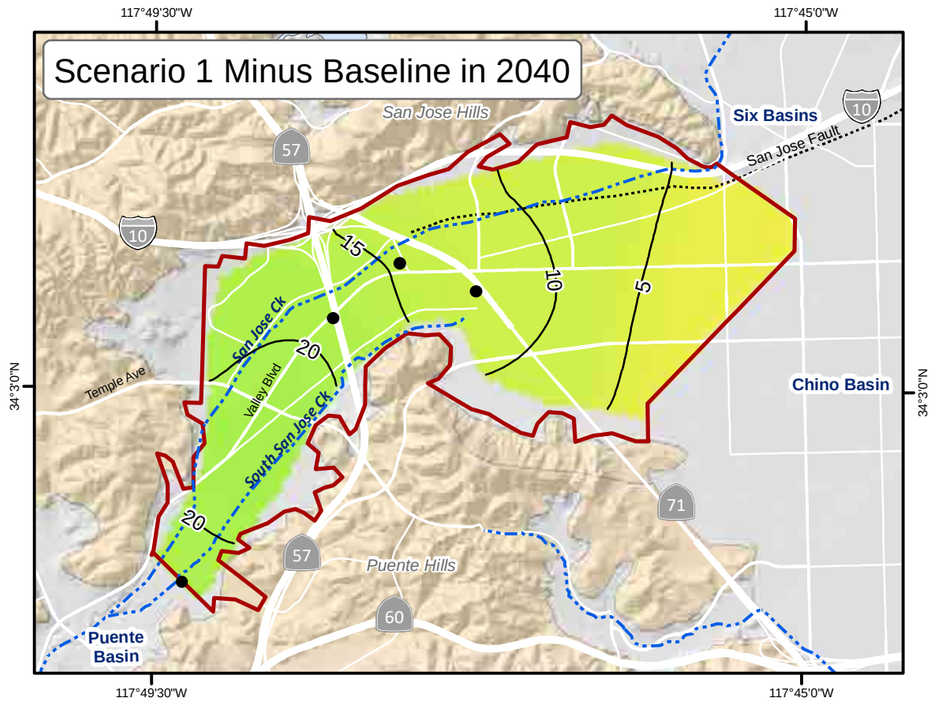
- In Basin Optimization Scenario 1, groundwater elevations across the basin are projected to be about 5 to 25 ft higher compared to the Baseline Scenario.
- In Basin Optimization Scenario 2, groundwater elevations across the basin are projected to be about 5 to 30 ft higher compared to the Baseline Scenario.
- In Basin Optimization Scenario 3, groundwater elevations across the basin are projected to be about 5 to 55 ft higher compared to the Baseline Scenario.

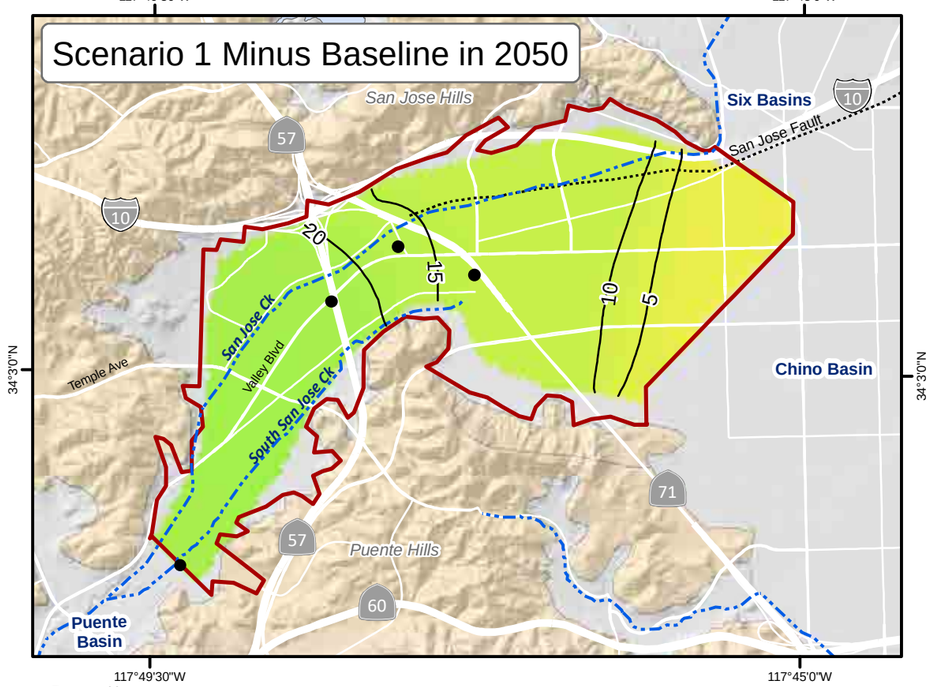
The greatest differences in groundwater elevations between the Basin Optimization Scenarios and the Baseline occur in the areas of the Spadra Basin where projects for either reduced pumping or artificial recharge are proposed. The greatest differences in groundwater elevations compared to the Baseline Scenario occur in the west for Basin Optimization Scenario 1; the central portion of the basin for Basin Optimization Scenario 2; and in the northern portion of the basin for Basin Optimization Scenario 3.

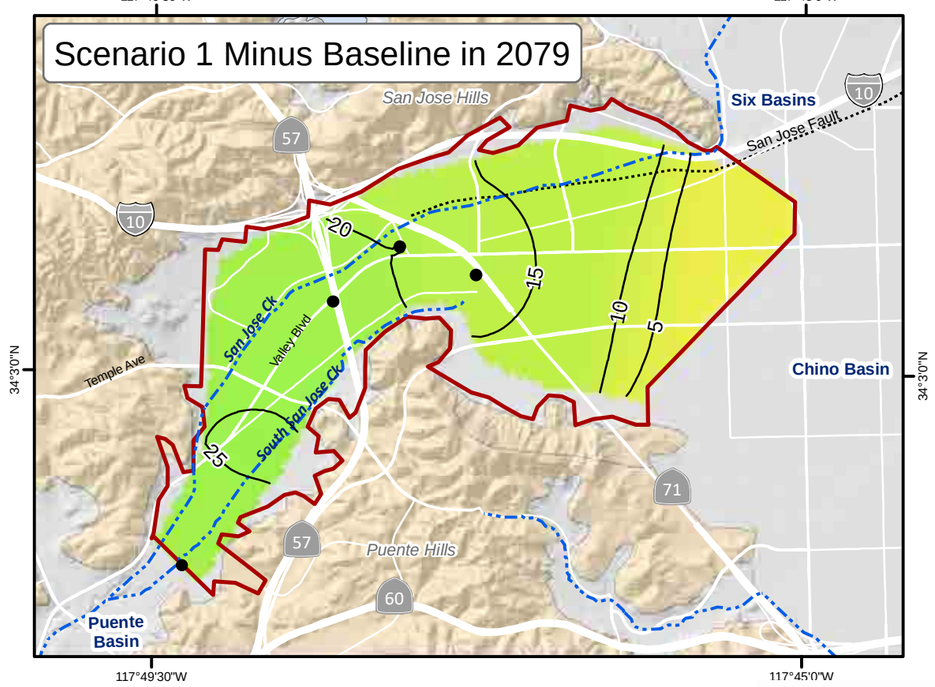
5.4.1.1.1 Groundwater Elevations at Wells

Figure 5-21 shows the locations of eleven wells across the Spadra Basin where time series of model-predicted groundwater elevations were analyzed to evaluate the change in water levels over the planning period and the sustainability of the Basin Optimization Scenarios. Figures 5-22a through 5-22k are time series charts of the historical and projected groundwater elevations for the three Basin Optimization Scenarios compared to the Baseline Scenario for the eleven wells. The wells include all active municipal pumping wells and/or representative monitoring wells where Sustainable Management Criteria were established in Section 3 Sustainable Management Criteria, two proposed pumping well locations in Basin Optimization Scenario 3, and one proposed injection well location in Basin Optimization Scenarios 2 and 3. For the wells that are representative monitoring locations with Sustainable Management Criteria, the Minimum Thresholds and Measurable Objectives are shown on the time-series charts.









Groundwater Elevation Difference

40 ft

0

-40 ft

Pumping and Recharge Facilities

- Production Wells Active in Scenario 1
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-20a_GWEL_Diff_BL_S1.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

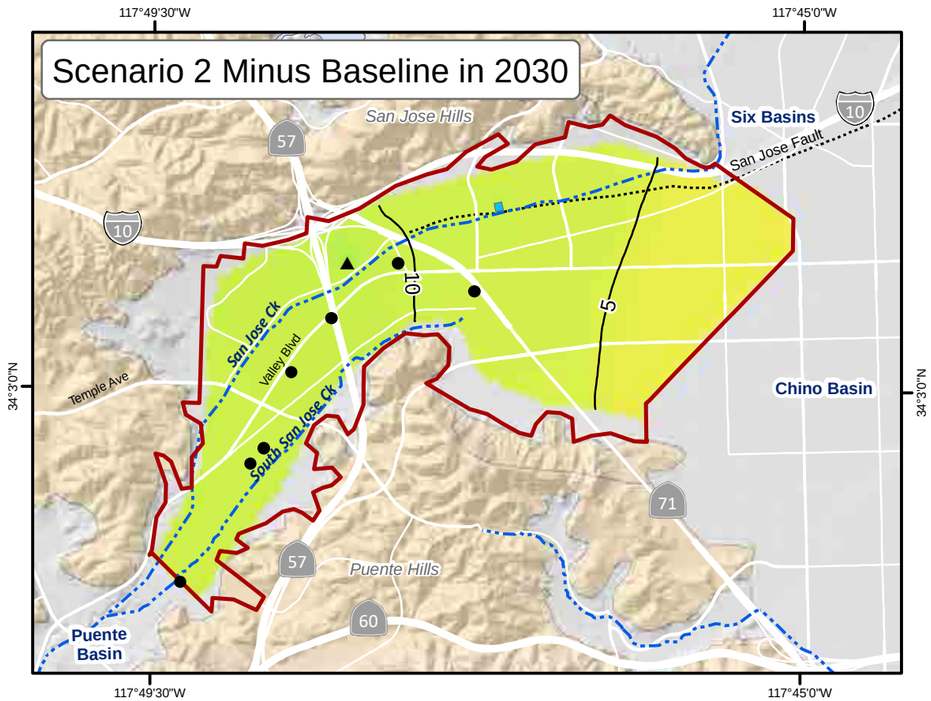
Groundwater Sustainability Plan

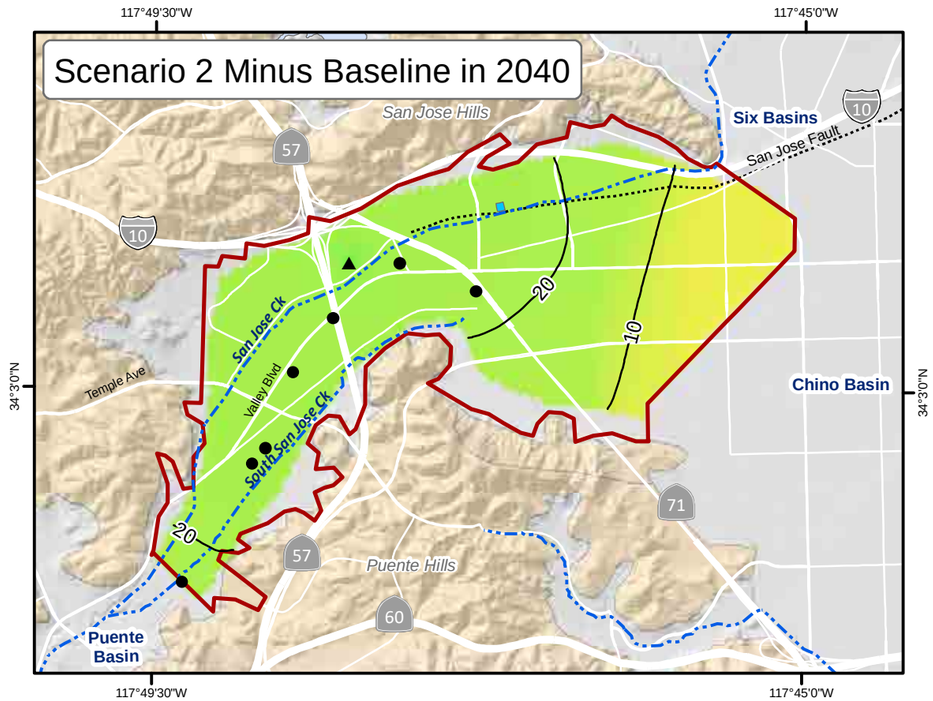
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

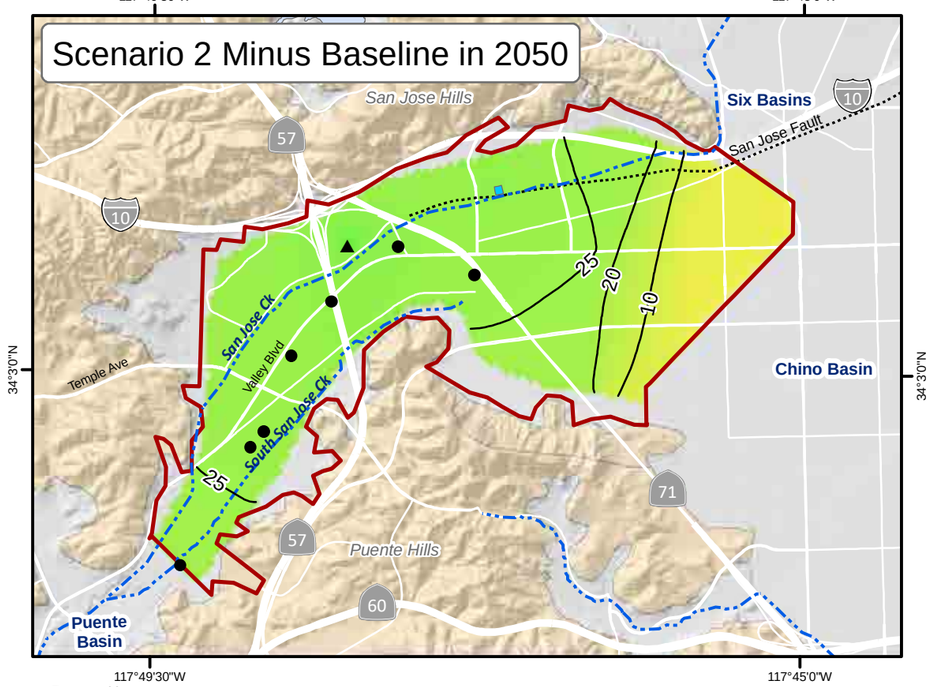
Difference in Groundwater Elevation

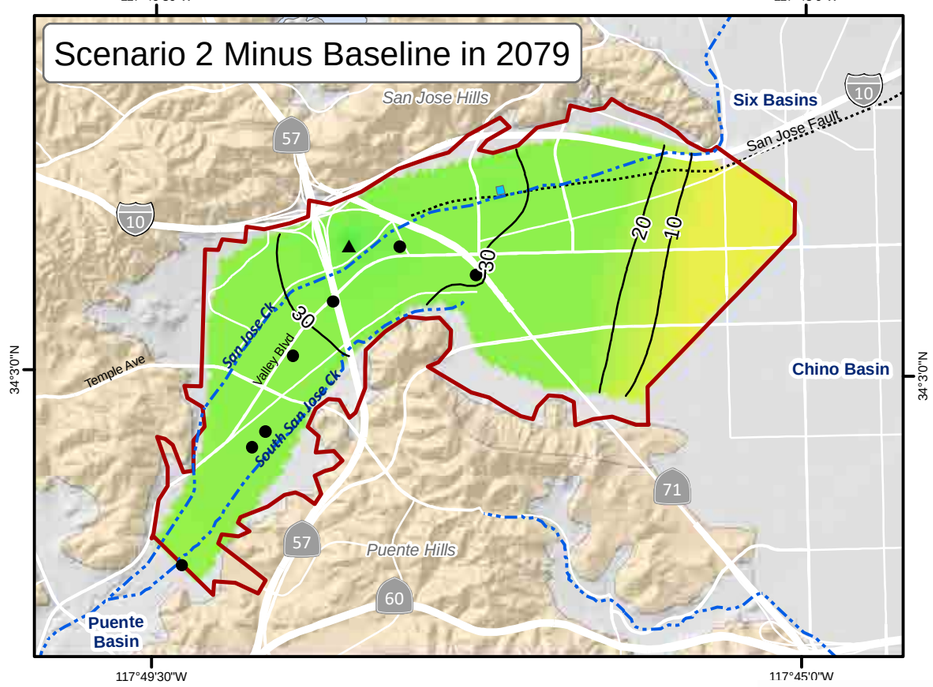
Basin Optimization Scenario 1

Figure 5-20a









Groundwater Elevation Difference

40 ft

0

-40 ft

Pumping and Recharge Facilities

- Production Wells Active in Scenario 2
- Underground Recharge Gallery in Scenario 2
- Injection Well in Scenario 2
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-20b_GWEL_Diff_BL_S2.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

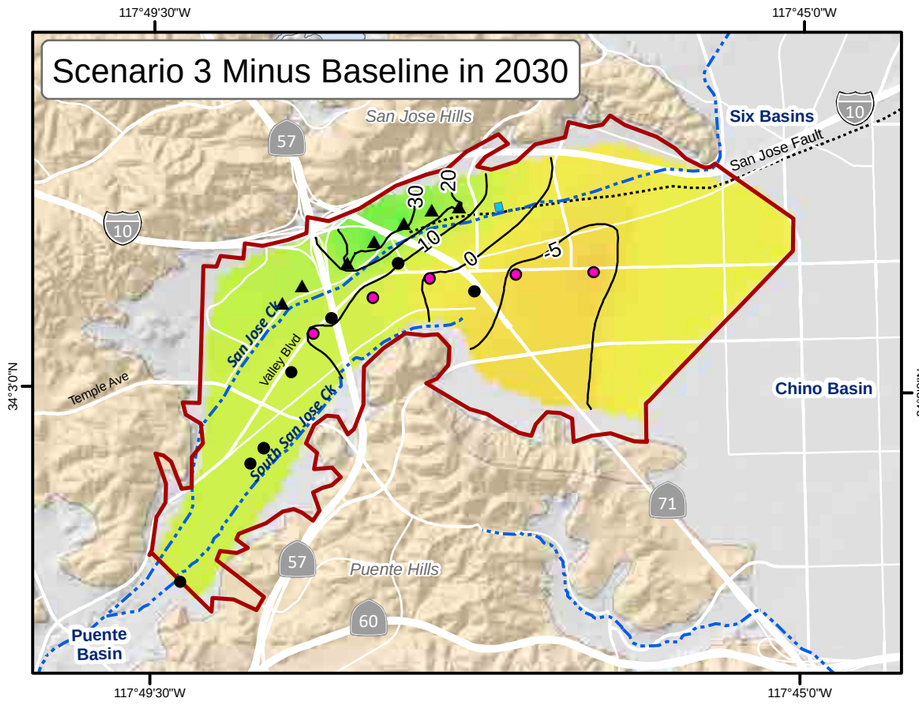
Groundwater Sustainability Plan

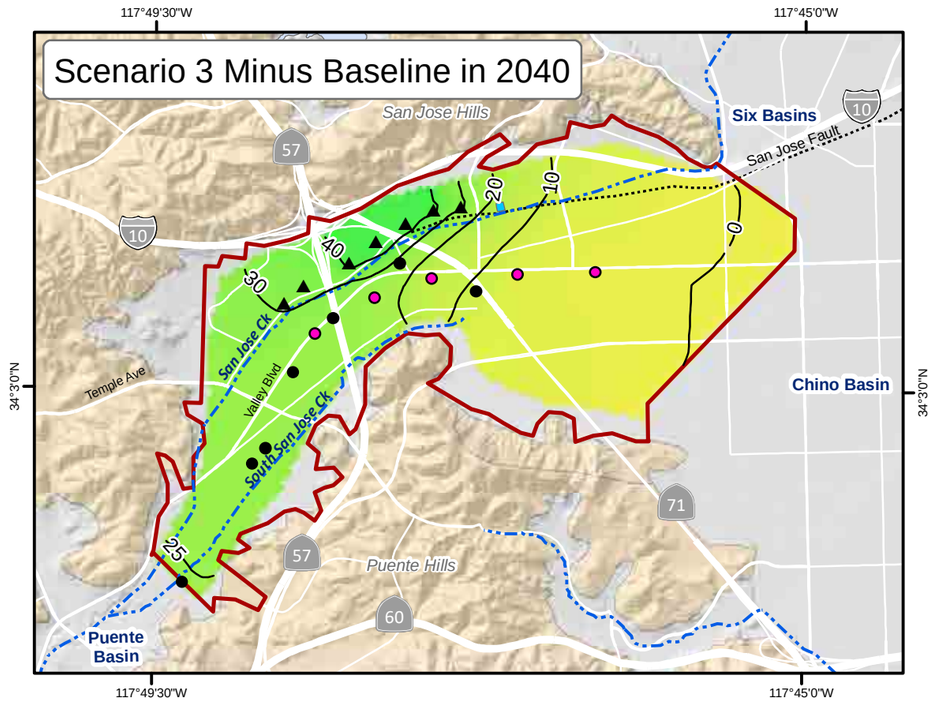
SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

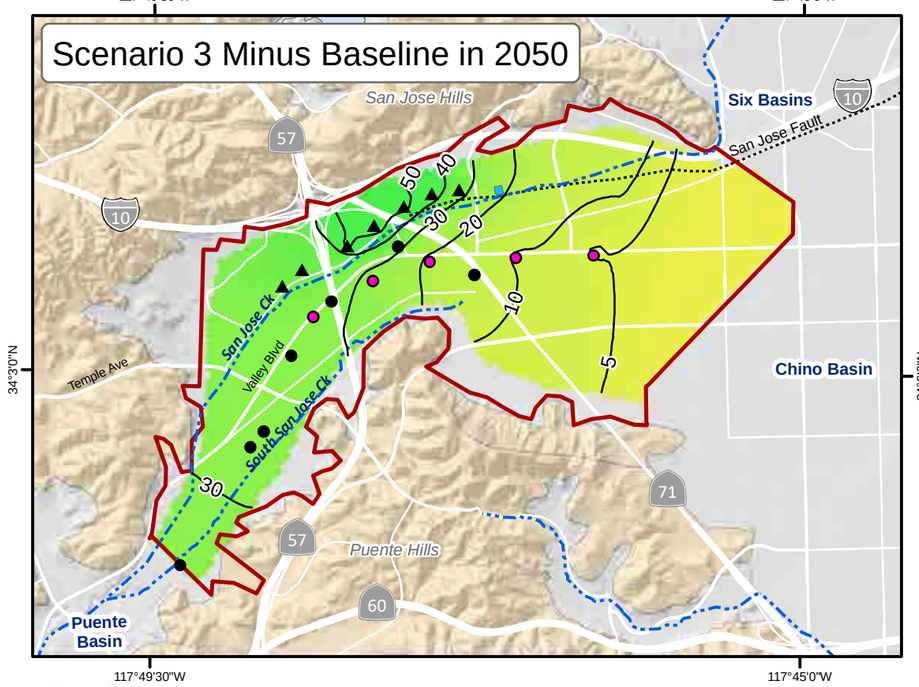
Difference in Groundwater Elevation

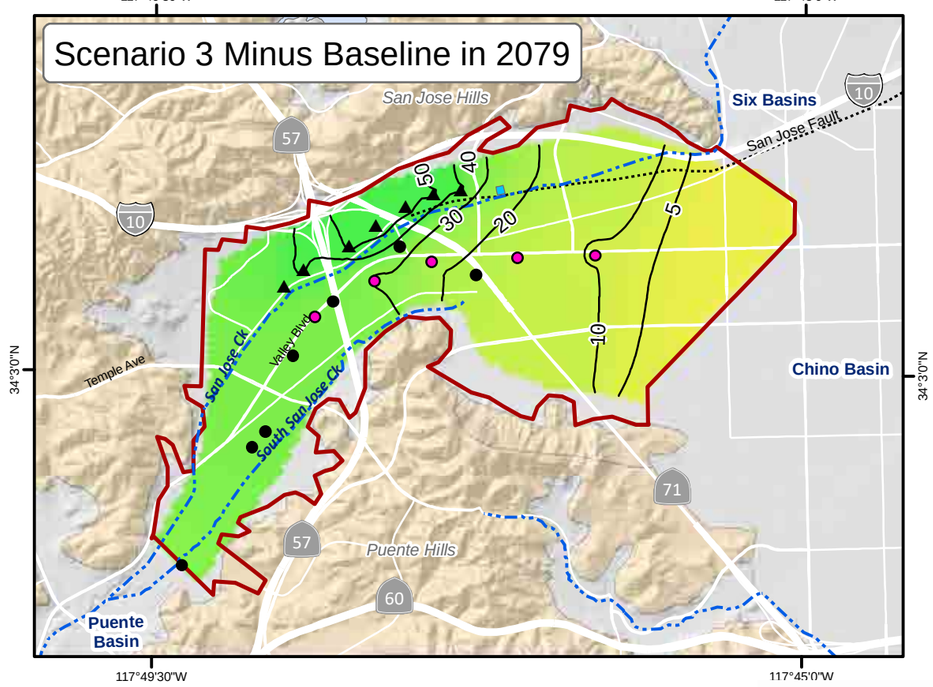
Basin Optimization Scenario 2

Figure 5-20b









Groundwater Elevation Difference

40 ft

0

-40 ft

Pumping and Recharge Facilities

- Production Wells Active in Scenario 3
- Underground Recharge Gallery in Scenario 3
- Injection Wells in Scenario 3
- New Production Wells in Scenario 3
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain

Prepared by:

WEST YOST
Water. Engineered.

Author: AC
Date: 10/8/2021
File: Figure 5-20c_GWEL_Diff_BL_S3.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

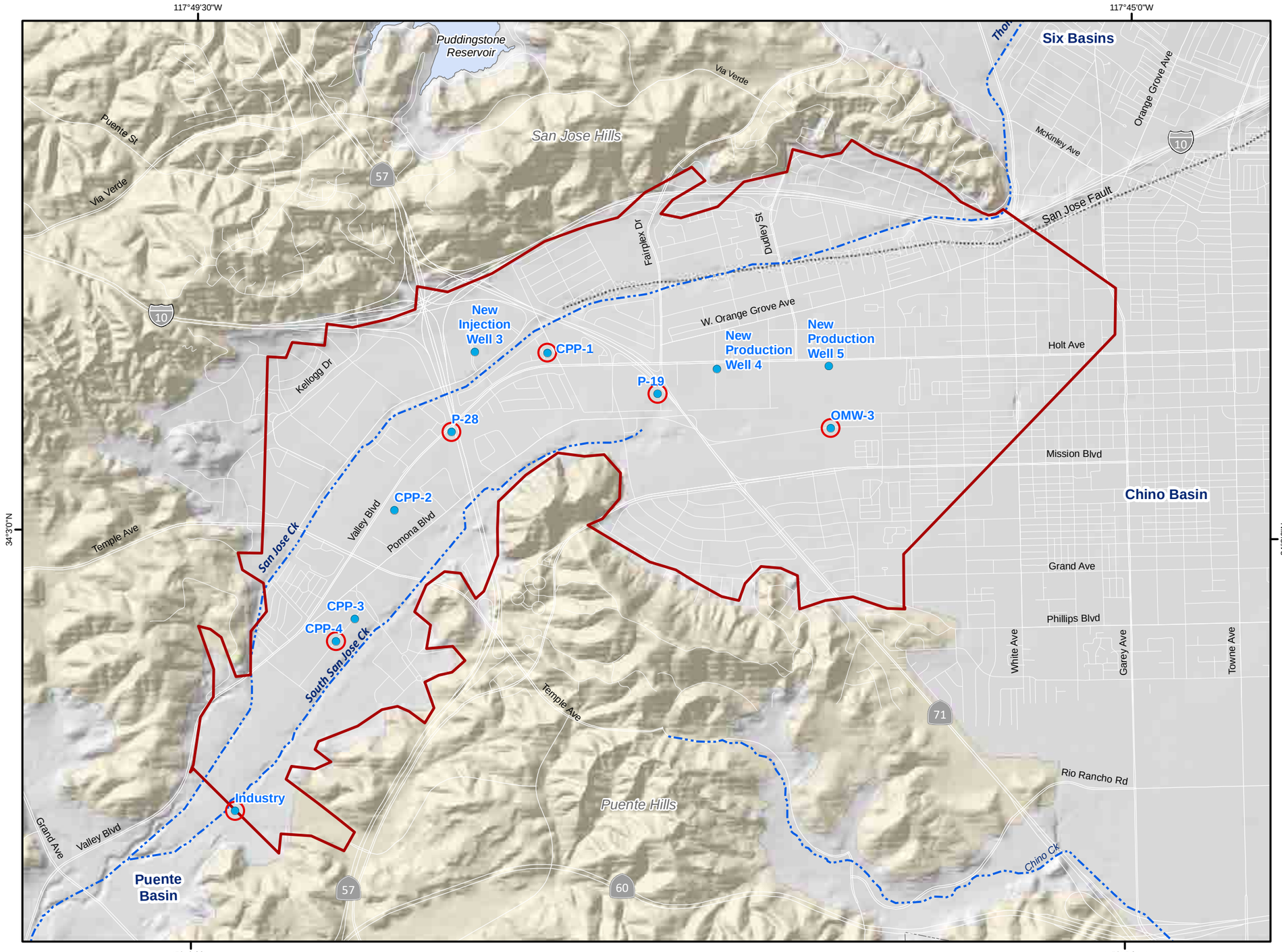
Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Difference in Groundwater Elevation
Basin Optimization Scenario 3

Figure 5-20c



Well with Time Series of Model-Predicted Groundwater Elevations in Figures 3-6a through 3-6k

Representative Monitoring Well with Sustainable Management Criteria for Groundwater Levels

10 Groundwater-Elevation Change Contours (ft)

Streams & Flood Control Channels

Spadra Basin (GSP Boundary)

Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 10/8/2021
File: Figure 5-21_TS_GWEL.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

Well with Time Series of Model-Predicted Groundwater Elevations

Figure 5-21

Figure 5-22a. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at Industry

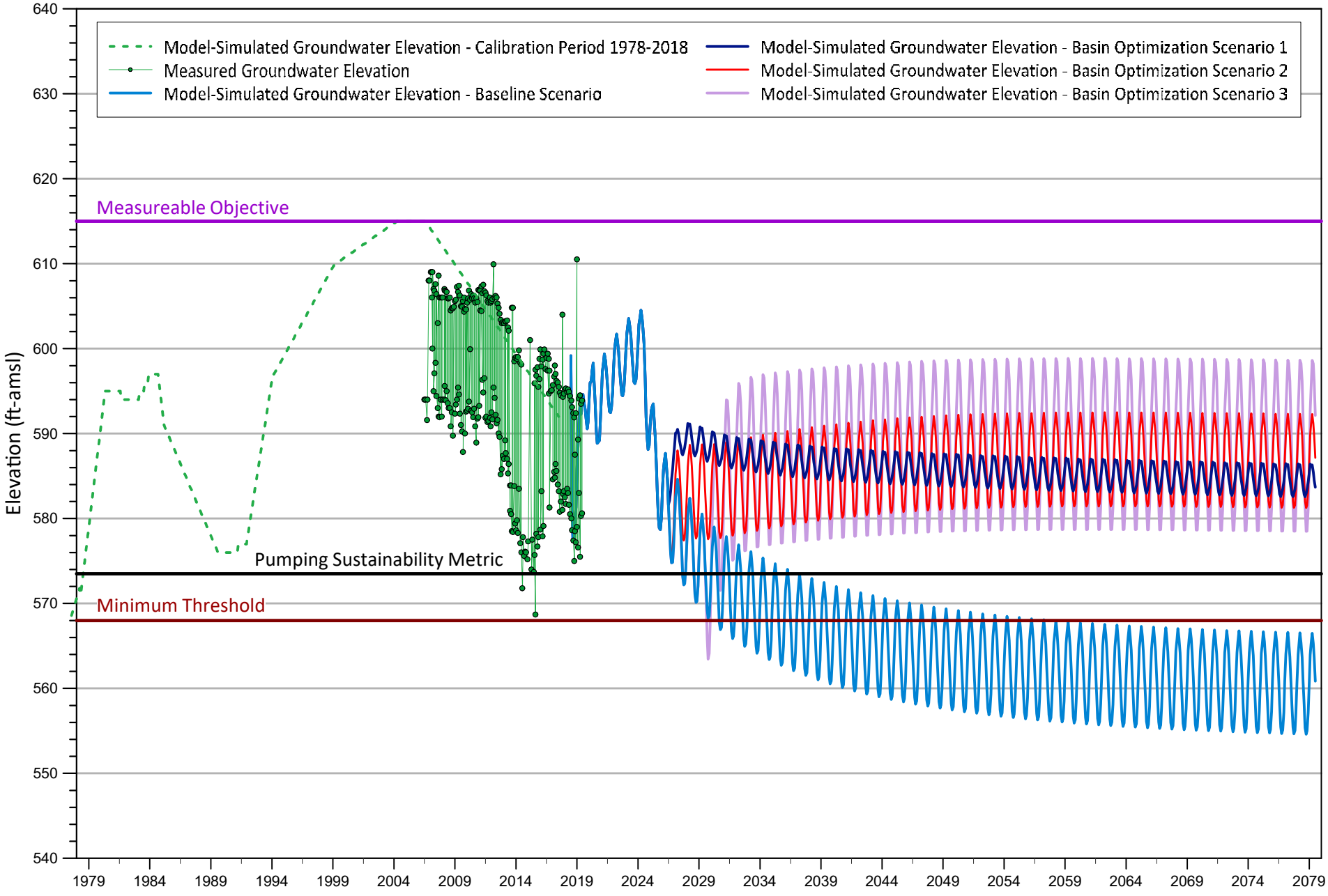


Figure 5-22b. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-4

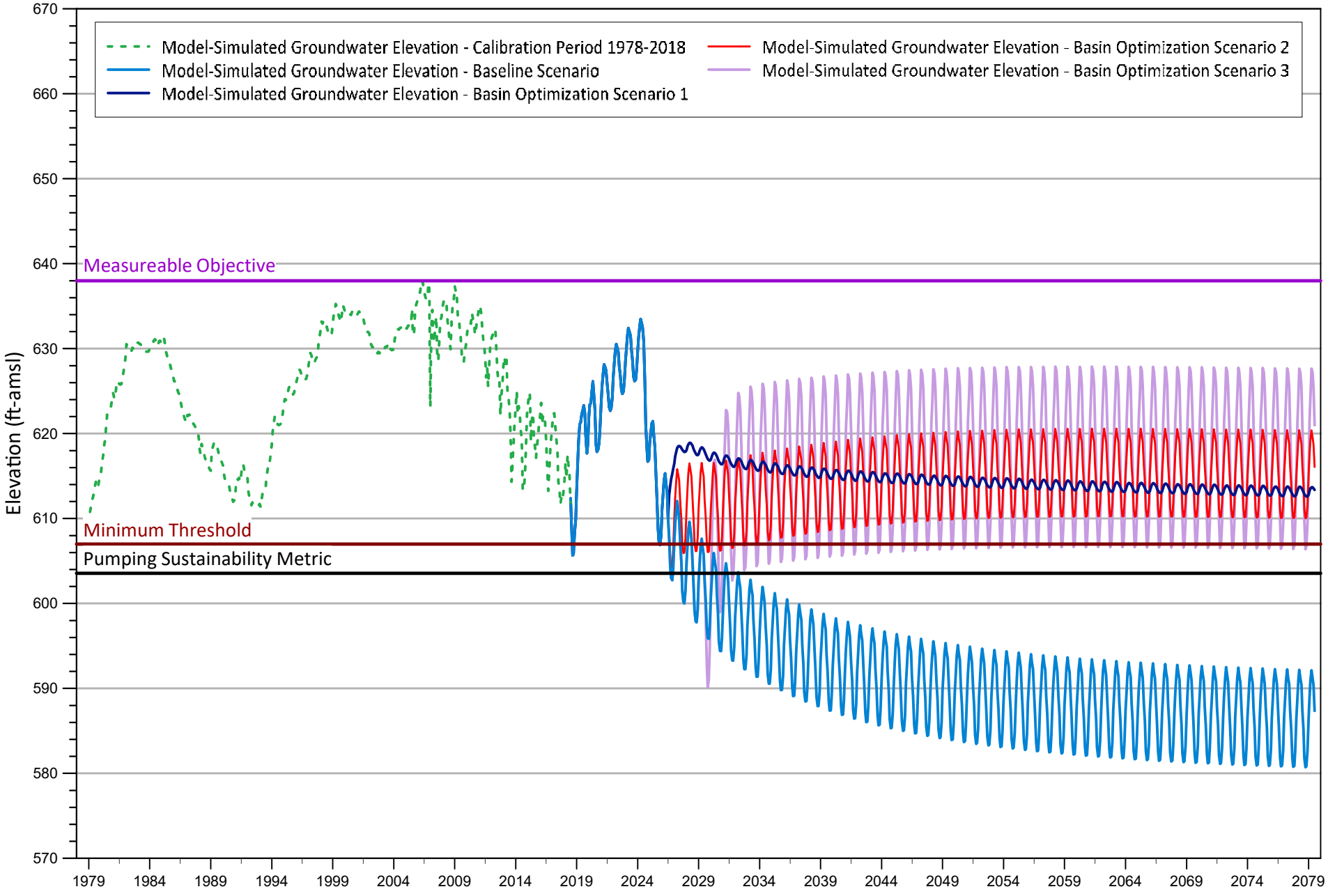


Figure 5-22c. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-3

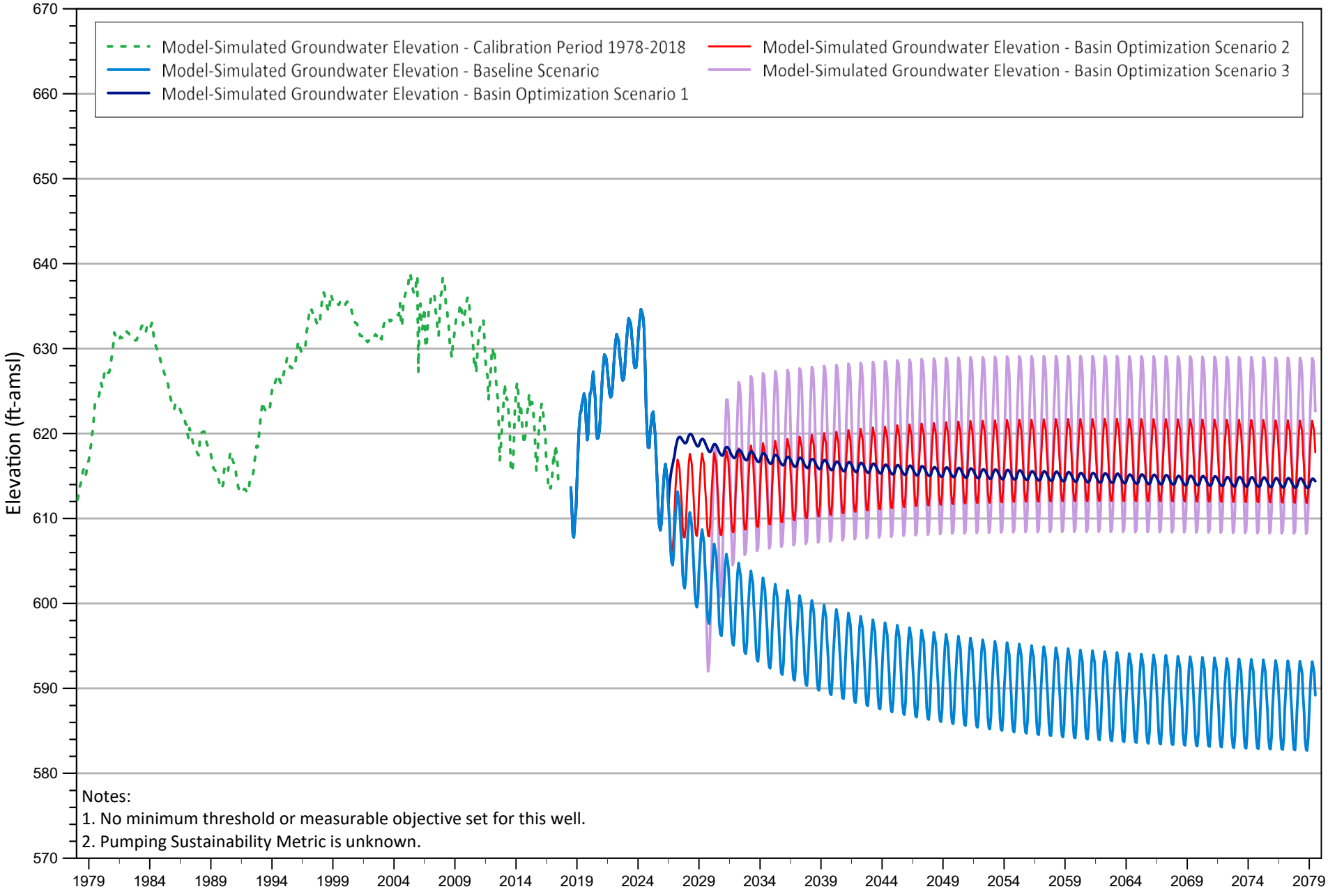


Figure 5-22d. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-2

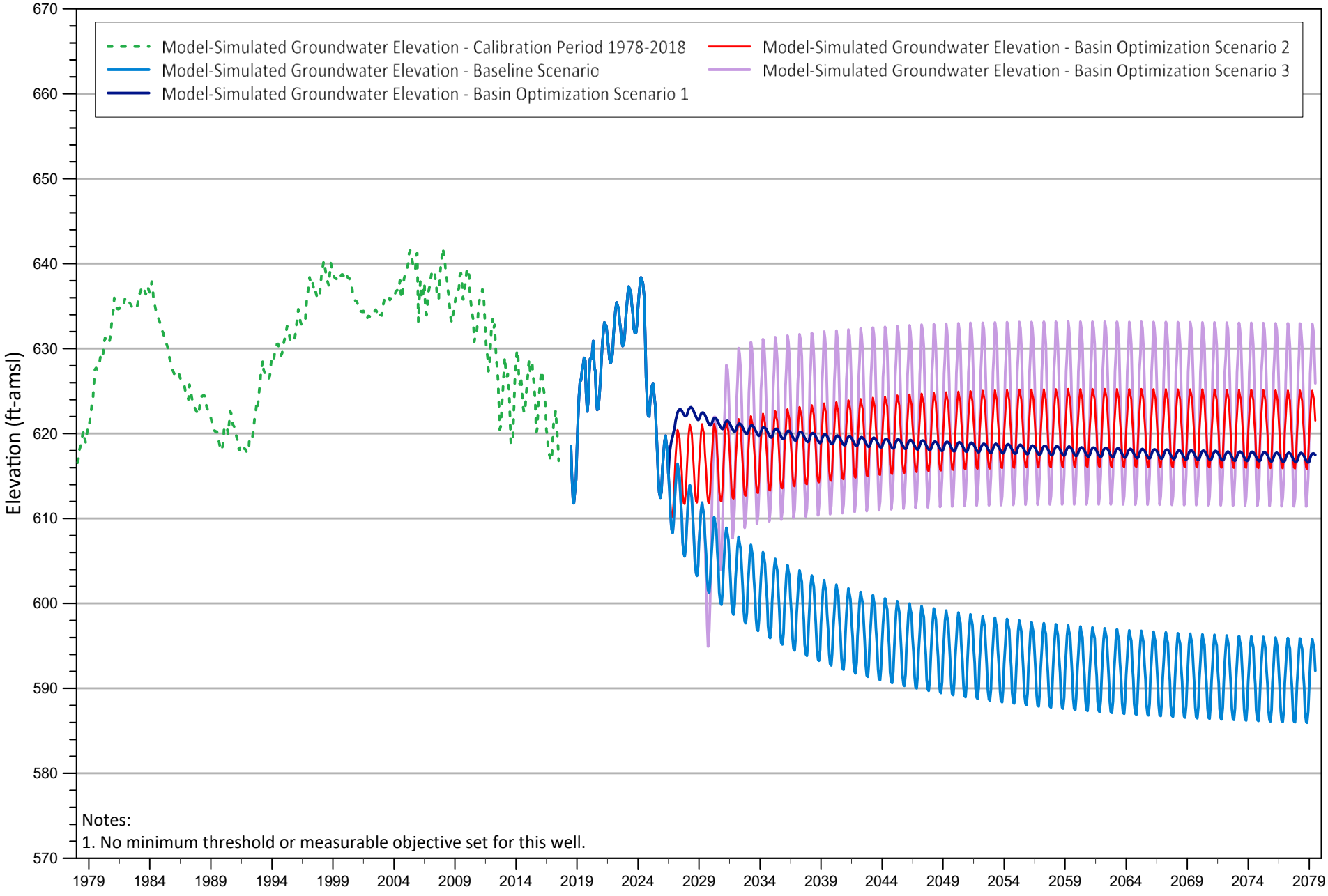


Figure 5-22e. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at P-28

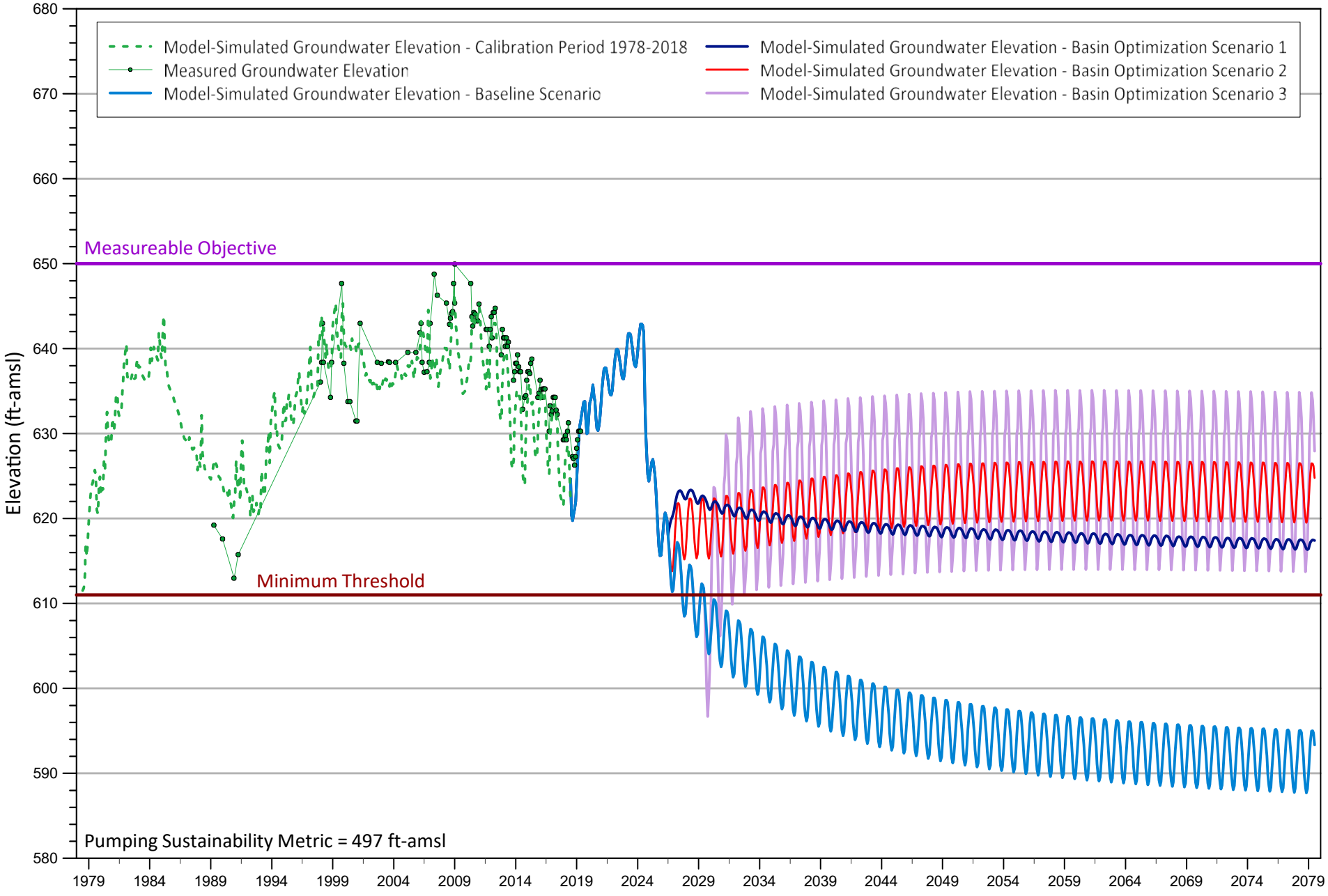


Figure 5-22f. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-1

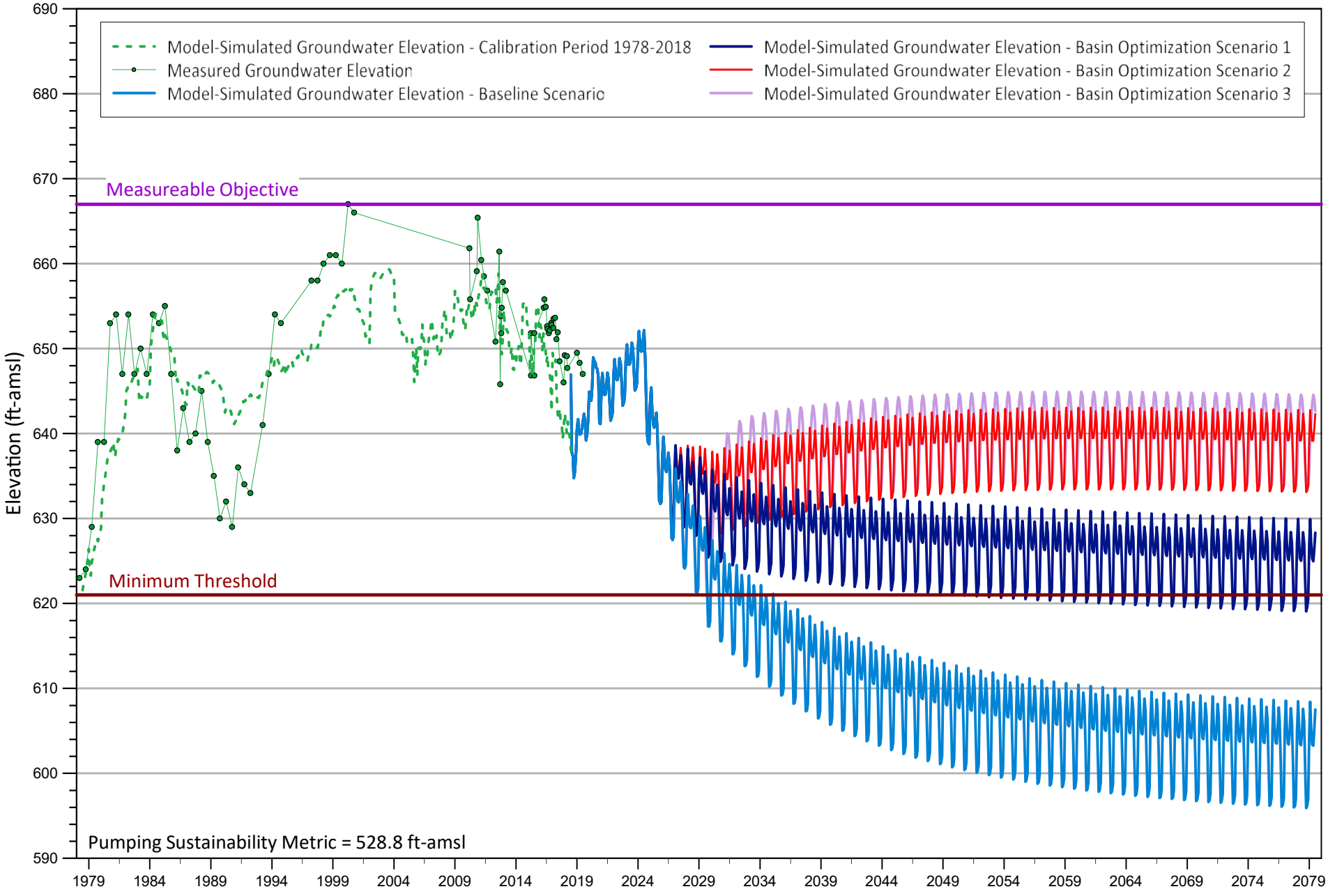


Figure 5-22g. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at P-19

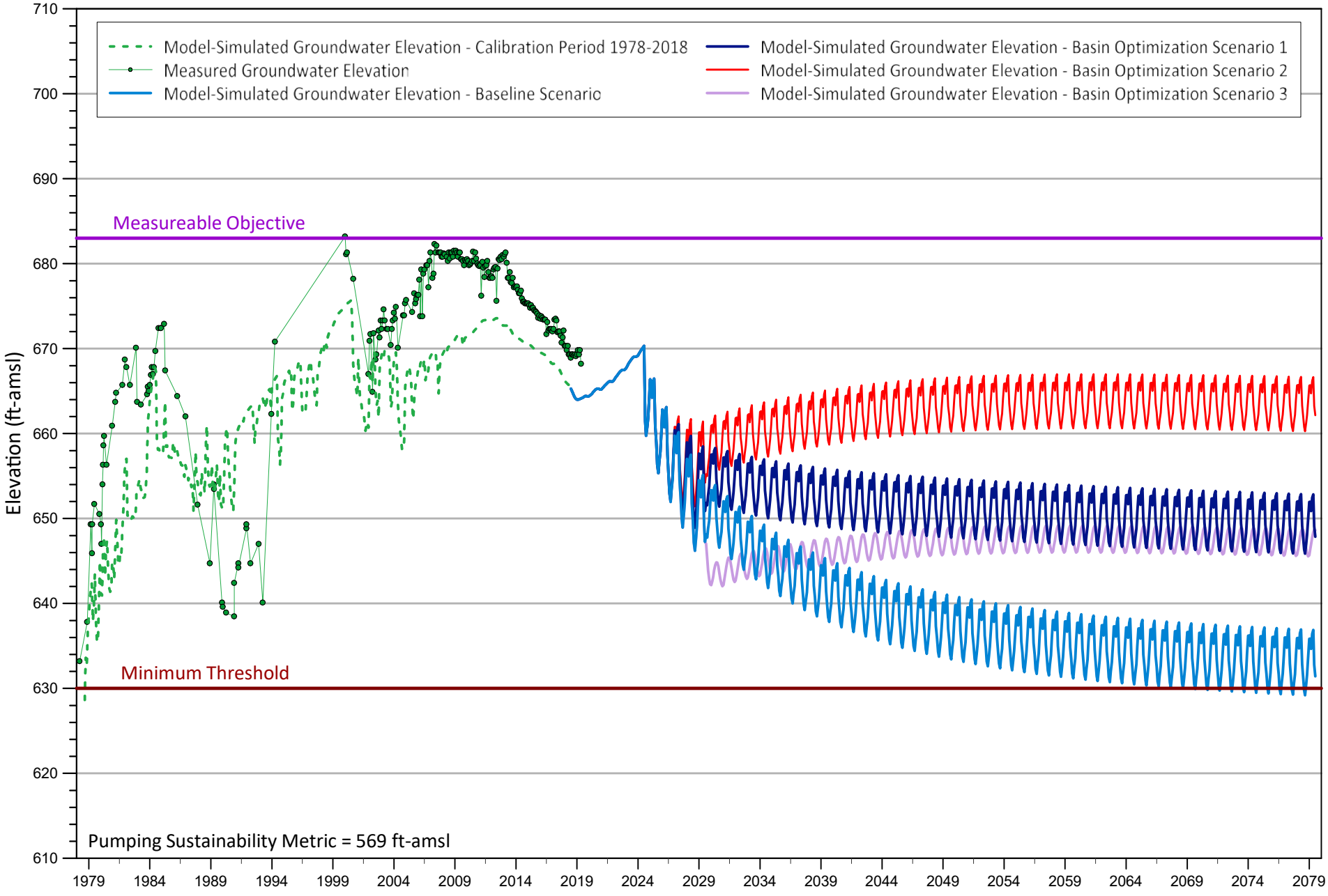


Figure 5-22h. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at OMW-3

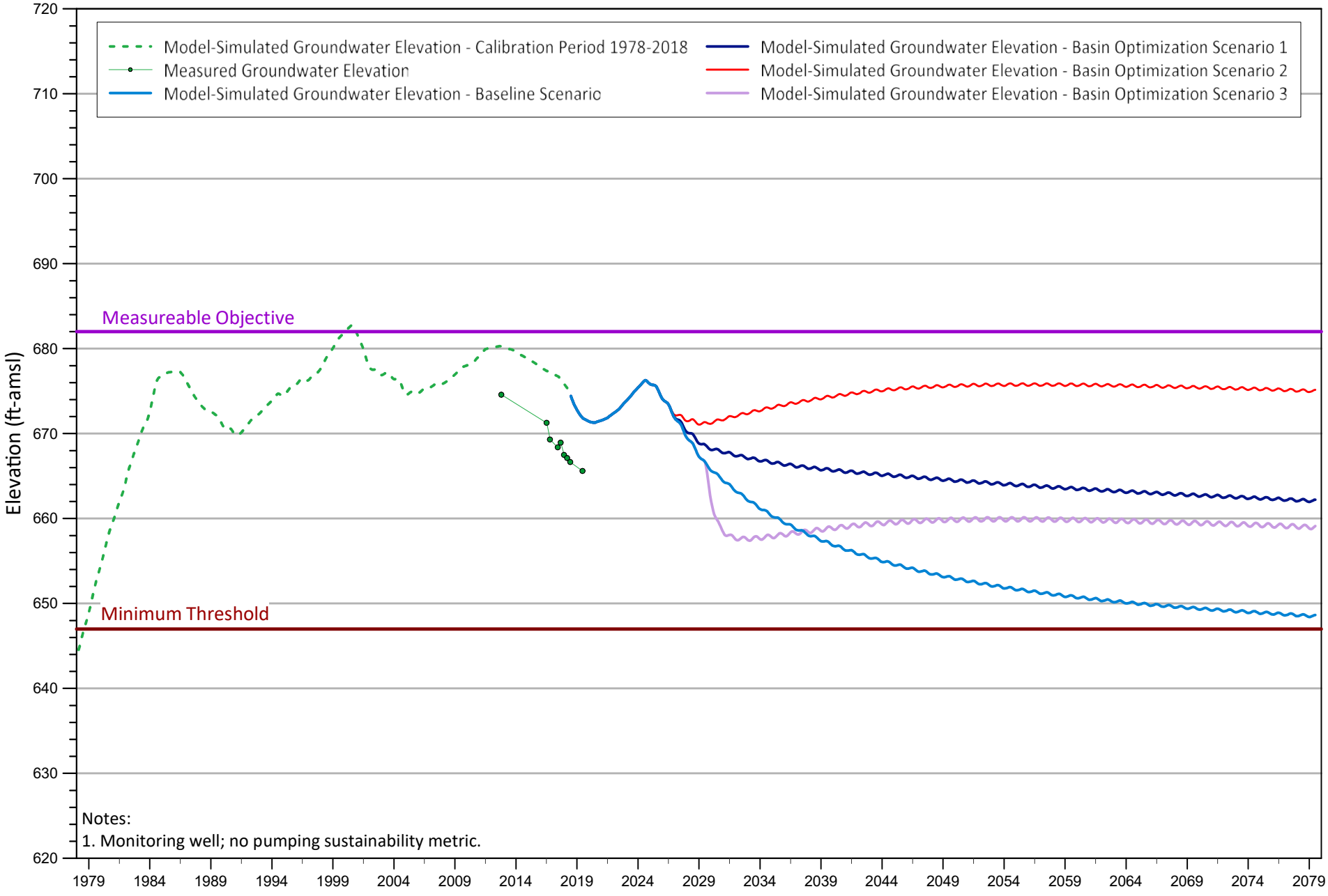


Figure 5-22i. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Production Well 4

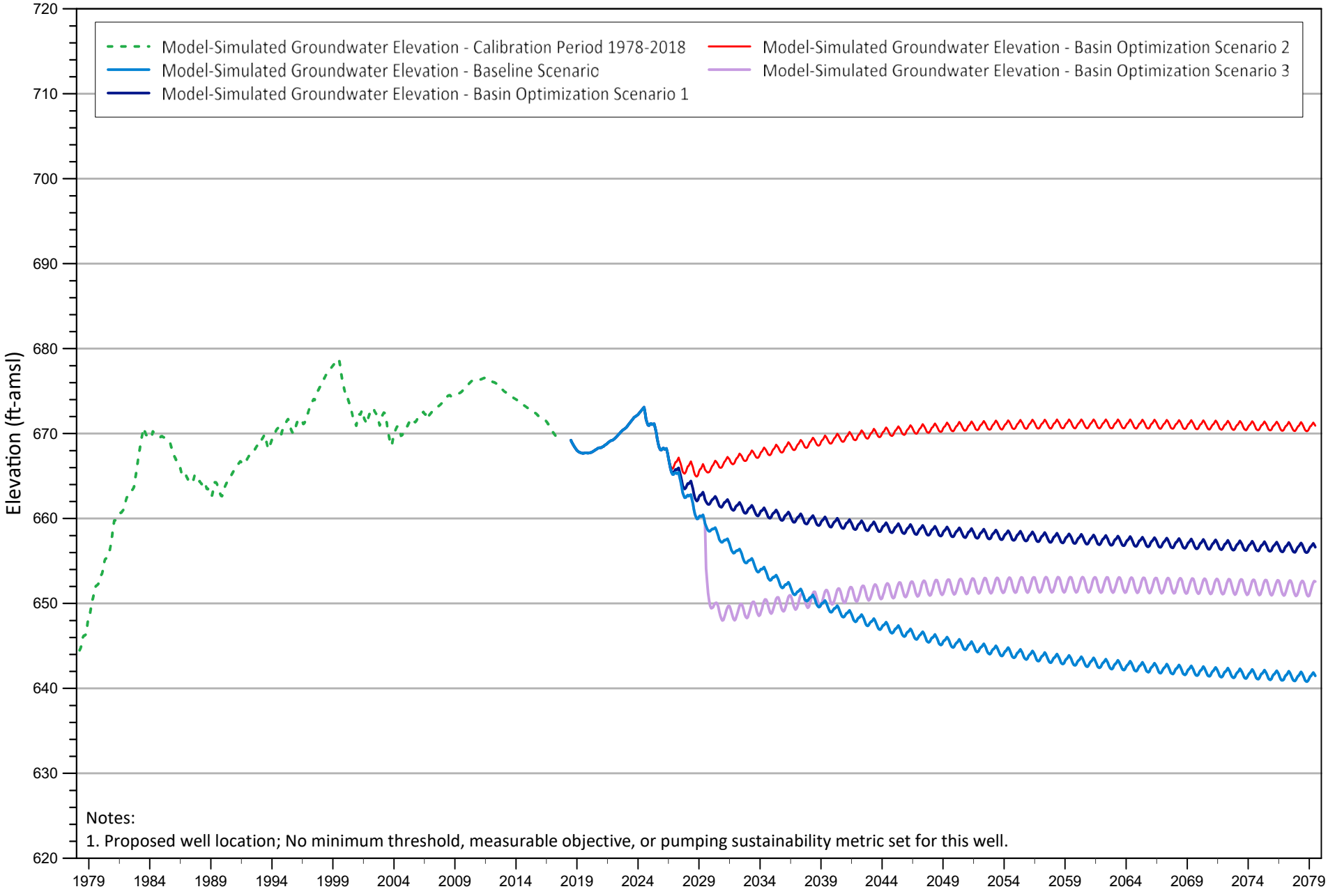


Figure 5-22j. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Production Well 5

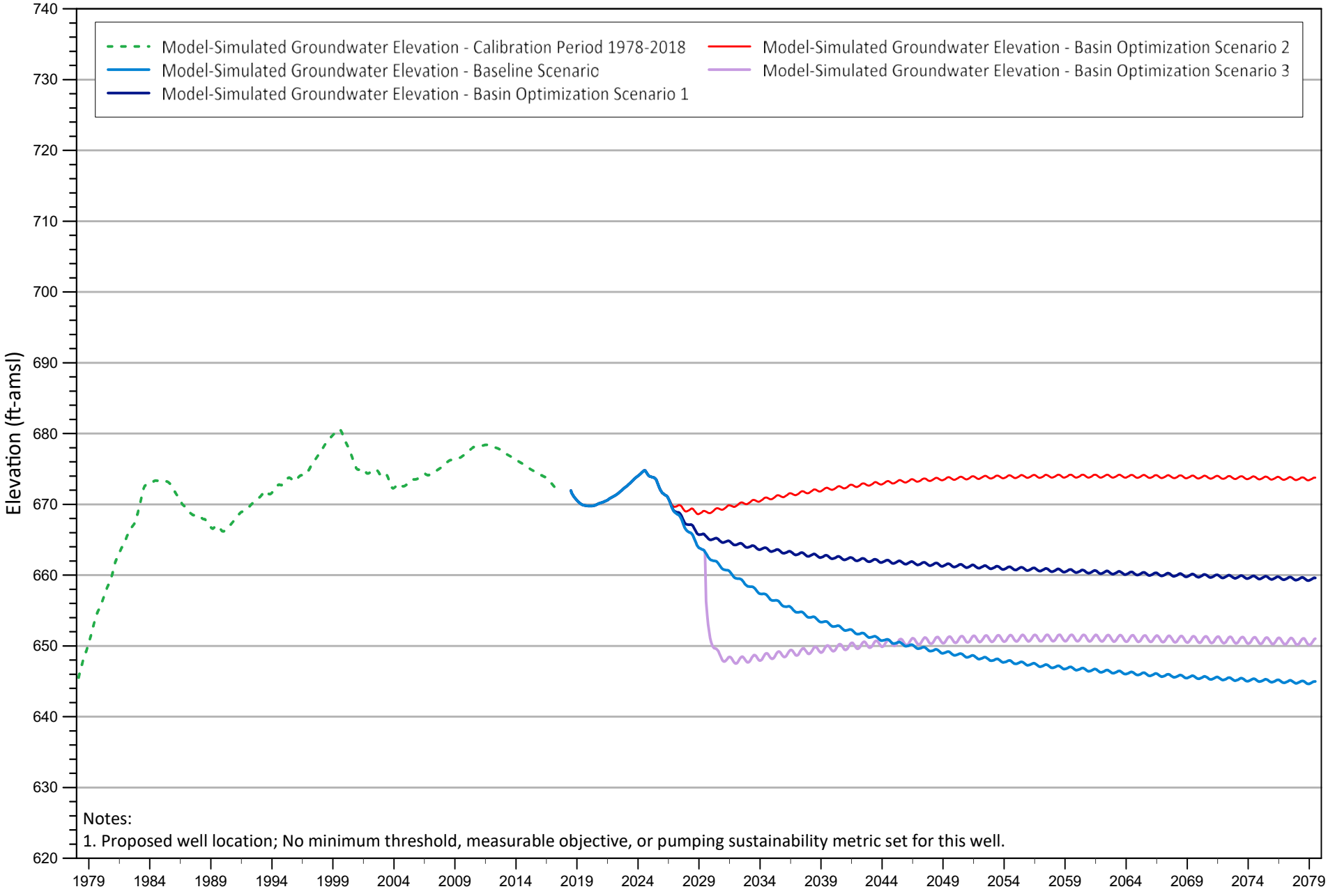
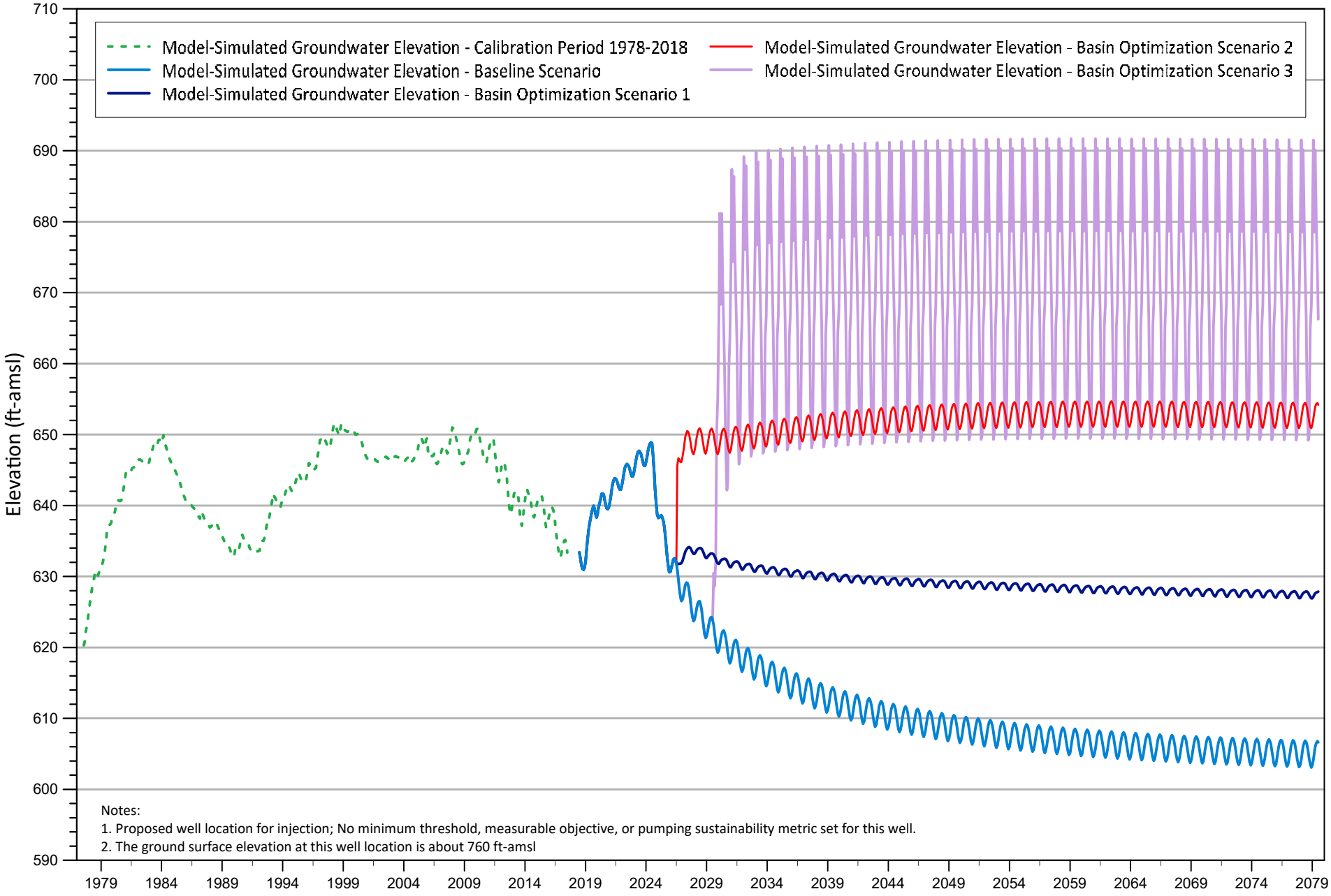


Figure 5-22k. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Injection Well 3



Figures 5-22a through 5-22k show that over the planning period, groundwater levels at all eleven wells are predicted to be higher for the three Basin Optimization Scenarios compared to the Baseline Scenario. The seasonal fluctuations of the predicted groundwater elevations are due to the seasonal availability of the recycled water for recharge—more is available for recharge during winter and spring months when recycled water demands are low compared to the summer and fall. The seasonal fluctuations of the predicted groundwater elevations are also due to seasonal pumping schedules for the wells in the basin. The range in the season fluctuations of groundwater elevations is greatest in the western portion of the Basin where most of the pumping occurs and is downgradient of the assumed artificial recharge facilities.

For the wells in the western portion of the Basin (CPP-1, P-28, CPP-2, CPP-3, CPP-4, Industry, Injection Well 3) the highest projected groundwater levels are for Basin Optimization Scenario 3 where artificial recharge is 3,500 afy. For the wells in the eastern portion of the Basin (P-19, New Production Well 4, New Production Well 5, and OMW-3) the highest projected groundwater levels are in Basin Optimization Scenario 2 where artificial recharge in the basin is 500 afy with no increase in the groundwater pumping in the central portion of the Basin. The lowest projected groundwater levels occur in the eastern portion of the basin in Basin Optimization Scenario 3 because pumping increases by 3,000 afy and this area is distant from the areas of artificial recharge.

Figure 5-22k shows the historical and projected groundwater elevations for one assumed injection well in Basin Optimization Scenarios 2 & 3. At this injection well, groundwater elevations are projected to be higher than the Baseline Scenario by about 50 ft for Scenario 2 and by about 85 ft for Scenario 3 by the end of the planning period. The ground-surface elevation at this assumed injection well is about 760 ft-amsl. The highest projected groundwater elevation at this well occurs in Scenario 3 at about 690 ft-amsl, which equates to a minimum depth-to-groundwater of about 70 ft-bgs during the peak periods of injection. Therefore, there is no projected threat of liquefaction hazards due to high groundwater, which would occur at depths to groundwater less than about 40 ft-bgs.

5.4.2 Sustainable Management Criteria

Figures 5-22a through 5-22k include the Minimum Thresholds and Measurable Objectives established as Sustainable Management Criteria for groundwater levels at representative monitoring wells throughout the Spada Basin when applicable. The Minimum Thresholds represent the groundwater level at a representative monitoring well that, when exceeded individually or in combination with Minimum Thresholds at other monitoring wells, may cause Undesirable Results in the basin. The avoidance of Undesirable Results is key to the success of a GSP and an indication of basin sustainability. The Measurable Objectives are quantitative goals for the maintenance or improvement of groundwater conditions to achieve or maintain sustainability in the basin. Maintaining groundwater levels within the operating band between the Measurable Objectives and Minimum Thresholds will avoid Undesirable Results and achieve and maintain basin sustainability. These Minimum Thresholds and Measurable Objectives are also used as a proxy to assess the Sustainability Indicators of groundwater storage and land subsidence.

The wells in Figure 5-22a through 5-22k where the Minimum Thresholds and Measurable Objectives have been established are: Industry, CPP-4, P-28, CPP-1, P-19, and OMW-3.[5] The wells in Figures 5-22a through 5-22k that do not have Minimum Thresholds and Measurable Objectives established are wells that are

[5] Well MW-5 has Minimum Thresholds and Measurable Objectives but was excluded from this analysis because the model-predicted groundwater elevations cannot be used as this is an area of uncertainty identified during calibration of the Spadra Basin Groundwater Model.

close to wells that have Sustainable Management Criteria established and it is not needed as a representative monitoring site, or they are theoretical well locations proposed for Basin Optimization Scenario 3.

Figures 5-22a through 5-22k show that groundwater elevations for all three Basin Optimization Scenarios remain above the Minimum Thresholds throughout the planning period after projects are implemented. This indicates that all three Basin Optimization Scenarios are sustainable relative to these Minimum Thresholds and will not cause an Undesirable Results for groundwater levels, and by proxy groundwater storage and land subsidence. In comparison, the Baseline Scenario is not a sustainable option because groundwater elevations are predicted to decline to levels below the Minimum Thresholds at some of the wells.

At well CPP-4 the seasonal low groundwater elevation is slightly below the Minimum Threshold; this is not considered to be an exceedance of the Minimum Threshold and an Undesirable Result because the evaluation criteria established in *Section 3 Sustainable Management Criteria* is that static groundwater elevations must remain below a Minimum Threshold for an entire year to constitute an Undesirable Result. If a Minimum Threshold for the theoretical well locations for the New Pumping Wells 4 and 5 were set based on the lowest historical groundwater elevation at these locations, the groundwater elevations projected for all three Basin Optimization Scenarios remain above these elevations.

At wells Industry, CPP-4, and P-28, the predicted groundwater elevations for Basin Optimization Scenario 3 temporarily decline below the Minimum Thresholds between 2028 and 2031. This is because the artificial recharge projects to support groundwater levels in Scenario 3 are not implemented until 2030, and increased pumping is assumed to start in 2030 simultaneously with the artificial recharge. If Basin Optimization Scenario 3 is implemented, the startup timing of artificial recharge and new pumping may need to be adjusted to avoid these projected declines of groundwater levels below the Minimum Thresholds.

5.4.3 Pumping Sustainability

The time-series charts in Figures 5-22a through 5-22k include a pumping sustainability metric for the active pumping wells. The pumping sustainability metric is the lowest water-level elevation that enables the well owner to pump groundwater at a desired pumping rate, given the well construction and pumping equipment. Groundwater pumping at a well is presumed to be sustainable if the water level at that well remains above the pumping sustainability metric. Information on the pumping sustainability metric was provided by the well owners for each well. The active pumping wells where these pumping sustainability metrics have been established include: Industry, CPP-4, CPP-2, P-28, CPP-1, and P-19. The pumping sustainability metric for one active well (CPP-3) is undetermined at this time.

Figures 5-22a through 5-22k show that groundwater levels in all three Basin Optimization Scenarios remain above the pumping sustainability metric throughout the planning period after the projects are implemented. This indicates that all three Basin Optimization Scenarios are sustainable relative to the pumping sustainability metrics and improve upon the Baseline Scenario where groundwater levels decline below the pumping sustainability metrics at some wells.

Well No. CPP-4 (Figure 5-22b) in Scenario 3 is an exception where the seasonal low groundwater level declines below the pumping sustainability metric between 2028 and 2031. This is because the artificial recharge projects to support groundwater levels in Scenario 3 are not implemented until 2030, and increased pumping is assumed to start in 2030 simultaneously with the artificial recharge. If Basin Optimization Scenario 3 is implemented, the startup timing of artificial recharge and new pumping may

need to be adjusted to avoid these projected declines of groundwater levels below the pumping sustainability metric.

5.4.4 Change in Storage

Tables 5-6a, 5-6b, 5-6c are water-budget tables for the Spadra Basin that show the model-estimated storage changes that are expected to occur under the three Basin Optimization Scenarios. Figure 5-23 is a time-series chart that shows the cumulative storage change for the three Basin Optimization Scenarios compared against the Baseline Scenario. This chart shows that the storage changes in all three Basin Optimization Scenarios over the planning period are less than in the Baseline Scenario. The increases in storage in Basin Optimization Scenarios 1, 2, and 3 coincide with the implementation of the proposed projects in each scenario in 2027, 2027, and 2030, respectively. Storage is the greatest in Basin Optimization Scenario 2 where storage remains relatively stable over the planning period. At the end of the planning period, the net storage change for Basin Optimization Scenario 1, 2, and 3 is -2,516 af, +3 af, and -1,201 af, respectively.

The Minimum Thresholds for groundwater levels are used as a proxy for groundwater storage. Groundwater levels for the three Basin Optimization Scenarios are predicted to remain above the Minimum Thresholds at the representative monitoring wells over the planning period (see *Section 3 Sustainable Management Criteria*), and hence, this indicates that all three Basin Optimization Scenarios are sustainable for groundwater storage. In comparison, the Baseline Scenario is not a sustainable option because the groundwater elevations are predicted to decline below the Minimum Thresholds at some of the wells.

5.4.5 Subsurface Outflow to the Chino Basin

Tables 5-6a, 5-6b, 5-6c show the model-estimated annual subsurface outflow to the Chino Basin as a discharge component in the water budget for the three Basin Optimization Scenarios. Figure 5-24 is a time-series chart that compares the subsurface outflow to the Chino Basin for the three Basin Optimization Scenarios to the Baseline Scenario. Subsurface outflow to Chino Basin for all three Basin Optimization Scenarios is greater than in the Baseline Scenario, with Scenario 2 resulting in the greatest outflow. In all scenarios, the outflow to Chino Basin is relatively stable over the planning period and the differences between the scenarios is relatively small (typically, less than 60 afy). As described in *Section 2.2.7 Data Gaps*, the groundwater model simulates this boundary area with Chino Basin as having very low hydraulic conductivity with highest model uncertainty. The low hydraulic conductivity in this area of the model domain appears to govern the subsurface outflow to Chino Basin, keeping it relatively constant even as storage changes occur within the Spadra Basin.

Figure 5-23. Cumulative Change in Storage for the Baseline and Basin Optimization Scenarios

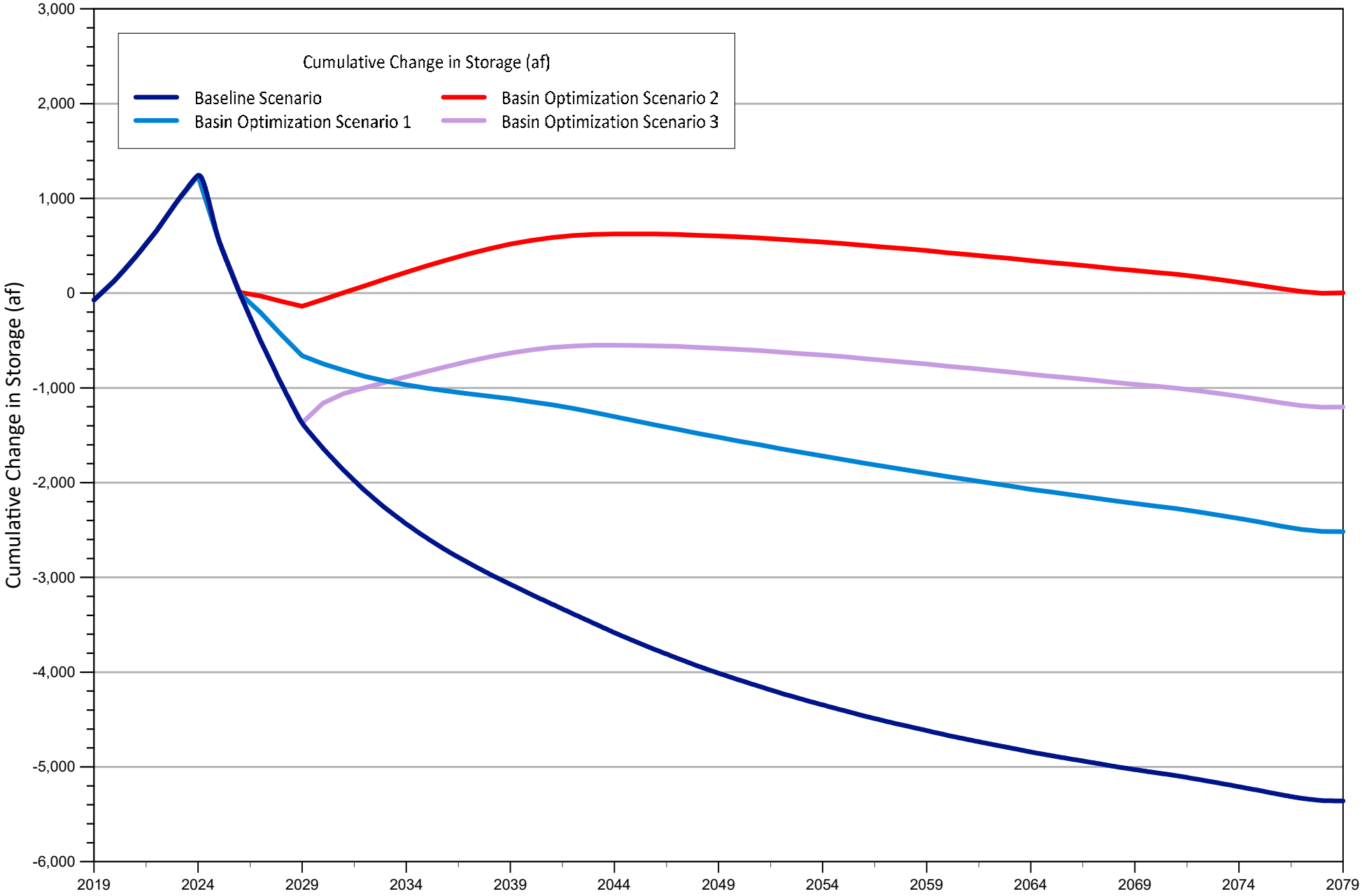
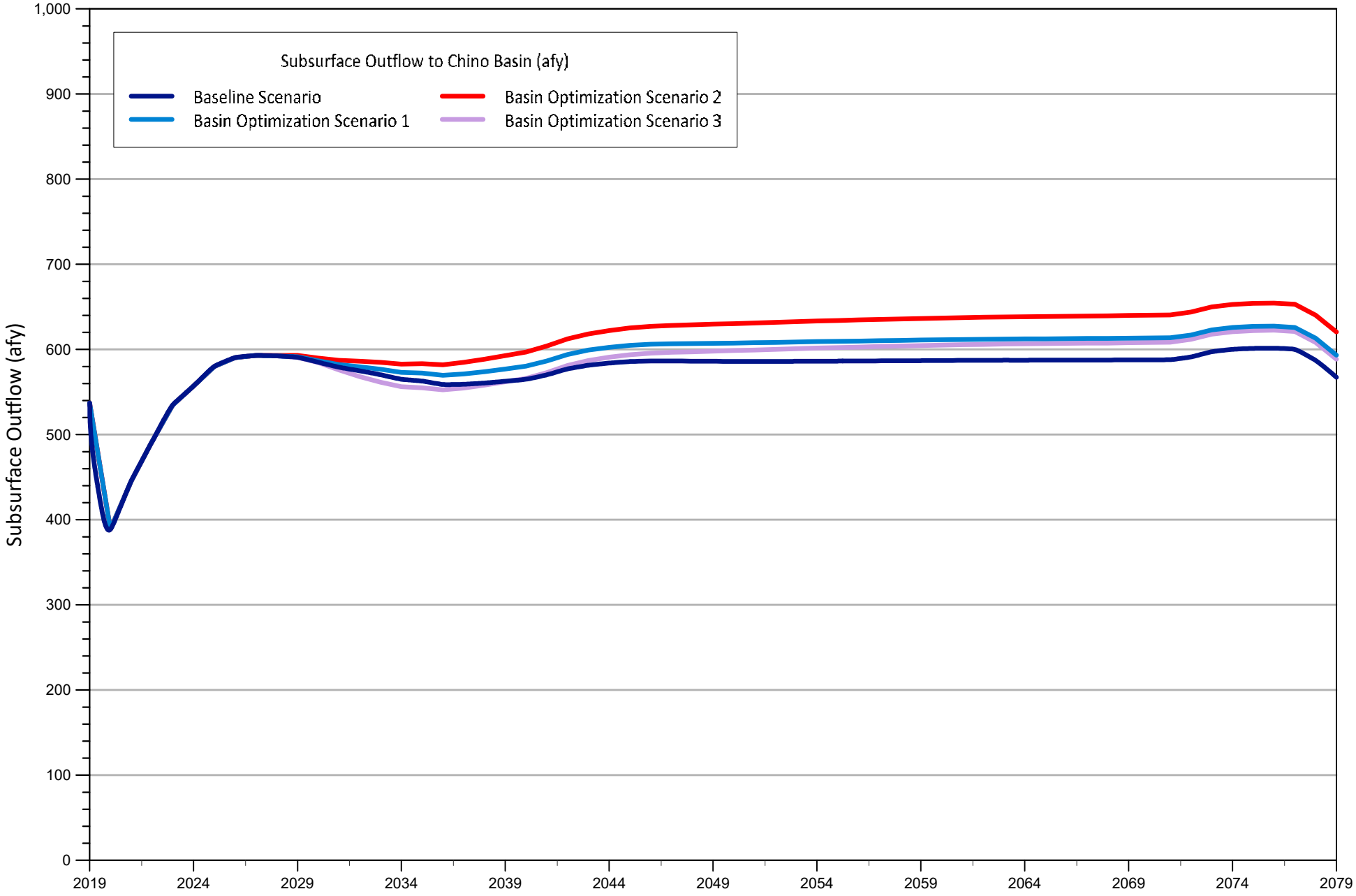


Figure 5-24. Subsurface Outflow to Chino Basin for the Baseline and Basin Optimization Scenarios



5.4.6 Subsurface Outflow to the Puente Basin

Tables 5-6a, 5-6b, 5-6c show the model-estimated annual subsurface outflow to the Puente Basin as a discharge component in the water budget for the three Basin Optimization Scenarios. Figure 5-25 is a time-series chart that compares the subsurface outflow to the Puente Basin for the three Basin Optimization Scenarios to the Baseline Scenario. Subsurface outflow to the Puente Basin for all three Basin Optimization Scenarios is greater than in the Baseline Scenario, with Scenario 3 resulting in the greatest outflow. The increase in the subsurface outflow to Puente Basin for Basin Optimization Scenarios 1, 2, and 3 occurs after implementation of the proposed projects that support groundwater levels. In all scenarios, the outflow to Puente Basin is relatively stable over the planning period after about 2035 and the differences between the scenarios is relatively small (typically, less than 70 afy). By the end of the planning period, subsurface outflow to the Puente Basin in the three Basin Optimization Scenarios is about 400 to 500 afy greater than in the Baseline Scenario.

5.4.7 Sustainable Yield

The term Sustainable Yield is central to SGMA and is defined as the maximum quantity of water that can be withdrawn annually from a groundwater supply without causing Undesirable Results. The model-simulated groundwater elevations at the individual wells analyzed in Section 5.4.1.2 above indicate that for all three Basin Optimization Scenarios groundwater elevations remaining above the Minimum Thresholds over the planning period. Thus, there are no Undesirable Results anticipated for Basin Optimization Scenarios 1, 2, and 3, and the long-term pumping volume associated with each Basin Optimization Scenario (after project startup) is the Sustainable Yield for that scenario. Figure 5-26 is a chart that shows the annual pumping for the three Basin Optimization Scenarios. The chart shows that the Sustainable Yields for Basin Optimization Scenario 1, 2, and 3 are: 1,376 afy, 1,806 afy, and 4,806 afy, respectively.

5.5 COST ANALYSES OF THE BASELINE AND BASIN OPTIMIZATION SCENARIOS

Cost models were developed of the water supply for the Baseline Scenario and the three Basin Optimization Scenarios. The cost model of the Baseline Scenario is used for comparison to the cost models of the three Basin Optimization Scenarios to assist the GSA with selecting projects or a Basin Optimization Scenario for implementation in the GSP implementation plan. However, the Baseline Scenario cannot be directly compared to the Basin Optimization Scenarios because the Baseline Scenario does not have the benefits of basin sustainability like all three Basin Optimization Scenarios.

Figure 5-25. Subsurface Outflow to Puente Basin for the Baseline and Basin Optimization Scenarios

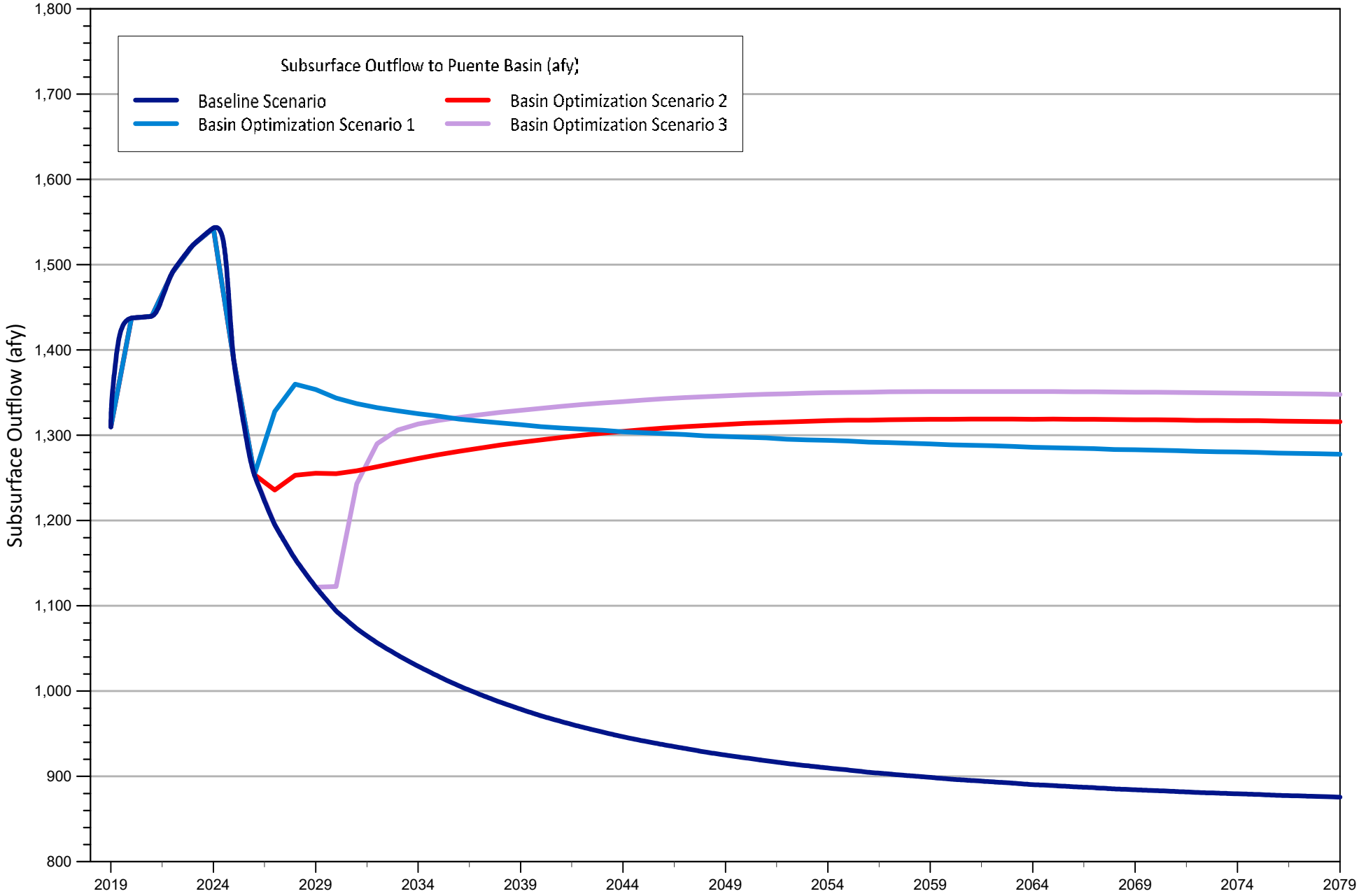
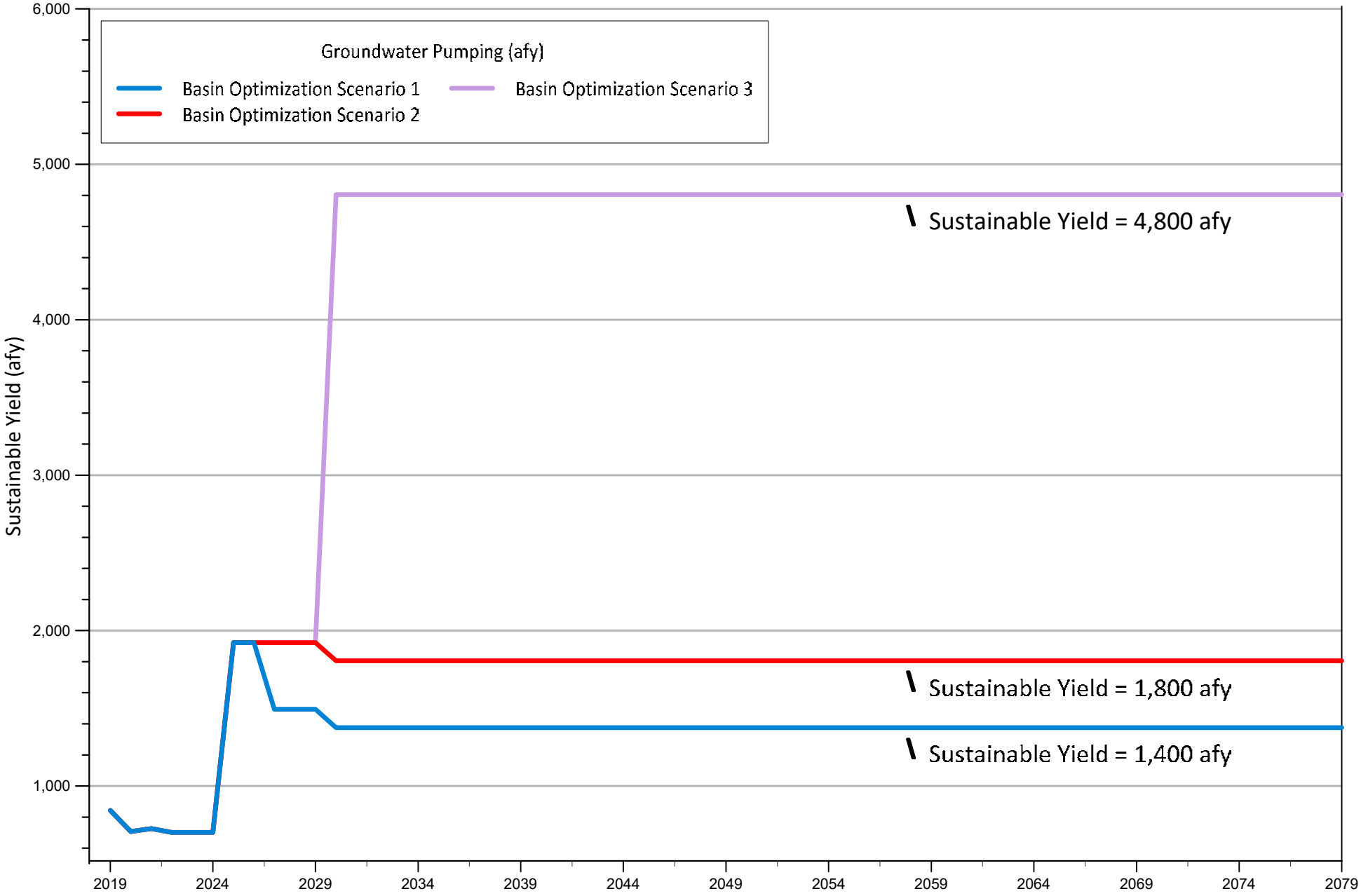


Figure 5-26. Sustainable Yield for the Basin Optimization Scenarios



5.5.1 Water Supply Cost for Baseline Scenario

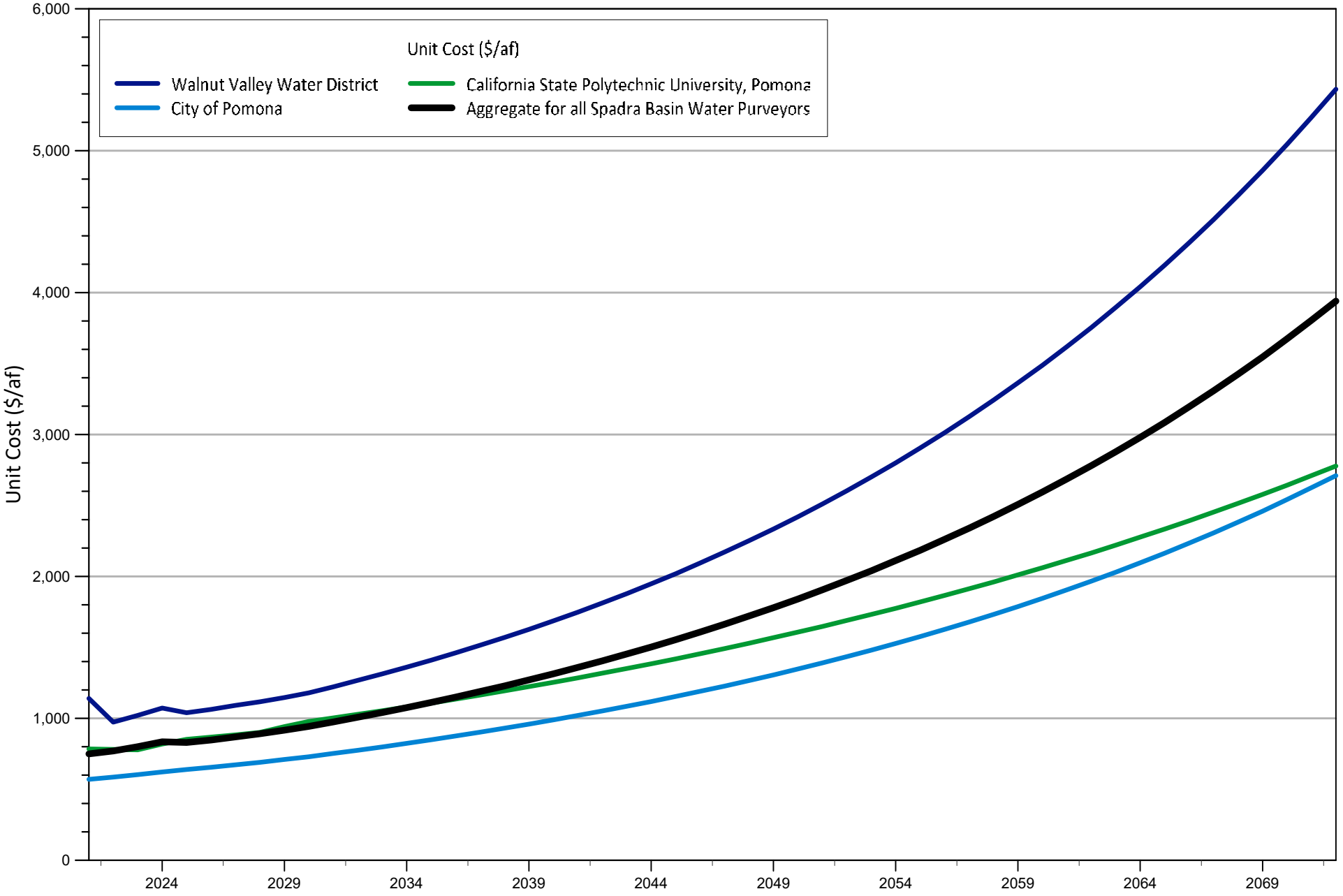
A cost model for the Baseline Scenario was developed for the water-supply plans of the individual water purveyors in the Spadra Basin and in aggregate. The cost model for the Baseline Scenario is shown in multiple steps as listed below and tables in Appendix K:

- Appendix K Tables K-1a, K-1b, and K-1c include a breakdown of the water-supply plan for the Baseline Scenario into annual estimates for the period 2021-2072 for each water purveyor and total aggregate of all water purveyors.
- Appendix K Tables K-2a, K-2b, and K-2c include a breakdown of the annual unit costs for each of the water purveyors' water supplies for the period of 2021-2072, and the melded cost for all water supplies for each water purveyor. Each water purveyor provided the unit costs for 2021. Each water purveyor provided data and information in different formats and level of detail. The unit costs were grouped into the following categories:
  - **Commodity Costs** are the cost of acquiring the water supply. For example, the commodity costs for Six Basins and Chino Basin groundwater are the Watermaster assessments in those basins.
  - **Production Costs** are the energy costs associated with producing the water supply.
  - **Operations and Maintenance** *(O&M) costs* are the variable costs for field staff, contract services, tools and equipment, training and supplies, repairs and general maintenance, and the regulatory compliance associated with producing the water supply. This excludes maintenance on reservoirs or pipelines and the variable O&M costs associated with treatment.
  - **Treatment Costs** include the costs for chemicals and other variable O&M associated with the treatment necessary to produce potable water.
- Appendix K Table K-3 includes a breakdown of annual water-supply plan as a total aggregate of all water purveyors in the Spadra Basin for the Baseline Scenario.
- Appendix K Table K-4 includes a breakdown of the melded unit cost for all water supplies as a total aggregate for all water purveyors in the Spadra Basin for the Baseline Scenario.

All unit costs, except for the imported water, were assumed to increase by 2.5 percent per year. The unit cost of Tier 1 treated imported water from the TVMWD was obtained from the TVMWD for the cost through 2030, then assumed to increase 4.0 percent annually thereafter based on average rate of inflation from 2003 to 2021 of Tier 1 water.

Figure 5-27 displays the melded unit cost of each water purveyors' water-supply plan for the Baseline Scenario (breakdown shown in Appendix K Tables K-2a, K-2b, and K-2c) along with the melded unit cost for the water purveyors in aggregate (breakdown shown in Appendix K Table K-3b). The melded unit cost of the water purveyors' water-supply plans increases over time, and the rate of increase for each water purveyor is dependent on its mix of water sources. The aggregate melded unit cost of water for the Spadra Basin water purveyors for the Baseline Scenario increases from $751 af in 2021 to $3,941 in 2072.

Figure 5-27. Melded Unit Cost of Water Supply for the Spadra Basin Water Purveyors for the Baseline Scenario



5.5.2 Water Supply Cost for Basin Optimization Scenarios

Cost models for the three Basin Optimization Scenarios were developed for the water-supply of the water purveyors in the Spadra Basin in aggregate. The cost model for the Basin Optimization Scenarios includes the conceptual engineering cost estimates for the implementation of the projects in the Basin Optimization Scenarios, and water supply plans and unit costs for water for the Spadra Basin water purveyors in aggregate. The cost model for the Basin Optimization Scenarios 1, 2, and 3 is shown in multiple steps and tables in Appendix L:

- Appendix L Table L-1 lists planning criteria for the unit cost of equipment and materials and other assumptions that were used to estimate the cost for implementing the projects for the three Basin Optimization Scenarios.
- Appendix L Tables L-2a, L-2b, and L-2c include high-level conceptual engineering cost estimates for the projects envisioned for Basin Optimization Scenarios 1, 2, and 3. Feasibility-level design and operating schemes for each new project were cost estimated based on the unit cost and assumptions in Table L-1. The estimates include costs for construction (including engineering, management, and administrative), operations and maintenance, and loans to pay for these capital improvements (assumed 30 years).
- Appendix L Tables L-3a, L-3b, and L-3c include a breakdown of annual water-supply plan as a total aggregate of all water purveyors in the Spadra Basin for the Basin Optimization Scenarios 1, 2, and 3.
- Appendix L Tables L-4a, L-4b, and L-4c include a breakdown of the annual melded unit cost for all water supplies as a total aggregate of all water purveyors in the Spadra Basin for the Basin Optimization Scenarios 1, 2, and 3.

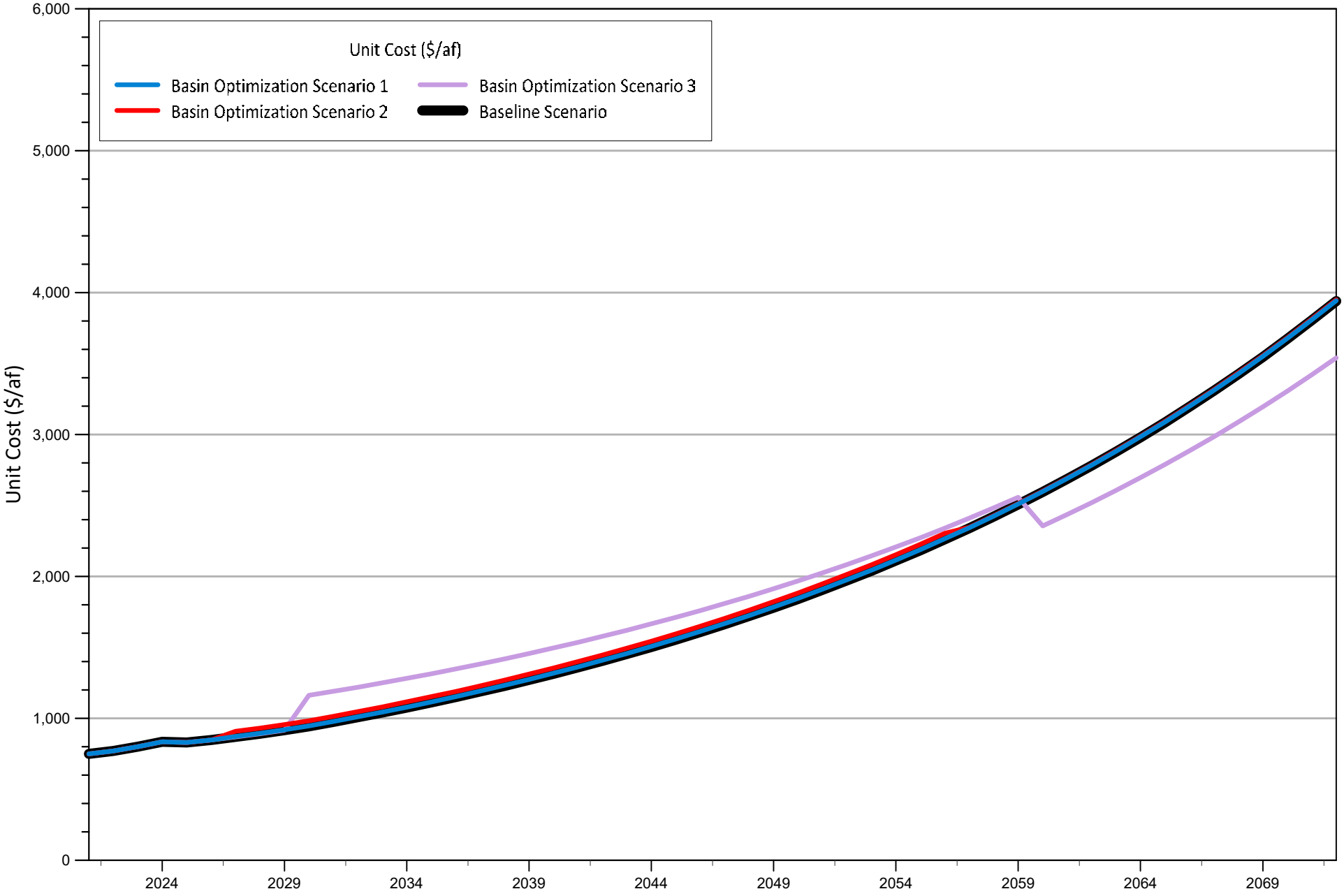
Like the Baseline Scenario, all unit costs, except for the imported water, were assumed to increase by 2.5 percent per year. The unit cost of Tier 1 treated imported water from the TVMWD was obtained from the TVMWD for the cost through 2030, then assumed to increase 4.0 percent annually thereafter based on average rate of inflation from 2003 to 2021 of Tier 1 water.

Figure 5-28 is a time-series chart that displays the annual melded unit cost of water for all Spadra Basin water purveyors in aggregate for the Basin Optimization Scenarios 1, 2, and 3 (breakdown shown in Appendix L Tables L-4a, L-4b, and L-4c) plotted with the annual melded unit cost of water for all Spadra Basin water purveyors in aggregate for the Baseline Scenario (breakdown shown in Appendix K, Table K-3b). Table 5-7 summarizes these annual aggregate melded unit costs of water for the Baseline Scenario and Basin Optimization Scenarios 1, 2, and 3.

Table 5-7. Aggregate Melded Unit Costs of Water Supply for the Baseline and Basin Optimization Scenarios

Year	Total Annual Cost				
	Baseline	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b
2021	$751	$751	$751	$751	$751
2022	$771	$771	$771	$771	$771
2023	$801	$801	$801	$801	$801
2024	$835	$835	$835	$835	$835
2025	$830	$830	$830	$830	$830
2026	$848	$848	$848	$848	$848
2027	$870	$873	$909	$870	$870
2028	$892	$895	$931	$892	$892
2029	$917	$920	$956	$917	$917
2030	$944	$947	$983	$1,163	$1,160
2031	$975	$979	$1,015	$1,191	$1,188
2032	$1,008	$1,011	$1,048	$1,220	$1,217
2033	$1,042	$1,045	$1,082	$1,251	$1,248
2034	$1,077	$1,080	$1,117	$1,282	$1,279
2035	$1,113	$1,116	$1,153	$1,315	$1,312
2036	$1,150	$1,154	$1,190	$1,349	$1,346
2037	$1,189	$1,193	$1,230	$1,384	$1,381
2038	$1,230	$1,233	$1,270	$1,420	$1,417
2039	$1,271	$1,275	$1,312	$1,458	$1,455
2040	$1,315	$1,318	$1,355	$1,497	$1,494
2041	$1,359	$1,363	$1,400	$1,537	$1,534
2042	$1,406	$1,410	$1,447	$1,578	$1,575
2043	$1,454	$1,458	$1,495	$1,622	$1,619
2044	$1,504	$1,507	$1,545	$1,666	$1,663
2045	$1,555	$1,559	$1,596	$1,712	$1,709
2046	$1,609	$1,613	$1,650	$1,760	$1,757
2047	$1,664	$1,668	$1,705	$1,810	$1,807
2048	$1,721	$1,725	$1,763	$1,861	$1,858
2049	$1,781	$1,785	$1,822	$1,914	$1,911
2050	$1,842	$1,847	$1,884	$1,969	$1,966
2051	$1,906	$1,910	$1,948	$2,025	$2,022
2052	$1,972	$1,977	$2,014	$2,084	$2,081
2053	$2,041	$2,045	$2,083	$2,145	$2,142
2054	$2,112	$2,116	$2,154	$2,208	$2,205
2055	$2,185	$2,190	$2,228	$2,274	$2,270
2056	$2,262	$2,266	$2,304	$2,341	$2,338
2057	$2,341	$2,344	$2,347	$2,411	$2,408
2058	$2,423	$2,425	$2,429	$2,484	$2,481
2059	$2,507	$2,510	$2,515	$2,559	$2,556
2060	$2,595	$2,599	$2,603	$2,357	$2,357
2061	$2,687	$2,690	$2,694	$2,438	$2,437
2062	$2,781	$2,784	$2,789	$2,521	$2,521
2063	$2,879	$2,883	$2,887	$2,607	$2,607
2064	$2,981	$2,984	$2,989	$2,697	$2,697
2065	$3,086	$3,090	$3,094	$2,790	$2,790
2066	$3,195	$3,199	$3,204	$2,886	$2,886
2067	$3,309	$3,312	$3,317	$2,986	$2,985
2068	$3,426	$3,430	$3,435	$3,089	$3,088
2069	$3,548	$3,552	$3,557	$3,196	$3,195
2070	$3,674	$3,678	$3,683	$3,307	$3,306
2071	$3,805	$3,809	$3,814	$3,421	$3,421
2072	$3,941	$3,945	$3,950	$3,540	$3,540

Figure 5-28. Aggregate Melded Unit Cost of Water Supply for the Baseline and Basin Optimization Scenarios



The aggregate melded unit cost of water for the Baseline Scenario is plotted and shown in Figure 5-28 and Table 5-7 with the aggregate melded unit cost of water for the three Basin Optimization Scenarios for comparison. However, as described above, the Baseline Scenario cannot be directly compared to the Basin Optimization Scenarios because the Baseline Scenario does not have the benefits of basin sustainability like all three Basin Optimization Scenarios.

The aggregate melded unit cost of water for Basin Optimization Scenarios 1 and 2 are slightly more expensive than the aggregate melded unit cost of water for the Baseline Scenario. This is because the Spadra Basin is a relatively small portion of the total water supply, and these scenarios include only a few capital projects.

The aggregate melded unit cost of water for Basin Optimization Scenario 3 averages about $150/af more than the aggregate melded unit cost of water for the Baseline Scenario and Basin Optimization Scenarios 1 and 2 from 2030-2059, and then declines to about $400/af less than these other scenarios after the loans for capital improvements are paid off. Basin Optimization Scenario 3 is less expensive in the long run because of the investment in facilities that produce a local, more reliable, and less expensive water supply as an alternative to the imported water.

5.6 CONCLUSIONS AND RECOMMENDATIONS

Table 5-8 summarizes the evaluation of the three Basin Optimization Scenarios compared to the Baseline Scenario.

The Baseline Scenario is not projected to be sustainable with respect to the Sustainable Management Criteria established in *Section 3 Sustainable Management Criteria.* The GSP implementation plan should include plans to implement projects and management actions to support groundwater levels, avoid Undesirable Results, and maintain the sustainability of the Spadra Basin.

The three Basin Optimization Scenarios described and evaluated herein are hydrologically feasible and sustainable based on the model-estimated response of the Spadra Basin. Compared to the Baseline Scenario, all three Basin Optimization Scenarios are expected to result in: (i) higher groundwater levels that do not decline below Minimum Thresholds or pumping sustainability metrics; (ii) no significant and unreasonable land subsidence or reductions of groundwater storage; (iii) higher Sustainable Yields; and (iv) no reductions in subsurface outflow to the neighboring groundwater basins. In other words, the Basin Optimization Scenarios are sustainable and will avoid the occurrence of Undesirable Results.

Basin Optimization Scenario 3 is the recommended scenario for GSP implementation. It produces the highest Sustainable Yield of the Spadra Basin by recharging surplus recycled water from the Pomona WRP and increasing groundwater production by similar volumes. Through groundwater treatment, it increases local, reliable, potable water supplies as an alternative to the use of less reliable imported waters (which are expected to experience higher inflation rates than the local water supplies).

Scenario 3 will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). The permitting process and the development of an SNMP are both extensive efforts that will require multiple years to complete. These efforts will be completed during Phase 4 of the planning process necessary for the implementation of these projects that is described in the GSP in *Section 6 Implementation Plan.* Additionally, the costs and

schedule for permitting and development of an SNMP are considered in the cost and schedules presented in the GSP in Sections 6.2 and 6.1.

Basin Optimization Scenario 3 is the most expensive scenario through 2059 but is the least expensive scenario thereafter when the assumed loans to fund the capital improvements are paid off. Sections 6.1.1 and 6.3 include potential grant funding opportunities to reduce the cost of implementing Basin Optimization Scenario 3.

In Basin Optimization Scenario 3, groundwater levels are projected to decline in the eastern portion of the basin because of increased pumping. This is an area of highest uncertainty in the Spadra Basin Groundwater Model (see *Section 2.2.7 Data Gaps*), and hence, an area that should be monitored in the future for changes in groundwater levels and potential adverse impacts to the neighboring Chino Basin, such as reduced subsurface outflow. The Spadra Basin GSA is in the process of constructing a new monitoring well within the eastern portion of the basin near the Spadra/Chino Basin boundary. The data collected from the new monitoring well, and additional monitoring data collected in the eastern portion of the basin, will be used to detect potential adverse impacts and Undesirable Results, and also can be used to update and improve the groundwater model in the future.

Table 5-8. Summary of the Evaluation of Basin Optimization Scenarios Compared to the Baseline Scenario

		Baseline	Scenario 1	Scenario 2	Scenario 3
Project Description	Objective	n/a	Basin Sustainability	Basin Sustainability	Basin Sustainability and Maximum Beneficial Use
	Increase in Artificial Recharge from Baseline	n/a	0 afy	500 afy	3,500 afy
	Change in Pumping from Baseline	n/a	- 430 afy	0 afy	2,994 afy
	New Facilities	none	● Additional recycled water pipeline and connections	● Underground recharge gallery and pipeline ●Injection well and pipeline	● Underground recharge gallery and pipeline ● Seven injection wells and pipeline ● Five production wells and pipeline ● Expansion of CPP RO Plant and pipeline
Project Evaluation	Do groundwater levels decline below Minimum Thresholds?	Yes	No	No	No
	Do groundwater levels decline below pumping sustainability metrics?	Yes	No	No	No
	Subsurface Outflow to the Chino Basin	567 afy	593 afy	621 afy	589 afy
	Subsurface Outflow to the Puente Basin	876 afy	1,278 afy	1,316 afy	1,348 afy
	Sustainable Yield	n/a	1,376 afy	1,806 afy	4,806 afy
	Aggregate melded unit cost of water supply in 2072 ($/af)	$3,941	$3,945	$3,950	$3,540
	Benefits Other Than Sustainability	n/a	● Partial utilization of surplus recycled water	● Partial utilization of surplus recycled water	● Utilization of all surplus recycled water ● Increasing the reliability of potable water supplies

SECTION 6
Plan Implementation

6.1 GSP IMPLEMENTION

The implementation of the GSP for the Spadra Basin includes five main categories: administration and legal support, monitoring, annual reporting, five-year evaluation reporting, and planning and implementation of projects and management actions.

6.1.1 Administrative and Legal Services

The GSA will perform all the administrative activities and legal services to implement the GSP. These include:

- ***GSA Administration and Operations.*** Includes administrative staff support, finance staff support and related expenses.
- ***Coordination and Management of GSP***. Includes all coordination and management for continuation of Stakeholder outreach and conducting Advisory Committee meetings; conducting Executive Committee meetings; tracking and prioritizing grant funding and completing grant applications; coordination with technical consultants on monitoring and reporting; review of annual reports and other work products; and ad-hoc tasks to support GSP implementation.
- ***Legal Services***. Any legal services needed for: reviewing reports and other work products; preparing for and attending Executive Committee and Advisory Committee meetings; drafting agreements and documents as needed for the GSA; and ad-hoc legal needs for administrating and implementing the GSP.

6.1.2 Monitoring

The GSA will conduct the monitoring program for the Spadra Basin GSP described in *Section 4 Monitoring Program.* The monitoring program includes either direct monitoring by the GSA and/or collection of data in the basin for groundwater (levels, quality, and production), surface water, and land subsidence. All data from the monitoring program is reviewed for QA/QC to ensure data validity and uploaded to the data management system. The monitoring program also includes periodic efforts to fill the data gaps described in Section 4.3

6.1.3 Annual Reporting

Annual reports are required to be submitted to the DWR by April 1 of every year following the adoption of the GSP. Requirements include the preparation and submittal of an annual report and electronic data deliverables. The first annual report for the Spadra Basin GSP will be completed and submitted by April 1, 2023 for the reporting period of water year 2021-2022 (October 2021-September 2022). Pursuant to 23 CCR § 356.2 of the GSP Regulations, the annual report will include the following:

- General information, including an executive summary and a location map depicting the area covered by the report.
- Groundwater elevation data from wells in the monitoring network, including:
  - Groundwater elevation contour maps illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

  - Hydrographs of groundwater elevations for a historical period through the current reporting year.
- Groundwater extraction, including:
  - A table that summarizes groundwater extractions by water use sector and identifies the method of measurement (direct or estimate) and accuracy of measurements.
  - Map that illustrates the location and volume of groundwater extractions.
- Annual volume of surface water supply used, or available for use, for groundwater recharge or in-lieu use.
- Annual volumes of total water use in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements.
- Annual change in groundwater in storage, including:
  - Change in groundwater in storage maps
  - Graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for a historical period through the current reporting year
- A description of progress towards implementing the GSP, including achieving Interim Milestones, and implementation of projects or management actions since the previous annual report.

Data collected and maintained from the monitoring program (see Section 4 Monitoring Program) along with water use data collected annually from the Spadra Basin water purveyors, will be used to perform the required analyses and prepare the annual report. The groundwater elevation hydrographs required in item 2 above will include a comparison to Minimum Thresholds, Measurable Objectives, and Interim Milestones at the representative monitoring sites. This analysis will be an annual check in, between the five-year evaluations described below, on current groundwater conditions and the potential for exceedance of Minimum Thresholds and occurrence of Undesirable Results.

The annual report will be submitted to the DWR's GSP Reporting System on the SGMA Portal by April 1 of each year, along with the required electronic data submittals for corresponding water year. The electronic data will be submitted using standardized Excel templates provided by the DWR to submit the following required data for the water year: groundwater extractions, groundwater extraction methods, surface water supply, total water use, change in storage, and monitoring network wells and groundwater elevation measurements.

6.1.4 Five-Year Evaluation Reporting

Periodic written assessments of the GSP are required to be submitted to the DWR at least once every five years. The five-year assessments shall describe whether the implementation of the GSP, including the implementation of projects and management actions, are meeting the Sustainability Goal. The first five-year assessment for the Spadra Basin GSP will occur in 2027. Pursuant to 23 CCR § 356.4 of the GSP Regulations, the five-year assessments will include the following information:

- A description of current groundwater conditions for each applicable Sustainability Indicator relative to Measurable Objectives, Interim Milestones, and Minimum Thresholds.
- A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

- Elements of the GSP, including the Basin Setting, the identification of Undesirable Results, and the setting of Minimum Thresholds and Measurable Objectives, shall be reconsidered and revisions proposed, if determined necessary.
- An evaluation of the Basin Setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the GSA's evaluation shows that the basin is experiencing overdraft conditions, the GSA shall include an assessment of measures to mitigate the overdraft.
- A description of the monitoring network within the basin, including whether data gaps exist, or if there are areas within the basin represented by data that does not satisfy requirements in the GSP Regulations (23 CCR § 352.4 and 23 CCR § 354.34[c]). This shall include:
  - An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of 23 CCR § 354.38.
  - If the GSA identifies data gaps, the GSP will be updated with a program for the acquisition of additional data sources, and the incorporation of new information into the GSP.
  - If the GSA identifies new data collection facilities are needed, the installation and analysis of new facilities will be prioritized.
- A description of significant new information that has been made available since the adoption or amendment of the GSP, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the GSP, including the evaluation of the Basin Setting, Measurable Objectives, Minimum Thresholds, or the criteria defining Undesirable Results.
- A description of any relevant actions taken by the GSA, including any regulations or ordinances related to the GSP.
- Information describing any enforcement or legal actions taken by the GSA in furtherance of the Sustainability Goal for the Basin.
- A description of any completed or proposed GSP amendments, if applicable.
- Where appropriate, a summary of coordination that occurred between multiple agencies in the Basin, agencies in hydrologically connected basins, and land use agencies.
- Other information the GSA deems appropriate, along with any information required by the DWR to conduct a periodic review as required by Water Code § 10733.

The GSA will perform these periodic evaluations of the GSP every-five years in accordance 23 CCR § 356.4 unless new information or analyses warrant an interim evaluation to address conditions such as the exceedance of Minimum Thresholds.

As described in the Section 3.4 Sustainability Goal, the GSA will use new hydrological data and information obtained through the monitoring program for periodic updates and recalibration of the Spadra Basin groundwater-flow model (minimum of every ten years) and use it to evaluate sustainability of current and future conditions for the Spadra Basin GSP implementation. These periodic model updates should coincide with the five-year evaluations to support the various components required in the evaluation. The modeling results can inform if updates are required to the GSP to achieve the Sustainability Goal, and what updates

are needed including adaptation of pumping and recharge and/or revisions to the Sustainable Management Criteria.

6.1.5 Planning and Implementation of Projects and Management Actions

The GSA, in collaboration with the Spadra Basin stakeholders, developed concepts for proposed projects and management actions as three "Basin Optimization Scenarios" to achieve sustainability and/or maximize the beneficial use of the Spadra Basin (Section 5.3). The Basin Optimization Scenarios were described at a conceptual level for the location, size, and operating schemes for the capital improvements (i.e., facilities). The Basin Optimization Scenarios were evaluated with the Spadra Basin groundwater model to assess hydrologic feasibility, and Class-5[1] engineering cost options were developed for each scenario to assess economic feasibility (Section 5.4). The evaluation concluded that all Basin Optimization Scenarios are hydrologically feasible, and that Basin Optimization Scenario 3 is the preferred scenario for GSP implementation to achieve the Sustainability Goal.

Taking the projects in Basin Optimization Scenario 3 from the concepts described in this GSP to final design and then through construction will occur in a phased approach:

- ***Phase 1*** – Identify Project Alternatives. In this phase, existing information is collected, compiled and reviewed, and the need to develop new information is identified. If necessary, new information is developed (e.g., new monitoring, surveys, studies, etc.). The new information is incorporated with the existing information and is used to develop project concepts and describe project alternatives for assessment in Phase 2.
- ***Phase 2*** – Project Screening Assessment. In this phase, a reconnaissance-level feasibility investigation is conducted to estimate the range in project yield and develop associated Class-5 cost opinions. An engineering economic analysis is prepared and used to refine the project alternatives. In this phase, major implementation requirements and challenges are identified, and a preliminary implementation plan is developed. This information is used to determine if the project should advance to a feasibility assessment in Phase 3.
- ***Phase 3*** – Feasibility Assessment. In this phase, a preliminary design report (PDR) and project- specific environmental review are prepared. The PDR effort includes a 10 to 20 percent design and a Class-4[2]cost opinion. The PDR is used to refine the engineering economic analysis, refine the implementation plan, and to determine whether the project should proceed to implementation in Phase 4.
- ***Phase 4*** – Project Implementation. In this phase, permits are acquired, implementation and financing agreements are developed and finalized, project financing is secured, final design is completed, and the project is constructed.

[1] As defined by Advancement of Cost Engineering International, a Class-5 cost opinion is based on a limited amount of information on the project and is used for project screening. Class-5 cost opinion accuracy range is - 20 to -50 percent on the low side, and +30 to +100 percent on the high side.
[2] As defined by Advancement of Cost Engineering International, a Class-4 cost opinion is based on a one to 15 percent engineering design and is used during studies and feasibility. A Class-4 accuracy range is -15 to -30 percent on the low side, and +20 to +50 percent on the high side.

6.2 ESTIMATE OF GSP IMPLEMENTATION COST

The Spadra Basin GSA will incur cost for the implementation of the GSP, which will require funding. The costs have been categorized as:

- ***Administrative***. These are costs associated with GSA administration and legal expenses.
- ***Monitoring/Reporting***. These are costs associated with monitoring and data collection, data management, and reporting required by the DWR annually and for five-year evaluations.
- ***Projects and Management Actions***. These are costs associated with the planning, permitting, construction, and O&M.

Conceptual costs estimates for GSP implementation were developed for these categories. The costs are shown in Table 6-1 and described in below in more detail. The cost estimates are based on the best information available. Actual costs may vary. The GSA will have an annual budgeting process to determine and approve an annual budget based on the requirements and needs for GSP implementation for the upcoming year.

Table 6-1. Cost of The Spadra Basin GSP Implementation

Category	Cost	Frequency
Administrative		
GSA Administration and Operations	$9,000	annually
Coordination and Management of GSP	$31,000	annually
Legal Services	$6,000	annually
Contingency (15 percent)	$7,000	annually
Administrative - Annual Cost:	**$53,000**	
Monitoring/Reporting		
Monitoring, Data Collection, and Database Maintenance		
Setup of monitoring network	$18,000	one-time annual event 1st year
Groundwater-level monitoring	$22,000	annually
Groundwater-quality monitoring	$22,000	annually
Production monitoring	$5,000	annually
Surface water monitoring	$5,000	annually
Subsidence monitoring	$3,000	annually
Data Gap Filling Efforts - Private Well Canvas and Outreach	$11,000	one-time annual event 1st year
Reporting		
Annual Reporting - first year	$100,000	one-time annual event 1st year
Annual Reporting - subsequent years	$80,000	annually
Model Update and Five-Year Evaluation of the GSP [(a)]	$250,000	every five years
Monitoring/Reporting - Annual Cost - First Year Only:	$186,000	
Monitoring/Reporting - Annual Cost:	$137,000	
Monitoring/Reporting - Annual Cost - With Five-Year Evaluation:	$387,000	
Administrative & Monitoring/Reporting - Annual Cost - First Year:	$239,000	
Administrative & Monitoring/Reporting - Annual Cost:	$190,000	
Administrative & Monitoring/Reporting- Annual Cost - With Five-Year Evaluation:	$440,000	
3. Projects and Management Actions		
Basin Optimization Scenario 3 - Recommended/Preferred Scenario		
Construction	$160,000,000	Assume 30 years for planning, construction, and payoff of capital improvement loans
Operations and Maintenance	$472,000	annually after construction
Annual Cost Range[(b)]	$5,300,000 to 5,800,000	
Basin Optimization Scenario 2		
Construction	$23,000,000	Assume 30 years for planning, construction, and payoff of capital improvement loans
Operations and Maintenance	$43,000	annually after construction
Annual Cost Range[(b)]	$767,000 to $810,000	
Basin Optimization Scenario 1		
Construction	$1,100,000	Assume 30 years for planning, construction, and payoff of capital improvement loans
Operations and Maintenance	$4,000	annually after construction
Annual Cost Range[(b)]	$37,000 to $ 41,000	

(a) The cost for the five-year elevation assumes that the concurrence of a periodic update and recalibration of the Spadra groundwater-flow model to evaluate sustainability and inform the evaluation and any updates required to the GSP.
(b) The annual cost range: Low end is cost for a 30-year loan for the lump sum costs for planning and construction divide by 30 years; High end is cost for a 30-year loan for the lump sum costs for planning and construction divide by 30 years plus annual O&M

6.2.1 Administrative Costs

These costs are broken down into the following main categories:

- **GSA Administration and Operations**. These are costs for administrative staff support, finance staff support and related expenses..
- **Coordination and Management of GSP**. These are costs for continuation of Stakeholder outreach and conducting Advisory Committee meetings; conducting Executive Committee meetings; tracking and prioritizing grant funding and completing grant applications; coordination with technical consultants on monitoring and reporting; review of annual reports and other work products; and ad-hoc tasks to support GSP implementation.
- **Legal Services**. These are costs for legal services for: reviewing reports and other work products; preparing for and attending Executive Committee and Advisory Committee meetings; drafting agreements and documents as needed for the GSA; and ad-hoc legal needs for administrating and implementing the GSP.
- **Contingency**. A 15 percent contingency is added for unknown variables and unanticipated costs.

The GSP implementation costs for Administrative are estimated to be about $53,000 annually.

6.2.2 Monitoring/Reporting Costs

These costs are broken down into the following main categories:

- **Monitoring, Data Collection, and Database Maintenance**. These are costs to conduct all monitoring activities described in Section 4 of the GSP, including: fill gaps in the monitoring network; data collection; and the QA/QC and upload of the data into the data management. Some of these costs are one-time expenses for setting up the monitoring network and installing transducers in the 12 wells monitoring by the GSA and conducting the canvas of private wells.
- **Reporting**. These are costs for preparing annual reports, DWR data deliverables described in Section 6.1.3, and the five-year GSP evaluation described in Section 6.1.4. The cost to prepare the first annual report are higher than for the subsequent years due to the work required to set up the format and processes to prepare the annual report. The cost for the five-year elevation assumes an update and recalibration of the Spadra groundwater-flow model to evaluate sustainability and inform the any required updates to the GSP (see Section 6.1.4).

The GSP implementation costs for Monitoring/Reporting are estimated to range between $137,000 to $612,000. The estimated annual cost for the first year of GSP implementation is $186,000, and subsequent years are $137,000. The costs for the years when a five-year evaluation of the GSP is performed is expected to be higher at $612,000.

6.2.3 Projects and Management Actions Costs

The costs for the projects and management actions shown in Table 6-1 are the Class-5 engineering cost estimates presented in Appendix L (Tables L-2a, L-2b, L-2c) for implementation of the three Basin Optimization Scenarios described and evaluated in Sections 5.3 and 5.4 of this GSP. Basin Optimization Scenario 3 is the preferred scenario for GSP implementation. The cost estimates in Table 6-1 include the one-time capital costs for planning and construction of the facilities and the ongoing annual costs for O&M of the facilities after startup.

The annual costs for these Basin Optimization Scenarios will vary depending on the stage of project implementation (planning, construction, and O&M). Table 6-1 also shows an estimated annual range in cost for each scenario that assumes the cost for a 30-year loan for the lump sum costs for planning and construction divided by 30 years as the low end, and the cost for a 30-year loan lump sum cost for planning and construction divided by 30 years plus the annual O&M cost as the high end. The annual cost for the preferred Basin Optimization Scenario 3 ranges from $5.3 to $ 5.8 million per year. As described in Section 5.5.3, Basin Optimization Scenario 3 is the most expensive scenario through 2059 as a total aggregate water supply cost for the Spadra Basin but is the least expensive scenario thereafter when the assumed loans to fund the capital improvements are paid off. The annual range shown in Table 6-1 does not account for annual cost after 30 years when the assumed loans for capital improvements would be paid off.

6.3 GSP FUNDING AND FINANCING

This GSP was funded 50 percent through a Proposition 1 Sustainable Groundwater Planning Grant (Appendix A). The Spadra Basin GSA operations are partially funded through this grant and by volunteer contributions from the GSA member agencies. The Spadra Basin GSA will fund the ongoing cost for the operation of GSA and implementation of the GSP through contributions from its member agencies and grant funding if available. Additionally, the Spadra Basin GSA has the authority to impose certain fees and assessments on groundwater pumping to fund all aspects of GSP implementation (Water Code § 10730 and § 10732). The GSA will develop a funding structure to pay for the costs to implement the GSP upon adoption of the GSP within the first year.

Additionally, the GSA may pursue other financing sources for capital projects, repayment of debt, O&M, and other ongoing expenses for the projects and management actions.

6.4 SCHEDULE FOR IMPLEMENTATION

Table 6-2 is a schedule for the first 20 years of GSP Implementation, showing an estimated timeline for the following major implementation categories: Administrative, Monitoring, Reporting, and Planning and Implementation of Projects and Management Actions.

Table 6-2. General Schedule for Spadra Basin GSP Implementation - 20 Years

Task	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Administrative																					
-- Ongoing GSA Administration and Operations, Coordination and Management of GSP, and Legal Services																					
Monitoring																					
-- Ongoing Monitoring, Data Collection, and Database Maintenance																					
-- Setup of monitoring network																					
-- Private Well Canvas and Outreach																					
-- Filling Other Data Gaps																					
Reporting																					
-- Annual Reporting																					
-- Five-Year Evaluation Reports																					
Planning and Implementation of Projects and Management Actions																					
Implementation of Projects and Management Actions in the Preferred Basin Optimization Scenario 3 [(a)]																					
-- Planning/Permitting/CEQA																					
-- Construction																					
-- Operation and Maintenance																					

(a) Basin Optimization Scenario 3 is assumed operational in fiscal year 2030 (July 1, 2029 - June 30, 2030)

SECTION 7
References

ASCE. 1993. *Criteria for evaluation of watershed models*. J. Irrigation Drainage Eng. 119(3): 429-442.

Bicknell, B. R., et al. 2005. *Hydrological Simulation Program - Fortran (HSPF). User's Manual for Release 12.2.* U.S. EPA National Exposure Research Laboratory Athens, GA, in cooperation with U.S. Geological Survey, Water Resources Division, Reston, VA.

Black & Veatch. August 2001. Phase 2 (Chino Basin) Recharge Master Plan. Prepared for the Chino Basin Watermaster.

Bouwer, H. 1978. *Groundwater Hydrology.* McGraw-Hill Book, New York, p. 480.

California Department of Water Resources. March 1966. *Planned utilization of ground water basins: San Gabriel Valley. Appendix A, Geohydrology*.

California Department of Water Resources (DWR). 1970. *Meeting Water Demands in the Chino-Riverside Area*. Bulletin No. 104-3, Appendix A: Water Supply, 108 p.

California Department of Water Resources (DWR). October 2003. *California's Groundwater* Bulletin 118 Update.

California Department of Water Resources (DWR). December 2014. *The State Water Project Final Delivery Reliability Report 2013*.

California Department of Water Resources (DWR). November 2017. *Draft Best Management Practices for the Sustainable Management of Groundwater. Sustainable Management Criteria BMP*.

California Department of Water Resources (DWR). July 2018. *Sustainable Groundwater Management Program Resource Guide. DWR-Provided Climate Change Data and Guidance for Use During Groundwater Sustainability Plan Development*.

California Department of Water Resources (DWR). August 2020. *The Final State Water Project Delivery Capability Report 2019*.

California State Water Resources Control Board (State Water Board). October 2019. Notice of Wastewater Change Petition WW0104. *County: Los Angeles. Streat System: San Jose Creek/San Gabriel River.*

California State Water Resources Control Board (State Water Board) and California Environmental Protection Agency (EPA). October 2020. *In the Matter of Wastewater Change Petition WW0104 Los Angeles County Sanitation Districts. Order Approving Change in Place of Use, Purpose of Use, and Quantity of Discharge. County: Los Angeles. Streat System: San Jose Creek/San Gabriel River.*

Carollo Engineers. November 2009. *City of Pomona Recycled Water Master Plan Final.*

Carsel, R. F., and Parrish, R. S. 1988. *Developing joint probability distributions of soil water retention characteristics.* Water Resour. Res., 24(5), 755– 769, doi:10.1029/WR024i005p00755.

Chino Basin Judgment. 1978. *Chino Basin Municipal Water District vs. City of Chino et al.,* Superior Court of California for the County of San Bernardino (Case No. 164327).

Chino Basin Watermaster (CBWM). July 2015. *Chino Basin Subsidence Management Plan*.

Civiltec Engineering Inc. June 2016. *Walnut Valley Water District 2015 Urban Water Management Plan.* Prepared for Walnut Valley Water District.

City of Pomona. June 2016. *City of Pomona 2015 Urban Water Management Plan Final.* Prepared by Water/Wastewater Operations Department.

Doherty, John. 2015. *Calibration and uncertainty analysis for complex environmental models.* Brisbane, Australia : Watermark Numerical Computing, 2015. p. 227. ISBN-13: 978-0-9943786-0-6.

Doherty, John. 2019. *Model-Independent Parameter Estimation User Manual: 7th Edition* published in 2018. Latest additions: May 2019. Brisbane, Australia : Watermark Numerical Computing, 2019.

Doherty, John. 2019b. *Model-Independent Parameter Estimation User Manual: 7th Edition* published in 2018. Latest additions: May 2019. Brisbane, Australia : Watermark Numerical Computing, 2019b.

Doherty, John. 2019. *Model-Independent Parameter Estimation Version 17*. Watermark Numerical Computing, 2019.

Domenico, Patrick A. and Schwartz, Franklin W. 1997. *Physical and Chemical Hydrogeology.* 2nd Edition, published by Wiley.

Donald R. Howard Consulting Engineers. 1999. Hydrogeologic Evaluation of Well Sites in the Spadra and Puente Basins. Prepared for the Walnut Valley Water District. 12 p.

Eckis, R. 1934. *Geology and Ground Water Storage Capacity of Valley Fill, South Coastal Basin Investigation: California Department of Public Works, Division of Water Resources Bulletin No. 45*, 273 p.

Ecological Systems Corporation. 1975. *Pomona Valley Water Quality/Management Study, Hydrogeology, Nitrates and Dissolved Solids*. Prepared for the Pomona Valley Municipal Water District. 44 p.

Ecological Systems Corporation. 1975. *Pomona Valley Water Quality/Management Study, Hydrogeology, Nitrates and Dissolved Solids*. Prepared for the Pomona Valley Municipal Water District. 44 p.

Environmental Science Associates (ESA). October 2019. *Final San Gabriel River Watershed Project to Reduce River Discharge in Support of Increased Recycled Water Reuse. Final Environmental Impact Report State Clearinghouse No. 2018071021*. Prepared for Los Angeles County Sanitation Districts.

Fetter, C. W. 2001. Applied Hydrogeology. 4th Edition. Prentice Hall, 2001.

Freeze, R.A. and Cherry, J.A. 1979. *Groundwater*. Prentice-Hall Inc., Englewood Cliffs, Vol. 7632, 604.

Fox/Roberts. 2001. Hydrogeologic Study of the Spadra Groundwater Basin for Well Site Feasibility. Prepared for the Walnut Valley Water District. 75 p.

Hartling, E., at Los Angeles County Sanitation Districts. 2022. Email communication on January 10, 2022.

Hill, Mary C. and Tiedeman, Claire R. 2005. Effective Groundwater Model Calibration: With Analysis of Data, Sensitivities, Predictions, and Uncertainty. Wiley, 2005. 9780471776369.

Hill, Mary C., et al. 2000. MODFLOW-2000, the U.S. Geological Survey modular ground-water model; user guide to the observation, sensitivity, and parameter-estimation processes and three post-processing programs. Denver, CO, 2000.

Johnson, A. I. 1967. *Specific Yield—Compilation of Specific Yields for Various Materials*. U.S. Geological Survey Water Supply Paper 1662-D. 74 p.

Kennedy/Jenks Consultants. November 2013. *Impacts of Septic Tanks on Groundwater Quality*. Prepared for Elsinore Valley Municipal Water District.

Kuniansky and Hamrick. 1998. Hydroge*ology and simulation of ground-water flow in the Paluxy aquifer in the vicinity of Landfills 1 and 3, US Air Force Plant 4, Fort Worth, Texas.* Water-Resources Investigations Report 98-4023.

Los Angeles County Department of Public Works. January 2006. *Hydrology Manual.* Water Resources Division.

Los Angeles Regional Water Quality Control Board (LA Regional Board). 2019. *Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watershed of Los Angeles and Ventura Counties.* 2019 version including all adopted amendments through the download date of October 14, 2019, On October 14, 2019.

Main San Gabriel Basin Watermaster. 2020. *Main San Gabriel Basin Watermaster 2019-2020 Annual Report.*

Marquardt, Donald W. 1963. An Algorithm for Least-Squares Estimation of Nonlinear Parameters. Journal of the Society for Industrial and Applied Mathematics. 1963, Vol. 11, 2, pp. 431-441.

McCuen, R. H., Rawls, W. J., and Brakensiek, D. L. 1981. *Statistical analysis of the Brooks-Corey and the Green-Ampt parameters across soil textures.* Water Resour. Res., 17(4), p. 1005– 1013.

McDonald, Michael G. and Harbaugh, Arlen W. 1988. *MODFLOW, A modular three-dimensional finite difference ground-water flow model.* Reston, Virginia : U. S. Geological Survey, 1988.

Mehl, Steffen W. and Mary, Hill C. 2001. *MODFLOW-2000, the U. S. Geological Survey modular ground-water model; user guide to the Link-AMG (LMG) package for solving matrix equations using an algebraic multigrid solver*. Denver, Colorado : U. S. Geological Survey, 2001.

Mendenhall, W.C. 1908. Ground*waters and Irrigation Enterprises in the Foothill Belt, Southern California*. USGS Water-Supply Paper 219, 180 p.

Metropolitan Water District of Southern California (Metropolitan). 2016. *The Regional Urban Water Management Plan. June 2016*

Metropolitan Water District of Southern California (Metropolitan). 2020. *Rate Structure Administrative Procedure Handbook FY 2020/21.*

Moriasi, D. N., et al. 2007. Model Evaluation Guidelines for Systematic Quantification of Accuracy in Watershed Simulations. American Society of Agricultural and Biological Engineers. 2007, Vol. 50, 3, pp. 885- 900.

Morton, D.M. and Miller, F.K., 2006, Geologic map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California, http://ngmdb.usgs.gov/Prodesc/proddesc_78686.htm: U.S. Geological Survey, Open-File Report 2006-1217, scale 1:100,000.

Nash, J. E. and Sutcliffe, J. V. . 1970. River flow forecasting through conceptual models: Part 1. A discussion of principles. J. Hydrology. 1970, Vol. 10, 3, pp. 282-290.

Neuman, S. P. 1973. Saturated-unsaturated seepage by finite elements. pp. 2233-2251.

Niswonger, Richard G., Panday, Sorab and Ibaraki , Motomu. 2011. *MODFLOW-NWT, A Newton formulation for MODFLOW-2005*: U.S. Geological Survey Techniques and Methods 6-A37, 44 p. Reston, Virginia : U.S. Geological Survey, 2011.

Niswonger, Richard G. and Prudic, David E. 2006. *Documentation of the Streamflow-Routing (SFR2) Package to Include Unsaturated Flow Beneath Streams—A Modification to SFR1*. U.S. Geological Survey, 2006.

Poeter, Eileen P., et al. 2014. UCODE_2014, with new capabilities to define parameters unique to predictions, calculate weights using simulated values, estimate parameters with SVD, evaluate uncertainty with MCMC, and More. Report Number: GWMI 2014-02. Integrated Groundwater Modeling Center, 2014.

Prudic, David E. 1991. *Estimates of hydraulic conductivity from aquifer-test analyses and specific-capacity data, Gulf Coast Regional Aquifer Systems, south-central United States.n*Water-Resources Investigations Report 90-4121.

Puente Basin Judgment. 1981. *Puente Basin Water Agency, a joint powers agency, et al. vs. The City of Industry, a municipal corporation, et al*., Superior Court of California for the County of Los Angeles (Case No. C369220).

Rawls, W.J., D.L. Brakensiek, and K.E. Saxton. 1982. *Estimation of soil water properties*. Trans. ASAE 25: 1316–1320 & 1328.

Reese, R.S. and Cunningham, K.J. 2000. *Hydrogeology of the gray limestone aquifer in southern Florida*. USGS Water-Resources Investigations Report 99-4213, 244 p.

RMC Water and Environment. June 2016. *Rowland Water District 2015 Urban Water Management Plan Final Report.*

Sanitation Districts of Los Angeles County, 2018. *29th Annual Status Report on Recycled Water Use Fiscal Year 2017-18.*

Sanitation Districts of Los Angeles County (LA Sanitation Districts). 2019. *Pomona Water Reclamation Plant Reuse Annual Monitoring Report 2018. Order Nos 81-34 & 97-072 Monitoring and Reporting Program No. 6241.*

Schaap, M.G., and F.J. Leij. 1998. *Database related accuracy and uncertainty of pedotransfer functions*. Soil Sci. 163:765–779.

Servat, Eric and Dezetter, Alain. 1991. Selection of calibration objective fonctions in the context of rainfall-ronoff modelling in a Sudanese savannah area. Hydrological Sciences Journal. 1991, Vol. 36, 4, pp. 307-330.

Simunek, J., Sejna, M. and van Genuchten, M. Th. . 1999. *The HYDRUS-2D software package for simulating two-dimensional movement of water, heat, and multiple solutes in variably saturated media.* Version 2.0 IGWMC - TPS - 53. Golden : International Groundwater Modeling Center, Colorado School of Mines, 1999. p. 251.

Six Basins Judgment. December 1998. *Southern California Water Company vs. City of La Verne, et al.* Superior Court of California for the County of Los Angeles (Case No. KC029152).

Stetson Engineers Inc., 2016. *San Gabriel Valley Groundwater Basin Salt and Nutrient Management Plan. Main* San Gabriel Basin Watermaster. Final Draft Report May 2016.

Three Valleys Municipal Water District (TVMWD). June 2011. *Urban Water Management Plan—2010*.

United States Department of the Interior, Bureau of Reclamation (USBR). 2008. *Law of the River*.

Wildermuth Environmental, Inc. (WEI). 1998. Phase 1 Recharge Master Plan (Chino Basin). Prepared for the Chino Basin Watermaster and the Chino Basin Water Conservation District.

Wildermuth Environmental, Inc. (WEI). 2002. TIN/TDS Study – *Phase 2B, Wasteload Allocation Investigation, Final Technical Memorandum.* Prepared for the TIN/TDS Task Force.

Wildermuth Environmental, Inc. (WEI). 2003. *Chino Basin Dry-Year Yield Program Modeling Report.* Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (WEI). February 2006. *Management Zone 1 Interim Monitoring Program: MZ-1 Summary Report.* Prepared for the MZ-1 Technical Committee.

Wildermuth Environmental, Inc. (WEI). March 2007. *Water Quality Impacts of On-Site Waste Disposal Systems in the Cherry Valley Community of Interest*. Prepared for San Timoteo Watershed Management Authority – Project Committee 1.

Wildermuth Environmental, Inc. (WEI). 2007. *2007 CBWM Groundwater Model Documentation and Evaluation of the Peace II Project Description.*

Wildermuth Environmental, Inc. (WEI). 2008. *Analysis of Material Physical Injury from the Proposed Expansion of the Dry-Year Yield Program.*

Wildermuth Environmental, Inc. (WEI). 2008b. *Draft Title 22 Engineering Report for Potential GRRPs in the Beaumont Basin.* Prepared for the San Timoteo Watershed Management Agency.

Wildermuth Environmental, Inc. (WEI). 2008c. *2008 Santa Ana River Wasteload Allocation Model Report.* Prepared for the Basin Monitoring Program Task Force.

Wildermuth Environmental, Inc. (WEI). 2009. *2009 Production Optimization and Evaluation of the Peace II Project Description.* Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (WEI). 2010. *2010 Recharge Master Plan Update.* Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (WEI). 2010a. *Recycled Water Planning Investigation Report.* Prepare for the San Bernardino Municipal Water Department.

Wildermuth Environmental, Inc. (WEI). September 2012. *2011 Water Supply Master Plan – Administrative Draft Report.* Prepared for the Cucamonga Valley Water District. (Unpublished).

Wildermuth Environmental, Inc. (WEI). September 2013. *2013 Amendment to 2010 Recharge Master Plan Update*. Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (WEI). January 2015. *2013 Chino Basin Groundwater Model Update and Recalculation of the Safe Yield Pursuant to the Peace Agreement.*

Wildermuth Environmental, Inc. (WEI). November 2017. *Strategic Plan for the Six Basins*. Prepared for the Six Basins Watermaster.

Wildermuth Environmental, Inc. (WEI). November 2019. *2018/19 Final Annual Report of the Ground Level Monitoring Committee.* Prepared for Chino Basin Watermaster.

Wildermuth Environmental, Inc. (WEI). January 2019. *Storage Framework Investigation*. Final Report October 2018. Revised in January 2019.

Wildermuth Environmental, Inc. (WEI). 2020. Unpublished modeling work for the recalibrated Six Basin Model; to be published in 2020. Prepared for the Six Basins Watermaster.

Wildermuth Environmental, Inc. (WEI). May 2020. *2020 Safe Yield Recalculation Final Report.*

Wildermuth, Mark J. 1995. *Annual Recharge Estimates at the Chino Basin, Water Conservation District Spreading Basins*.

Wood Environment & Infrastructure Solutions, Inc. October 2019. *Draft Adaptive Management Plan for Los Angeles County Sanitation Districts San Gabriel River Watershed Project to Reduce River Discharge in Support of Increased Recycled Water Reuse.* Wood Project Number 1755500035. Prepared for Los Angeles County Sanitation Districts.

Worley Parsons Resources and Energy. 2009. Spadra Basin Groundwater Modeling Report. Prepared for Brownstein Hyatt Farber Schreck, LLP. 12 p.

Appendix A

Proposition 1 Sustainable Groundwater Planning Grant

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY
EDMUND G. BROWN JR., Governor

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

November 27, 2018

Ms. Sherry Shaw
Director of Engineering
Walnut Valley Water District
271 South Brea Canyon Road
Walnut, California 91789

2017 Proposition 1 Sustainable Groundwater Planning (SGWP) Grant; Agreement #4600012726

Dear Ms. Shaw:

Enclosed is an original executed copy of Agreement #4600012726.

If you have any questions, please contact Jennifer Wong, Project Manager at (818)549-2343 or via email at Jennifer.Wong@water.ca.gov.

Sincerely,

Lana Quidgeon Graber
Associate Government Program Analyst
Financial Assistance Branch
Division of Integrated Regional Water Management

Enclosures

GRANT AGREEMENT BETWEEN THE STATE OF CALIFORNIA
(DEPARTMENT OF WATER RESOURCES) AND
WALNUT VALLEY WATER DISTRICT
AGREEMENT NUMBER 4600012726
2017 PROPOSITION 1 SUSTAINABLE GROUNDWATER PLANNING (SGWP) GRANT

THIS GRANT AGREEMENT is entered into by and between the Department of Water Resources of the State of California, herein referred to as the "State" or "DWR" and the Walnut Valley Water District, a public agency in the State of California, duly organized, existing, and acting pursuant to the laws thereof, herein referred to as the "Grantee," which parties do hereby agree as follows:

1) PURPOSE. The State shall provide funding from the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) to assist the Grantee in financing the planning and/or selected project activities (Project) that will improve sustainable groundwater management, pursuant to Water Code Section 79700 et seq. The provision of State funds pursuant to this Agreement shall not be construed or interpreted to mean that the Groundwater Sustainability Plan (GSP), or any components of the GSP, implemented in accordance with the Work Plan as set forth in Exhibit A, will be: adopted by the applicable Groundwater Sustainability Agency (GSA); obtain the necessary desirable results of Sustainable Management Criteria; or, meet all of the evaluation and assessment criteria when submitted to the Department of Water Resources as required by the Sustainable Groundwater Management Act and implementing regulations.

2) TERM OF GRANT AGREEMENT. The term of this Grant Agreement begins on the date this Grant Agreement is executed by the State, through final payment plus three (3) years unless otherwise terminated or amended as provided in this Grant Agreement. However, all work shall be completed in accordance with the Schedule as set forth in Exhibit C.

3) GRANT AMOUNT. The maximum amount payable by the State under this Grant Agreement shall not exceed $338,500.

4) GRANTEE COST SHARE. The Grantee is required to provide a Local Cost Share (non-State funds) of not less than 50 percent of the Total Project Cost. The cost share requirement for projects benefiting a Severely Disadvantaged Community (SDAC), Disadvantaged Community (DAC), or an Economically Distressed Areas (EDA) may be waived or reduced. The Grantee agrees to provide a Local Cost Share (non-State funds) for the amount as documented in Exhibit B (Budget). Local Cost Share may include Eligible Project Costs directly related to Exhibit A incurred after January 1, 2015.

5) BASIC CONDITIONS. The State shall have no obligation to disburse money for a project under this Grant Agreement until the Grantee has satisfied the following conditions (if applicable):

    1. Prior to commencing development of the GSP, the Grantee shall comply with the public notification requirements set forth in the California Code of Regulations, title 23, Section 350 et seq. (GSP Regulations) and Water Code Section 10727.8.
    2. The Grantee must demonstrate compliance with all relevant eligibility criteria as set forth on pages 7 and 8 of the 2015 Grant Program Guidelines for the SGWP Grant Program.
    3. For the term of this Grant Agreement, the Grantee submits timely reports and all other deliverables as required by Paragraph 16, "Submission of Reports" and Exhibit A.
    4. Prior to the commencement of construction or implementation activities, if applicable, the Grantee shall submit the following to the State:

        a. Final plans and specifications certified, signed, and stamped by a California Registered Civil Engineer as to compliance for each approved project as listed in Exhibit A of this Grant Agreement.

9. Travel and per diem costs.
10. Support of existing agency requirements and mandates (e.g., punitive regulatory agency requirement).
11. Purchase of land in excess of the minimum required acreage necessary to operate as an integral part of a project, as set forth and detailed by engineering and feasibility studies, or land purchased prior to the execution date of this Grant Agreement.
12. Overhead and indirect costs: "Indirect Costs" means those costs that are incurred for a common or joint purpose benefiting more than one cost objective and are not readily assignable to the funded project (i.e., costs that are not directly related to the funded project). Examples of Indirect Costs include, but are not limited to: central service costs; general administration of the Grantee; non-project-specific accounting and personnel services performed within the Grantee's organization; depreciation or use allowances on buildings and equipment; the costs of operating and maintaining non-project-specific facilities; tuition and conference fees; and, generic overhead or markup. This prohibition applies to the Grantee and any subcontract or sub-agreement for work on the Project that will be reimbursed pursuant to this Agreement.

8) METHOD OF PAYMENT FOR REIMBURSEMENT. After the disbursement requirements in Paragraph 5 "Basic Conditions" are met, the State will disburse the whole or portions of State funding to the Grantee, following receipt from the Grantee via U.S. mail or Express mail delivery of a "wet signature" invoice for costs incurred, including Cost Share, and timely Progress Reports as required by Paragraph 16, "Submission of Reports." Payment will be made no more frequently than monthly, in arrears, upon receipt of an invoice bearing the Grant Agreement number. The State will notify the Grantee, in a timely manner, whenever, upon review of an Invoice, the State determines that any portion or portions of the costs claimed are not eligible costs or is not supported by documentation or receipts acceptable to the State. The Grantee may, within thirty (30) calendar days of the date of receipt of such notice, submit additional documentation to the State to cure such deficiency(ies). If the Grantee fails to submit adequate documentation curing the deficiency(ies), the State will adjust the pending invoice by the amount of ineligible or unapproved costs.

Invoices submitted by the Grantee shall include the following information:

1. Costs incurred for work performed in implementing the project during the period identified in the particular invoice.
2. Costs incurred for any interests in real property (land or easements) that have been necessarily acquired for a project during the period identified in the particular invoice for the implementation of a project.
3. Invoices shall be submitted on forms provided by the State and shall meet the following format requirements:
   a. Invoices must contain the date of the invoice, the time period covered by the invoice, and the total amount due.
   b. Invoices must be itemized based on the categories (i.e., tasks) specified in the Exhibit B. The amount claimed for salaries/wages/consultant fees must include a calculation formula (i.e., hours or days worked times the hourly or daily rate = the total amount claimed).
   c. One set of sufficient evidence (i.e., receipts, copies of checks, time sheets) must be provided for all costs included in the invoice.
   d. Each invoice shall clearly delineate those costs claimed for reimbursement from the State's funding amount, as depicted in Paragraph 3, "Grant Amount" and those costs that represent the Grantee's costs, as applicable, in Paragraph 4, "Grantee Cost Share."
   e. Original signature and date (in ink) of the Grantee's Project Representative. Submit the original "wet signature" copy of the invoice form to the address listed in Paragraph 23, "Project Representative."

Express mail delivery of a "wet signature" invoice for costs incurred, including Cost Share, and timely Progress Reports as required by Paragraph 16, "Submission of Reports."

4. On a quarterly basis, the Grantee will submit an Accountability Report to the State that demonstrates how actual expenditures compare with the scheduled budget. The Accountability Report shall include the following information:
   a. An itemization of how advanced funds have been expended to-date (Expenditure Summary), including documentation that supports the expenditures (e.g., contractor invoices, receipts, personnel hours, etc.). Invoices must be itemized based on the budget categories (i.e., tasks) specified in Exhibit B.
   b. A funding plan which shows how the remaining advanced funds will be expended.
   c. Documentation that the funds were placed in a non-interest bearing account, including the dates of deposits and withdrawals from that account.
   d. The State Project Manager will notify the Grantee, in a timely manner, when, upon review of the Expenditure Summary, the State determines that any portion of the expenditures claimed are not eligible costs. The Grantee may, within thirty (30) calendar days of the date of receipt of such notice, submit additional documentation to cure such deficiency(ies). If costs are not consistent with the tasks in Exhibit B, the State will reject the claim and remove them from the Expenditure Summary.
5. Once the Grantee has expended all advanced funds, then the method of payment will revert to the reimbursement process specified in Paragraph 8, "Method of Payment for Reimbursement.", and any remaining requirements of Paragraph 5, "Basic Conditions."

10) REPAYMENT OF ADVANCES. The State may demand repayment from the Grantee of all or any portion of the advanced State funding along with interest at the California general obligation bond interest rate at the time the State notifies the Grantee, as directed by the State, and take any other action that it deems necessary to protect its interests for the following conditions:
   1. A project is not being implemented in accordance with the provisions of the Grant Agreement.
   2. The Grantee has failed in any other respect to comply with the provisions of this Grant Agreement, and if the Grantee does not remedy any such failure to the State's satisfaction.
   3. Repayment amounts may also include:
      a. Advance funds which have not been expended within 18 months of the Grant Agreement's execution.
      b. Actual costs incurred are not consistent with the activities presented in Exhibit A, not supported, or are ineligible.
      c. At the completion of the project, the funds have not been expended.

   For conditions 10) 3.a. and 10) 3.b., repayment may consist of deducting the amount from future reimbursement invoices. The State may consider the Grantee's refusal to repay the requested advanced amount a substantial breach of this Grant Agreement subject to the default provisions in Paragraph 12, "Default Provisions." If the State notifies the Grantee of its decision to demand repayment or withhold the entire funding amount from the Grantee pursuant to this paragraph, this Grant Agreement shall terminate upon receipt of such notice by the Grantee and the State shall no longer be required to provide funds under this Grant Agreement and the Grant Agreement shall no longer be binding on either party.

11) WITHHOLDING OF DISBURSEMENTS BY THE STATE. If the State determines that a project is not being implemented in accordance with the provisions of this Grant Agreement, or that the Grantee has failed in any other respect to comply with the provisions of this Grant Agreement, and if the Grantee does not remedy any such failure to the State's satisfaction, the State may withhold from the Grantee all or any

and DWR deems the UWMP consistent. For more information, visit the following website: https://www.water.ca.gov/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Urban-Water-Management-Plans.

b. All urban water suppliers must submit documentation that demonstrates they are meeting the 2015 interim gallons per capita per day (GPCD) target. If not meeting the interim target, the Grantee must submit a schedule, financing plan, and budget for achieving the GPCD target, as required pursuant to Water Code Section 10608.24. Urban water suppliers that did not meet their 2015 interim GPCD target must also submit annual reports that include a schedule, financing plan, and budget for achieving the GPCD target by June 30 of each year.

2. An agricultural water supplier receiving grant funding must:

   a. Comply with Sustainable Water Use and Demand Reduction requirements outlined in Water Code Section 10608, et seq. Submit to the State a schedule, financing plan, and budget for implementation of the efficient water management practices, required pursuant to Water Code Section 10608.48.

   b. Have their Agricultural Water Management Plan (AWMP) deemed consistent by DWR. To maintain eligibility and continue funding disbursements, an agricultural water supply must have their 2015 AWMP identified on the State's website. For more information, visit the following website: https://www.water.ca.gov/Work-With-Us/Grants-And-Loans/Agriculture-Water-Use-Efficiency.

3. The Grantee diverting surface water must maintain compliance with diversion reporting requirements as outlined in Part 5.1 of Division 2 of the Water Code.

4. If applicable, the Grantee must demonstrate compliance with the Groundwater Management Act set forth on pages 7 and 8 of the 2015 SGWP Grant Program Guidelines, dated October 2015.

5. Grantees that have been designated as monitoring entities under the California Statewide Groundwater Elevation Monitoring (CASGEM) Program must maintain reporting compliance, as required by Water Code Section 10932 and the CASGEM Program.

14) PERMITS, LICENSES, APPROVALS, AND LEGAL OBLIGATIONS. The Grantee shall be responsible for obtaining any and all permits, licenses, and approvals required for performing any work under this Grant Agreement, including those necessary to perform design, construction, or operation and maintenance of the Project(s). The Grantee shall be responsible for observing and complying with any applicable federal, state, and local laws, rules or regulations affecting any such work, specifically those including, but not limited to, environmental, procurement, and safety laws, rules, regulations, and ordinances. The Grantee shall provide copies of permits and approvals to the State.

15) RELATIONSHIP OF PARTIES. If applicable, the Grantee is solely responsible for design, construction, and operation and maintenance of projects within the work plan. Review or approval of plans, specifications, bid documents, or other construction documents by the State is solely for the purpose of proper administration of funds by the State and shall not be deemed to relieve or restrict responsibilities of the Grantee under this Grant Agreement.

16) SUBMISSION OF REPORTS. The submittal and approval of all reports is a requirement for the successful completion of this Grant Agreement. Reports shall meet generally accepted professional standards for technical reporting and shall be proofread for content, numerical accuracy, spelling, and grammar prior to submittal to the State. All reports shall be submitted to the State's Project Manager, and shall be submitted via Department of Water Resources (DWR) "Grant Review and Tracking System" (GRanTS). If requested, the Grantee shall promptly provide any additional information deemed necessary by the State for the approval of reports. Reports shall be presented in the formats described in the applicable portion of Exhibit F. The timely submittal of reports is a requirement for initial and continued disbursement of State funds. Submittal and subsequent approval by the State of a Project Completion Report is a requirement for the release of any funds retained for such project.

purposes of this Grant Agreement, "useful life" means period during which an asset, property, or activity is expected to be usable for the purpose it was acquired or implemented; "operation costs" include direct costs incurred for material and labor needed for operations, utilities, insurance, and similar expenses, and "maintenance costs" include ordinary repairs and replacements of a recurring nature necessary for capital assets and basic structures and the expenditure of funds necessary to replace or reconstruct capital assets or basic structures. Refusal by the Grantee to ensure operation and maintenance of the projects in accordance with this provision may, at the option of the State, be considered a breach of this Grant Agreement and may be treated as default under Paragraph 12, "Default Provisions."

18) MONITORING PLAN REQUIREMENTS. Pertinent to Implementation Projects or Components, a Monitoring Plan shall be submitted to the State prior to disbursement of State funds for construction or monitoring activities. The Monitoring Plan should incorporate items defined and listed in Exhibit K.

19) STATEWIDE MONITORING REQUIREMENTS. The Grantee shall ensure that all groundwater projects and projects that include groundwater monitoring requirements are consistent with the Groundwater Quality Monitoring Act of 2001 (Wat. Code, § 10780 et seq.) and, where applicable, projects that affect water quality shall include a monitoring component that allows the integration of data into statewide monitoring efforts, including where applicable, the Surface Water Ambient Monitoring Program carried out by the State Water Resources Control Board. See Exhibit G for web links and information regarding other State monitoring and data reporting requirements.

20) NOTIFICATION OF STATE. The Grantee shall promptly notify the State, in writing, of the following items:

1. Events or proposed changes that could affect the scope, budget, or work performed under this Grant Agreement. The Grantee agrees that no substantial change in the scope of a project will be undertaken until written notice of the proposed change has been provided to the State and the State has given written approval for such change. Substantial changes generally include changes to the scope of work, schedule or term, and budget.
2. Any public or media event publicizing the accomplishments and/or results of this Grant Agreement and provide the opportunity for attendance and participation by the State's representatives. The Grantee shall make such notification at least fourteen (14) calendar days prior to the event.
3. Applicable to Implementation Projects only, Final inspection of the completed work on a project by a Registered Professional (Civil Engineer, Engineering Geologist, or other State approved certified/license Professional), in accordance with Exhibit D. The Grantee shall notify the State's Project Manager of the inspection date at least 14 calendar days prior to the inspection in order to provide the State the opportunity to participate in the inspection.

21) NOTICES. Any notice, demand, request, consent, or approval that either party desires or is required to give to the other party under this Grant Agreement shall be in writing. Notices may be transmitted by any of the following means:

1. By delivery in person.
2. By certified U.S. mail, return receipt requested, postage prepaid.
3. By "overnight" delivery service; provided that next-business-day delivery is requested by the sender.
4. By electronic means.
5. Notices delivered in person will be deemed effective immediately on receipt (or refusal of delivery or receipt). Notices sent by certified mail will be deemed effective given ten (10) calendar days after the date deposited with the U.S. Postal Service. Notices sent by overnight delivery service will be deemed effective one business day after the date deposited with the delivery service. Notices sent electronically will be effective on the date of transmission, which is documented in writing. Notices shall be sent to the addresses listed below. Either party may, by written notice to the other, designate a different address that shall be substituted for the one below.

IN WITNESS WHEREOF, the parties hereto have executed this Grant Agreement.

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Arthur Hinojosa
Chief, Division of Integrated Regional Water Management

Date 11/14/18

Walnut Valley Water District

Erik Hitchman
General Manager

Date 11/01/18

Approved as to Legal Form and Sufficiency

James Herink for

Robin Brewer, Assistant Chief Counsel
Office of Chief Counsel

Date 11-13-18

EXHIBIT A
WORK PLAN

Project Title: Spadra Groundwater Basin Groundwater Sustainability Plan Development

Project Description: Develop the necessary supporting information and generate a GSP for the Spadra Groundwater Subbasin (Subbasin) of the San Gabriel Valley Basin.

Category (a): Grant Administration
Prepare reports detailing work completed during reporting period as outlined in Exhibit F of this Agreement. Progress Reports will include sufficient information for DWR Program Manager to understand and review backup documentation submitted with invoices. Submit quarterly invoices to the DWR Project Manager for review. Collect and organize backup documentation by task and prepare a summary excel document detailing contents of the backup documentation organized by task.

Prepare Draft Grant Completion Report and submit to DWR Project Manager for comment and review no later than 90-days after work completion. Prepare Final Grant Completion Report addressing the Project Manager's comments. The report shall be prepared and presented in accordance with the provisions of Exhibit F.

Deliverables:

- Environmental Information Form
- Quarterly invoices, backup documentation, and summary document
- Quarterly Progress Reports
- Final Grant completion report

Category (b): Spadra Subbasin Model Development
Develop and calibrate a new numerical groundwater-flow model of the Subbasin. Develop the model using industry standards, allowing for future improvements and the on-going use of the model by the stakeholders to manage the Subbasin.

Task 1: Develop a Conceptual Model of the Spadra Basin Area
Collect all the data and information necessary to complete the investigation and develop a conceptual model of the Subbasin in enough detail to build and calibrate the numerical groundwater-flow model.

Deliverables:

- Conceptual Model Report

Task 2: Collect Additional Hydrologic Information
Drill a monitoring well and collect water level, water quality, and other hydrologic information. Monitoring of key Title 22 constituents is anticipated. Complete an environmental review and submit the appropriate California Environmental Quality Act (CEQA) document, as required in Paragraph D.7, to the County's Recorder's office and the State Clearinghouse prior to hiring a drilling company. Obtain all required permits to implement the well installation as stated in Paragraph 14. Develop a Project Monitoring Plan.

Deliverables:

- Technical Memo
- CEQA documentation and required permits
- Well completion report
- Monitoring Plan

Task 3: Build and Calibrate the Numerical Groundwater-Flow Model
Build and calibrate a numerical groundwater-flow model that reproduces the observed changes in groundwater levels and flows over the calibration period. Use the conceptual model of the Subbasin to build a 3-dimensional groundwater-flow model. Steady-state and transient flow calibrations will be performed. The model will be calibrated to a standard that ensures its usefulness as a predictive computer-simulation tool.

Deliverables:

- Technical Memorandum

Task 4: Develop and Evaluate the Baseline Scenario
Develop a Baseline Scenario that represents the uncoordinated actions of the pumpers and evaluate the Baseline Scenario over a 60-year future period. Prepare a technical memorandum titled "Evaluation of the Baseline Scenarios" that describes and documents the results of the simulations. A draft memorandum will be distributed to the parties for review and comment. A final memorandum will be prepared that incorporates the comments of the parties.

Deliverables:

- Technical Memorandum "Evaluation of the Baseline Scenarios"

Task 5: Outreach
Ensure that interested parties/stakeholders are engaged in the project, providing important feedback and consensus assumptions are fully vetted. Approximately six dedicated meetings are anticipated and will be in combinations of the Executive Committee, Implementation Committee, and Advisory Committee of the Subbasin GSA. The technical consultant executing the modeling work will prepare for and attend these meetings to describe progress and results and receive feedback from the parties.

Deliverables:

- Summaries of meetings and workshops included as attachments in the associated Quarterly Progress Report

Category (c): Spadra Basin Optimization Study
Develop up to four (4) Basin Optimization Scenarios that represent the coordinated actions of the pumpers and new infrastructure, simulate each alternative scenario over the planning period, and compare the results of each simulation to the Baseline Scenarios and to each other.

Task 7: Basin Optimization Scenarios
Develop Optimization Scenarios that are currently undefined. The optimization scenarios may include: new groundwater production patterns, pump-and-treat facilities and strategies to put poor-quality groundwater to beneficial use, and/or expanded storage and recovery programs, among others. Prepare tables and figures to describe the optimization scenario. Stakeholders will develop these optimization scenarios and will have the opportunity to review and comment on the assumptions of the optimization scenarios prior to simulation.

Deliverables:

- Table data describing Basin Optimization Scenarios

Task 8: Evaluate up to Four Basin Optimization Scenarios
Convert the tables and figures that describe the optimization scenarios to input files for MODFLOW. Simulate the optimization scenarios and analyze the results in tables, charts, and maps. Use the same metrics used to evaluate the Baseline Scenario to comparatively evaluate the optimization scenarios to the Baseline Scenario and to each other.

EXHIBIT B
BUDGET

Project Budget					
Project Title: Spadra Groundwater Basin Groundwater Sustainability Plan Development					
Budget Category		**Grant Amount**	**Required Cost Share (non-state source)***	**Other Cost Share**	**Total Cost**
(a)	Grant Administration	$8,500	$8,500	$0	**$17,000**
(b)	Spadra Basin Model Development	$175,000	$175,000	$0	**$350,000**
(c)	Spadra Basin Optimization Study	$65,000	$65,000	$0	**$130,000**
(d)	GSP Development	$90,000	$90,000	$0	**$180,000**
	TOTAL COSTS	**$338,500**	**$338,500**	**$0**	**$677,000**

NOTES:

**Grantee did not receive a DAC/EDA/SDAC cost share waiver or reduction.*

EXHIBIT D

STANDARD CONDITIONS

D.1) ACCOUNTING AND DEPOSIT OF FUNDING DISBURSEMENT:

a) Separate Accounting of Funding Disbursements: The Grantee shall account for the money disbursed pursuant to this Grant Agreement separately from all other Grantee funds. The Grantee shall maintain audit and accounting procedures that are in accordance with generally accepted accounting principles and practices, consistently applied. The Grantee shall keep complete and accurate records of all receipts and disbursements on expenditures of such funds. The Grantee shall require its contractors or subcontractors to maintain books, records, and other documents pertinent to their work in accordance with generally accepted accounting principles and practices. Records are subject to inspection by the State at any and all reasonable times.

b) Disposition of Money Disbursed: All money disbursed pursuant to this Grant Agreement shall be deposited in a non-interest bearing account, administered, and accounted for pursuant to the provisions of applicable law.

c) Remittance of Unexpended Funds: The Grantee shall remit to the State any unexpended funds that were disbursed to the Grantee under this Grant Agreement and were not used to pay Eligible Project Costs within a period of sixty (60) calendar days from the final disbursement from the State to the Grantee of funds or, within thirty (30) calendar days of the expiration of the Grant Agreement, whichever comes first.

D.2) ACKNOWLEDGEMENT OF CREDIT AND SIGNAGE: The Grantee shall include appropriate acknowledgement of credit to the State for its support when promoting the Project or using any data and/or information developed under this Grant Agreement. Signage shall be posted in a prominent location at Project site(s) (if applicable) or at the Grantee's headquarters and shall include the Department of Water Resources color logo and the following disclosure statement: "Funding for this project has been provided in full or in part from the Water Quality, Supply, and Infrastructure Improvement Act of 2014 and through an agreement with the State Department of Water Resources." The Grantee shall also include in each of its contracts for work under this Agreement a provision that incorporates the requirements stated within this paragraph.

D.3) AMENDMENT: This Grant Agreement may be amended at any time by mutual agreement of the Parties, except insofar as any proposed amendments are in any way contrary to applicable law. Requests by the Grantee for amendments must be in writing stating the amendment request and the reason for the request. The State shall have no obligation to agree to an amendment.

D.4) AMERICANS WITH DISABILITIES ACT: By signing this Grant Agreement, the Grantee assures the State that it complies with the Americans with Disabilities Act (ADA) of 1990, (42 U.S.C. § 12101 et seq.), which prohibits discrimination on the basis of disability, as well as all applicable regulations and guidelines issued pursuant to the ADA.

D.5) AUDITS: The State reserves the right to conduct an audit at any time between the execution of this Grant Agreement and the completion of the Project, with the costs of such audit borne by the State. After completion of the Project, the State may require the Grantee to conduct a final audit to the State's specifications, at the Grantee's expense, such audit to be conducted by and a report prepared by an independent Certified Public Accountant. Failure or refusal by the Grantee to comply with this provision shall be considered a breach of this Grant Agreement, and the State may elect to pursue any remedies provided in Paragraph 12 or take any other action it deems necessary to protect its interests.

Pursuant to Government Code Section 8546.7, the Grantee shall be subject to the examination and audit by the State for a period of three (3) years after final payment under this Grant Agreement with respect of all matters connected with this Grant Agreement, including but not limited to, the cost of administering this Grant Agreement. All records of the Grantee or its contractor or subcontractors shall

D.12) CONFLICT OF INTEREST: All participants are subject to state and federal conflict of interest laws. Failure to comply with these laws, including business and financial disclosure provisions, will result in the application being rejected and any subsequent contract being declared void. Other legal action may also be taken. Applicable statutes include, but are not limited to, Government Code Section 1090 and Public Contract Code Sections 10410 and 10411, for State conflict of interest requirements.

a) Current State Employees: No State officer or employee shall engage in any employment, activity, or enterprise from which the officer or employee receives compensation or has a financial interest and which is sponsored or funded by any State agency, unless the employment, activity, or enterprise is required as a condition of regular State employment. No State officer or employee shall contract on his or her own behalf as an independent contractor with any State agency to provide goods or services.

b) Former State Employees: For the two-year period from the date he or she left State employment, no former State officer or employee may enter into a contract in which he or she engaged in any of the negotiations, transactions, planning, arrangements, or any part of the decision-making process relevant to the contract while employed in any capacity by any State agency. For the twelve-month period from the date he or she left State employment, no former State officer or employee may enter into a contract with any State agency if he or she was employed by that State agency in a policy-making position in the same general subject area as the proposed contract within the twelve-month period prior to his or her leaving State service.

c) Employees of the Grantee: Employees of the Grantee shall comply with all applicable provisions of law pertaining to conflicts of interest, including but not limited to any applicable conflict of interest provisions of the California Political Reform Act. (Gov. Code, § 87100 et seq.)

d) Employees and Consultants to the Grantee: Individuals working on behalf of the Grantee may be required by DWR to file a Statement of Economic Interests (Fair Political Practices Commission Form 700) if it is determined that an individual is a consultant for Political Reform Act purposes.

D.13) DELIVERY OF INFORMATION, REPORTS, AND DATA: The Grantee agrees to expeditiously provide throughout the term of this Grant Agreement, such reports, data, information, and certifications as may be reasonably required by the State.

D.14) DISPOSITION OF EQUIPMENT: The Grantee shall provide to the State, not less than 30 calendar days prior to submission of the final invoice, an itemized inventory of equipment purchased with funds provided by the State. The inventory shall include all items with a current estimated fair market value of more than $5,000.00 per item. Within 60 calendar days of receipt of such inventory the State shall provide the Grantee with a list of the items on the inventory that the State will take title to. All other items shall become the property of the Grantee. The State shall arrange for delivery from the Grantee of items that it takes title to. Cost of transportation, if any, shall be borne by the State.

D.15) DRUG-FREE WORKPLACE CERTIFICATION: Certification of Compliance: By signing this Grant Agreement, the Grantee, its contractors or subcontractors hereby certify, under penalty of perjury under the laws of State of California, compliance with the requirements of the Drug-Free Workplace Act of 1990 (Gov. Code § 8350 et seq.) and have or will provide a drug-free workplace by taking the following actions:

a) Publish a statement notifying employees, contractors, and subcontractors that unlawful manufacture, distribution, dispensation, possession, or use of a controlled substance is prohibited and specifying actions to be taken against employees, contractors, or subcontractors for violations, as required by Government Code Section 8355.

b) Establish a Drug-Free Awareness Program, as required by Government Code Section 8355 to inform employees, contractors, or subcontractors about all of the following:

h) Be solely responsible for all work and for persons or entities engaged in work performed pursuant to this Grant Agreement, including, but not limited to, contractors, subcontractors, suppliers, and providers of services. The Grantee shall be responsible for any and all disputes arising out of its contracts for work on the Project, including but not limited to payment disputes with contractors and subcontractors. The State will not mediate disputes between the Grantee and any other entity concerning responsibility for performance of work.

D.19) GOVERNING LAW: This Grant Agreement is governed by and shall be interpreted in accordance with the laws of the State of California.

D.20) INCOME RESTRICTIONS: The Grantee agrees that any refunds, rebates, credits, or other amounts (including any interest thereon) accruing to or received by the Grantee under this Agreement shall be paid by the Grantee to the State, to the extent that they are properly allocable to costs for which the Grantee has been reimbursed by the State under this Agreement.

D.21) INDEMNIFICATION: The Grantee shall indemnify and hold and save the State, its officers, agents, and employees, free and harmless from any and all liabilities for any claims and damages (including inverse condemnation) that may arise out of the Project and this Agreement, including, but not limited to any claims or damages arising from planning, design, construction, maintenance and/or operation of this Project and any breach of this Agreement. The Grantee shall require its contractors or subcontractors to name the State, its officers, agents and employees as additional insureds on their liability insurance for activities undertaken pursuant to this Agreement.

D.22) INDEPENDENT CAPACITY: The Grantee, and the agents and employees of the Grantees, in the performance of the Grant Agreement, shall act in an independent capacity and not as officers, employees, or agents of the State.

D.23) INSPECTION OF BOOKS, RECORDS, AND REPORTS: During regular office hours, each of the parties hereto and their duly authorized representatives shall have the right to inspect and to make copies of any books, records, or reports of either party pertaining to this Grant Agreement or matters related hereto. Each of the parties hereto shall maintain and shall make available at all times for such inspection accurate records of all its costs, disbursements, and receipts with respect to its activities under this Grant Agreement. Failure or refusal by the Grantee to comply with this provision shall be considered a breach of this Grant Agreement, and the State may withhold disbursements to the Grantee or take any other action it deems necessary to protect its interests.

D.24) INSPECTIONS OF PROJECT BY STATE: The State shall have the right to inspect the work being performed at any and all reasonable times during the term of the Grant Agreement. This right shall extend to any subcontracts, and the Grantee shall include provisions ensuring such access in all its contracts or subcontracts entered into pursuant to its Grant Agreement with the State.

D.25) LABOR CODE COMPLIANCE: The Grantee agrees to be bound by all the provisions of the Labor Code regarding prevailing wages and shall monitor all contracts subject to reimbursement from this Agreement to assure that the prevailing wage provisions of the Labor Code are being met. Current Department of Industrial Relations (DIR) requirements may be found at http://www.dir.ca.gov/lcp.asp. For more information, please refer to DIR's *Public Works Manual* at: http://www.dir.ca.gov/dlse/PWManualCombined.pdf. The Grantee affirms that it is aware of the provisions of Section 3700 of the Labor Code, which requires every employer to be insured against liability for workers' compensation or to undertake self-insurance, and the Grantee affirms that it will comply with such provisions before commencing the performance of the work under this Agreement and will make its contractors and subcontractors aware of this provision.

D.26) MODIFICATION OF OVERALL WORK PLAN: At the request of the Grantee, the State may at its sole discretion approve non-material changes to the portions of Exhibit A which concern the budget and schedule without formally amending this Grant Agreement. Non-material changes with respect to the budget are changes that only result in reallocation of the budget and will not result in an increase in the

Code, § 6250 et seq.) The Grantee may disclose, disseminate and use in whole or in part, any final form data and information received, collected and developed under this Grant Agreement, subject to appropriate acknowledgement of credit to the State for financial support. The Grantee shall not utilize the materials for any profit-making venture or sell or grant rights to a third party who intends to do so. The State shall have the right to use any data described in this paragraph for any public purpose.

D.34) SEVERABILITY: Should any portion of this Grant Agreement be determined to be void or unenforceable, such shall be severed from the whole and the Grant Agreement shall continue as modified.

D.35) SUSPENSION OF PAYMENTS: This Grant Agreement may be subject to suspension of payments or termination, or both if the State determines that:

a) The Grantee, its contractors, or subcontractors have made a false certification, or

b) The Grantee, its contractors, or subcontractors violates the certification by failing to carry out the requirements noted in this Grant Agreement.

D.36) SUCCESSORS AND ASSIGNS: This Grant Agreement and all of its provisions shall apply to and bind the successors and assigns of the parties. No assignment or transfer of this Grant Agreement or any part thereof, rights hereunder, or interest herein by the Grantee shall be valid unless and until it is approved by State and made subject to such reasonable terms and conditions as the State may impose.

D.37) TERMINATION BY GRANTEE: Subject to State approval which may be reasonably withheld, the Grantee may terminate this Agreement and be relieved of contractual obligations. In doing so, the Grantee must provide a reason(s) for termination. The Grantee must submit all progress reports summarizing accomplishments up until termination date.

D.38) TERMINATION FOR CAUSE: Subject to the right to cure under Paragraph 12, the State may terminate this Grant Agreement and be relieved of any payments should the Grantee fail to perform the requirements of this Grant Agreement at the time and in the manner herein, provided including but not limited to reasons of default under Paragraph 12.

D.39) TERMINATION WITHOUT CAUSE: The State may terminate this Agreement without cause on 30 days advance written notice. The Grantee shall be reimbursed for all reasonable expenses incurred up to the date of termination.

D.40) THIRD PARTY BENEFICIARIES: The parties to this Agreement do not intend to create rights in, or grant remedies to, any third party as a beneficiary of this Agreement, or any duty, covenant, obligation or understanding established herein.

D.41) TIMELINESS: Time is of the essence in this Grant Agreement.

D.42) TRAVEL – DAC, EDA, or SDAC PROJECT/COMPONENT: If a Project/Component obtains a DAC, EDA, or SDAC Cost Share Waiver, the Grantee may submit travel and per diem costs for eligible reimbursement with State funds. Travel includes the reasonable and necessary costs of transportation, subsistence, and other associated costs incurred by personnel during the term of this Grant Agreement. Any reimbursement for necessary travel and per diem shall be at rates not to exceed those set by the California Department of Human Resources. These rates may be found at: http://www.calhr.ca.gov/employees/Pages/travel-reimbursements.aspx. Reimbursement will be at the State travel and per diem amounts that are current as of the date costs are incurred. No travel outside the State of California shall be reimbursed unless prior written authorization is obtained from the State. All travel approved expenses will be reimbursed at the percentage rate of the DAC, EDA, or SDAC Cost Share Waiver. For example, if the Grantee obtains a 100% Waiver, 100% of all approved travel expenses can be invoiced for reimbursement. If the Grantee obtains a 50% Waiver, only 50% of eligible travel expenses will be reimbursed by these grant funds.

EXHIBIT E

AUTHORIZING RESOLUTION ACCEPTING FUNDS

RESOLUTION NO. 10-17-644

RESOLUTION OF THE BOARD OF DIRECTORS OF WALNUT VALLEY WATER DISTRICT APPROVING APPLICATION FOR GRANT FUNDS UNDER THE SUSTAINABLE GROUNDWATER PLANNING GRANT PROGRAM ON BEHALF OF THE SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the Sustainable Groundwater Management Act (SGMA) requires the formation of groundwater sustainability agencies to oversee California's groundwater basins and to implement groundwater sustainability plans for those basins; and

WHEREAS, Walnut Valley Water District (District) and the city of Pomona (City) have formed the Spadra Basin Groundwater Sustainability Agency (Spadra Basin GSA) pursuant to a Memorandum of Agreement in accordance with SGMA to oversee the Spadra Basin (Basin); and

WHEREAS, the District and City are in the beginning stages of administering the Spadra Basin GSA and developing a groundwater sustainability plan for the Basin; and

WHEREAS, the California Department of Water Resources, using funds authorized by Proposition 1, has established the Sustainable Groundwater Planning Grant Program (Program) to provide funding to local agencies to assist in the preparation of groundwater sustainability plans under SGMA; and

WHEREAS, the Department of Water Resources is responsible for the administration of the Program and under its applicable procedures requires a resolution certifying the approval of application by the Applicant's governing board before submission of said application; and

WHEREAS, the District, as one of the two member agencies of the Spadra Basin GSA, desires to apply for funding under the Program on behalf of the Spadra Basin GSA; and

WHEREAS, the District, as applicant, if selected, will enter into an agreement with the State of California with respect to any grant provided under the Program.

NOW, THEREFORE, the Board of Directors of Walnut Valley Water District hereby resolves that application be made to the California Department of Water Resources to obtain a grant on behalf of the Spadra Basin Groundwater Sustainability Agency under the 2017 Sustainable Groundwater Planning Grant Program pursuant to the Water Quality, Supply and Infrastructure Improvement Act of 2014 (Proposition 1) (Water Code Section 79700 et seq.), and to enter into an agreement to receive a grant for the development of the Spadra Basin Groundwater Sustainability Plan and related necessary actions. The General Manager of Walnut Valley Water District, or designee, is hereby authorized and directed to prepare the necessary data, conduct investigations, file such application and execute a grant agreement with the California Department of Water Resources.

PASSED AND ADOPTED, at a regular meeting of the Board of Directors of Walnut Valley Water District, held October 16, 2017, by the following roll call vote:

AYES: EBENKAMP, HILDEN, LEE & WU
NAYS: NONE
ABSENT: KWONG

Allen Wu, President

ATTEST:

Michael K. Holmes, Secretary

Cost & Disposition of Funds

A list showing:

- Summary of Project costs including the following items:
  - Accounting of the cost of project expenditure
  - Include all internal and external costs not previously disclosed (i.e., additional cost share); and
  - A discussion of factors that positively or negatively affected the project cost and any deviation from the original Project cost estimate.

Additional Information

- Benefits derived from the Component, with quantification of such benefits provided, applicable for Implementation Components.
- A final project schedule showing actual progress versus planned progress as shown in Exhibit C.
- Certification from a California Registered Professional (Civil Engineer or Geologist, as appropriate) that the project was conducted in accordance with the approved work plan and any approved modifications thereto.
- Submittal schedule for the Post Performance Report.

GRANT COMPLETION REPORT

The Grant Completion Report shall generally use the following format. This format may be modified as necessary to effectively communicate information on the various projects in the SGWP Grant Program funded by this Grant Agreement, and includes the following:

Executive Summary

The Executive Summary consists of a maximum of ten (10) pages summarizing information for the grant as well as the individual components.

Reports and/or products

- Brief comparison of work proposed in the original 2017 SGWP Grant application and actual work done.
- Brief description of the Project or components completed and how they achieve either or both of the following:
  - Serve SDAC(s) and support groundwater sustainability planning and management in the basin (Implementation Projects); and/or
  - Support planning, development, and/or preparation of GSP(s) that will comply with and meet the requirements of the GSP Regulations (GSP Development Projects).
- Identify remaining work and mechanism for their implementation (Implementation Projects).
- If applicable (e.g., if a DAC, EDA, or SDAC Cost Share Waiver was approved), a discussion of the benefits to DAC, EDA, and/or SDAC as part of this Grant Agreement.

Cost & Disposition of Funds Information

- A summary of final funds disbursement for the Project, or each component.

Additional Information

- Summary of the submittal schedule for the Post Performance Reports applicable for the Project, or each of the components in this Grant Agreement.

EXHIBIT G

REQUIREMENTS FOR DATA SUBMITTAL

Surface and Groundwater Quality Data:

Groundwater quality and ambient surface water quality monitoring data that include chemical, physical, or biological data shall be submitted to the State as described below, with a narrative description of data submittal activities included in project reports, as described in Exhibit F.

Surface water quality monitoring data shall be prepared for submission to the California Environmental Data Exchange Network (CEDEN). The CEDEN data templates are available on the CEDEN website. Inclusion of additional data elements described on the data templates is desirable. Data ready for submission should be uploaded to your CEDEN Regional Data Center via the CEDEN website. (CEDEN website: http://www.ceden.org).

If a project's Work Plan contains a groundwater ambient monitoring element, groundwater quality monitoring data shall be submitted to the State for inclusion in the State Water Resources Control Board's Groundwater Ambient Monitoring and Assessment (GAMA) Program Information on the GAMA Program can be obtained at: http://www.waterboards.ca.gov/water_issues/programs/gama/. If further information is required, the Grantee can contact the State Water Resources Control Board (SWRCB) GAMA Program. A listing of SWRCB staff involved in the GAMA program can be found at: http://www.swrcb.ca.gov/water_issues/programs/gama/contact.shtml

Groundwater Level Data

The Grantee shall submit to DWR groundwater level data collected as part of this grant. Water level data must be submitted using the California Statewide Groundwater Elevation Monitoring (CASGEM) online data submission system. The Grantee should use their official CASGEM Monitoring Entity or Cooperating Agency status to gain access to the online submittal tool and submit data. If the data is from wells that are not part of the monitoring network, the water level measurements should be classified as voluntary measurements in the CASGEM system. If the Grantee is not a Monitoring Entity or Cooperating Agency, please contact your DWR grant project manager for further assistance with data submittal. The activity of data submittal should be documented in appropriate progress or final project reports, as described in Exhibit F. Information regarding the CASGEM program can be found at: http://www.water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM

Accounting Records:

1. Ledgers showing entries for the Grantee's receipts and cash disbursements.
2. Ledgers showing receipts and cash disbursement entries of other funding sources.
3. Bridging documents that tie the general ledger to requests for Grant Agreement reimbursement.

Administration Costs:

1. Supporting documents showing the calculation of administration costs.

Personnel:

1. List of all contractors and Agency staff that worked on the State funded Program/Project.
2. Payroll records including timesheets for contractor staff and the Agency personnel who provided services charged to the program

Project Files:

1. All supporting documentation maintained in the project files.
2. All Grant Agreement related correspondence.

Cost Share Guidelines

Cost Share consists of non-State funds, including in-kind services. In-kind services are defined as work performed (i.e., dollar value of non-cash contributions) by the Grantee (and potentially other parties) directly related to the execution of the funded project. Examples include volunteer services, equipment use, and use of facilities. The cost of in-kind service can be counted as cost share in-lieu of actual funds (or revenue) provided by the Grantee. Other cost share and in-kind service eligibility conditions may apply. Provided below is guidance for documenting cost share with and without in-kind services.

1. Although tracked separately, in-kind services shall be documented and, to the extent feasible, supported by the same methods used by the Grantee for its own employees. Such documentation should include the following:
    a. Detailed description of the contributed item(s) or service(s)
    b. Purpose for which the contribution was made (tied to project work plan)
    c. Name of contributing organization and date of contribution
    d. Real or approximate value of contribution. Who valued the contribution and how was the value determined? (e.g., actual, appraisal, fair market value, etc.). Justification of rate. (See item #2, below)
    e. Person's name and the function of the contributing person
    f. Number of hours contributed
    g. If multiple sources exist, these should be summarized on a table with summed charges
    h. Source of contribution if it was provided by, obtained with, or supported by government funds
2. Rates for volunteer or in-kind services shall be consistent with those paid for similar work in the Grantee's organization. For example, volunteer service of clearing vegetation performed by an attorney shall be valued at a fair market value for this service, not the rate for professional legal services. In those instances in which the required skills are not found in the recipient organization, rates shall be consistent with those paid for similar work in the labor market. Paid fringe benefits that are reasonable, allowable and allocable may be included in the valuation.
3. Cost Share contribution (including in kind services) shall be for costs and services directly attributed to activities included in the Grant Agreement. These services, furnished by professional and technical

EXHIBIT I

LOCAL PROJECT SPONSORS (NOT USED)

EXHIBIT K

MONITORING PLAN

Introduction

- Goals and objectives of project
- Site location and history
- Improvements implemented

Monitoring Plan

- Monitoring Metrics (e.g., Plant establishment, bank erosion, hydraulic characteristics, habitat expansion)
- Maintenance Metrics (e.g., irrigation, pest management, weed abatement, continuous invasive species removal until natives established)
- Special Environmental Considerations (e.g., resource agency requirements, permit requirements, CEQA/NEPA mitigation measures)
- Performance Measures, or success/failure criteria monitoring results measured against (e.g., percent canopy cover after 1, 5, 10 years, water temperature decrease, site specific sediment scour or retention)
- Method of Reporting (e.g., paper reports, online databases, public meetings)
- Frequency of Duration Monitoring and Reporting (daily, weekly, monthly, yearly)
- Frequency and Duration of Maintenance Activities
- Responsible Party (i.e., who is who is responsible for monitoring and maintenance)
- Implementing responsibility (i.e., conducting monitoring and/or maintenance)
- Adaptive Management Strategies (i.e., what happens when routine monitoring or maintenance encounters a problem)

Appendix B

Memorandum of Agreement – Spadra Basin GSA

MEMORANDUM OF AGREEMENT TO ESTABLISH A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SPADRA GROUNDWATER BASIN

This Memorandum of Agreement ("MOA") is entered into as of February 28, 2017 ("Effective Date") by and between the City of Pomona ("City") and Walnut Valley Water District ("WVWD") to collaborate to meet the requirements of the Sustainable Groundwater Management Act of 2014 in establishing a collaborative management structure for the Spadra Basin ("Basin"). The City and WVWD are collectively referred to herein as "Parties" and individually as a "Party."

RECITALS

WHEREAS, on September 16, 2014 Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act of 2014, Water Code Sections 10720 et seq. ("Act"); and

WHEREAS, the Act went into effect on January 1, 2015; and

WHEREAS, the intent of the Act is to provide sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, each Party is a governmental entity that produces groundwater from the Basin; and

WHEREAS, the Act requires that all basins not currently managed be managed through the development of Groundwater Sustainability Plans pursuant to the Act; and

WHEREAS, the Basin is not currently managed and the Parties desire to collectively, with other interested stakeholders, develop and implement a Groundwater Sustainability Plan to sustainably manage the Basin's water resources pursuant to Water Code Sections 10727 et seq.;

NOW, THEREFORE, it is mutually understood and agreed as follows:

Section 1: Purpose and Authorities. This MOA is entered into by the Parties for the purpose of establishing a Groundwater Sustainability Agency under the Act and a framework to develop and implement a Groundwater Sustainability Plan to sustainably manage the Basin in compliance with the Act's requirements. The Parties hereby create the Spadra Basin Groundwater Sustainability Agency ("Agency").

Section 2: Definitions. In addition to the terms previously defined, the following terms, whether used in the singular or plural, and when used with initial capitalization, shall have the meanings specified herein:

A. "Executive Committee" refers to the working group created in Section 4(A), below.

B. "Governing Body" means the legislative bodies, i.e. governing boards, of the Parties to this MOA.

C. "Groundwater Sustainability Agency" or "GSA" refers to the agencies created pursuant to Chapter 4 of the Act (Water Code Sections 10723 through 10724, inclusive), including the Agency created hereunder, to implement the Act's provisions.

D. "Groundwater Sustainability Plan" or "GSP" is the basin plan for the Basin, which the Parties are seeking to develop and implement through this MOA in accordance with the Act.

E. "Implementation Team" refers to the Parties' staff members who will collaborate in developing the Groundwater Sustainability Plan, as provided in Section 4(B), below.

Section 3: Powers of the Agency: The Agency shall have all powers available to a Groundwater Sustainability Agency under Chapters 5 through 9, inclusive of the Act (Water Code Sections 10725 through 10732, inclusive), which statutes are incorporated herein by this reference. The foregoing powers include the power under Water Code Section 10730 to impose fees on groundwater production to fund the preparation of a Basin study to provide information necessary to develop the GSP.

Section 4: Establishment of the Agency's Executive Committee and Related Processes:

A. Establishment of the Spadra Basin Groundwater Sustainability Agency Executive Committee.

1. The Parties hereby establish the Spadra Basin GSA Executive Committee. Each Party shall appoint a member to the Executive Committee. To provide for consistent and effective communication among the Parties, each Party agrees that its designated Executive Committee representative is its central point of contact on matters relating to this MOA. The Executive Committee may select an Administrative Officer from among the Parties' staffs to act as the chief administrative officer of the Agency. Additional representatives may be appointed to serve as points of contact on specific actions or issues.

2. Each Executive Committee member's compensation for their service on the Executive Committee will be the responsibility of the Party who appoints that member and on whose behalf that member serves.

3. Each Executive Committee member shall serve at the pleasure of the Party that appointed that member, and may be removed from the Executive Committee by that appointing Party at any time.

4. The Executive Committee will meet periodically as needed to carry out the activities described below, but at least annually. The Executive Committee shall establish policies and procedures regarding the conducting of its meetings, including, but not limited to, establishing notice requirements, quorum and required votes on Executive Committee decisions. The Executive Committee will prepare and maintain minutes of its meetings.

5. The Executive Committee shall direct the Implementation Team and any consultants in connection with the development of the Basin's Groundwater Sustainability Plan in accordance with Water Code Sections 10727.2 and 10727.4.

6. The Executive Committee will provide information, guidance, and advice to the Implementation Team regarding the Basin's GSP, on matters such as: (a) developing a GSP that achieves the goals and objectives outlined in the Act; (b) implementing the actions undertaken pursuant to this MOA and resolving any issues related to these actions; (c) measures that may be implemented in the event insufficient or unsatisfactory progress is being made in developing or implementing the Groundwater Sustainability Plan; and (d) to the extent deemed appropriate, developing a stakeholder participation plan (including establishment of an advisory committee) that involves the public and area stakeholders in developing and implementing the GSP.

7. Before a Party may withdraw from this MOA as provided below, the Parties agree to bring any disputes over any of the activities discussed in this MOA to the Executive Committee.

B. Establishment of the Implementation Team.

1. The Parties hereby establish the Implementation Team that will develop a process to direct and coordinate GSP activities, including the development, planning, financing, environmental review, permitting, implementation, and long-term monitoring of the GSP.

2. The Implementation Team will be selected by the Executive Committee from among the staffs of the Parties. Each Implementation Team member shall serve at the pleasure of the Executive Committee and may be removed by majority vote of the Executive Committee at any time.

3. Notwithstanding subdivision 2, above, the Executive Committee may appoint an outside consultant not employed by any Party to serve on the Implementation Team. In that event, the Executive Committee shall determine how the costs for that

consultant are to be equitably allocated among the Parties or among the producers of groundwater from the Basin.

4. Subject to subdivision 3, above, each Implementation Team member's compensation for their service on the Implementation Team is the responsibility of the Party who regularly employs that member.

5. The Implementation Team shall develop and implement, with input and oversight from the Executive Committee, a stakeholder participation plan and related outreach that involves the public and area stakeholders in developing and implementing the GSP. That plan shall include the establishment of an advisory committee pursuant to Water Code Section 10727.8(a) to include representatives of California State Polytechnic University, Pomona and Rowland Water District.

C. Implementation Team Meetings.

1. The Implementation Team will establish a meeting schedule for regular meetings to discuss GSP development and implementation activities, assignments, and ongoing work progress.

2. The Implementation Team may establish committees as it deems necessary to address particular issues and may schedule meetings of committees as it sees fit to coordinate development and implementation of the GSP.

3. Attendance at all Executive Committee and Implementation Team meetings may be augmented to include staff or consultants to ensure that the appropriate expertise is available.

4. The Implementation Team will meet at least quarterly with the Executive Committee, and more frequently as needed, to provide status updates and discuss matters covered in this MOA.

Section 5: Roles and Responsibilities of the Parties:

A. The Parties will work collectively to meet the objectives of this MOA.

B. The Parties will appoint representatives to the Executive Committee and Implementation Team in a timely manner.

C. The Parties will each be responsible for implementing the GSP in their respective jurisdictions.

D. The Parties will coordinate all activities related to fulfillment of the objectives of this MOA. The Parties shall cooperate with one another and work as efficiently as possible in the pursuit of all activities and decisions described in this MOA and those that are not particularly described but which are related to or arise out of the activities that are described.

E. As requested by the Executive Committee or Implementation Team, each of the Parties will provide expertise, guidance, and data on those matters for which it has specific expertise or authority, as needed to carry out the objectives of this MOA.

F. After execution of this MOA, the Implementation Team, with input from the Executive Committee, shall develop a plan that describes the anticipated tasks to be performed under this MOA and a schedule for performing said tasks. That plan and schedule shall become part of this MOA as an exhibit that is incorporated by reference. That plan and schedule may be amended as necessary to conform to developing information, permitting, and other requirements related to development of the GSP. Therefore, the exhibit setting forth that plan and schedule may be revised from time to time upon agreement of the Executive Committee without constituting an amendment to this MOA.

G. The Parties will provide support to the Executive Committee and Implementation Team by contributing staff time, information, and facilities within available resources.

Section 6: Funding:

A. WVWD shall serve as the treasurer for purposes of this MOA. WVWD shall hold all monies to be contributed by the Parties hereunder and shall, upon approval of the Executive Committee, pay all invoices and bills relating to work undertaken and/or services rendered in connection with this MOA.

B. Within seven (7) days after execution of this MOA by the last of the Parties to sign it, each Party shall contribute to the Agency, by payment to WVWD, an initial sum of $2,500 to provide startup funding for the Agency's initial operations.

C. The Executive Committee shall establish an annual budget and shall determine an equitable cost sharing arrangement among the Parties for work to be undertaken under this MOA. Other than the initial startup contributions set forth in subparagraph B, above, both the budget and cost sharing agreement shall be determined before any further contributions of the Parties shall be required.

Section 7: Termination and Withdrawal:

A. Terminating the Agreement. This MOA may be terminated upon unanimous written consent of all Parties. Upon the termination of this MOA, any remaining funds, after payment of all of the Agency's liabilities, shall be distributed to the Parties in the proportion that each Party contributed to the Agency.

B. Withdrawal. A Party may unilaterally withdraw from this MOA without causing or requiring termination of the MOA, effective upon thirty (30) days' written notice to the remaining Parties' designated addresses as listed in Section 10, below. A Party that has withdrawn from this MOA shall remain obligated to pay its share of expenses and obligations as

outlined in the budget and cost sharing agreement incurred or accrued up to the date the Party's withdrawal is completed.

Section 8: Amendments: This MOA may be amended only by a subsequent writing, approved and signed by all Parties. Approval from a Party is valid only after that Party's Governing Body approves the amendment at a public meeting. Executive Committee Members, Implementation Team Members, and individual Governing Board members do not have the authority, express or implied, to amend, modify, waive or in any way alter the terms and conditions of this MOA.

Section 9: Indemnification: No Party, nor any officer or employee of a Party, shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by another Party under or in connection with this MOA. The Parties further agree, pursuant to California Government Code section 895.4, that each Party shall fully indemnify and hold harmless each other Party and its agents, officers, employees and contractors from and against all claims, damages, losses, judgments, liabilities, expenses, and other costs, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any work delegated to or action taken or omitted to be taken by such Party under this MOA.

Section 10: Notices: Any written communication required or permitted to be given hereunder will be deemed received upon personal delivery, including by overnight delivery, delivery via e-mail or by fax (provided that any e-mail or fax notice must be confirmed telephonically); or forty-eight (48) hours after deposit in any United States mail depository, first class postage prepaid, and addressed to the Party for whom intended as follows:

If to City:
City of Pomona
Attn: Director of Public Works
505 South Garey Avenue
Pomona, CA 91766

If to WVWD:
Walnut Valley Water District
Attn: General Manager
271 South Brea Canyon Road
Walnut, CA 91789

Section 11: Miscellaneous:

A. Execution in Counterparts. This MOA may be signed in counterparts, or by signatures transmitted by electronic of fax transmission. Such electronic or faxed signatures shall be considered as valid as a wet ink signature.

B. Term of MOA. The term of this MOA is indefinite and will cease existence only upon termination by the Parties pursuant to Section 7 of this MOA.

C. Signing Authority. Each of the Parties represent that the persons signing this MOU have the appropriate authority to execute this MOU and bind the respective Party to the terms contained herein.

D. Governing Law. This MOA is governed by and is to be construed in accordance with the laws of the State of California.

E. Severability. If any provision of this MOA is determined to be invalid or unenforceable, the remaining provisions will remain in force and unaffected to the fullest extent permitted by law and regulation.

F. Entire Agreement. This MOA constitutes the sole, entire, integrated and exclusive agreement between the Parties regarding the contents herein. Any other contracts, agreements, terms, understandings, promises or representations not expressly set forth or referenced in this writing are null and void and of no force and effect.

G. Construction and Interpretation. The Parties agree and acknowledge that this MOA has been developed through negotiation, and that each party has had a full and fair opportunity to revise the terms of this MOA. Consequently, the normal rule of construction that any ambiguities are to be resolved against the drafting party shall not apply in construing or interpreting this MOA.

IN WITNESS WHEREOF, the Parties have agreed to execute this MOU as of February 28, 2017.

City of Pomona

By: Linda C. Lowry
Name:
Its:

Walnut Valley Water District

By: Michael Holmes
Name: Michael K. Holmes
Its: General Manager

Appendix C

Bylaws for Spadra Basin GSA

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY
BYLAWS

INTRODUCTION: These Bylaws are adopted by the Spadra Basin Groundwater Sustainability Agency (the "Agency") to implement the Memorandum of Agreement to Establish a Groundwater Sustainability Agency for the Spadra Groundwater Basin (the "MOA"), entered into by the City of Pomona (the "City") and Walnut Valley Water District (the "District") on February 27, 2017. The City and District are each referred to herein as a "Member Agency."

1. Executive Committee. The governing body of each Member Agency shall appoint one (1) representative to the Executive Committee and one (1) or more alternates to serve in the absence of the appointed representative. In the absence of an Executive Committee member, a duly appointed alternate shall assume the duties of appointed member and have full power and authority to act for and in the place of the absent Executive Committee member, and shall be counted for purposes of a quorum in the absence of a member.

Each Executive Committee member or alternate shall receive such compensation for his or her services as shall be determined and paid by the Member Agency appointing him or her.

Executive Committee members and alternates shall serve and be subject to removal and replacement at the pleasure of the Member Agency appointing him or her. On the resignation, removal or incapacity of any Executive Committee member or alternate, the Member Agency that appointed him or her shall within thirty (30) calendar days after such event appoint a replacement. Appointment of Executive Committee members and alternates shall be made by resolution or motion of the governing body of each Member Agency and each Member Agency shall file with the Agency a copy of the resolution or copies of the minutes appointing or approving the appointment of its Executive Committee member and alternate.

2. Executive Committee Officers. At the first regular meeting in a calendar year, the Executive Committee shall elect one of its members President and he or she shall preside at the meetings of the Executive Committee during that calendar year. The Executive Committee also shall annually elect one of its members Vice President who shall preside at meetings and events in the absence of the President.

In the event that each Member Agency's appointed member should be absent from a meeting, the alternate shall assume the duties of office of the member appointed by the Member Agency.

The term of the President and Vice President shall be one (1) year and a

President or Vice President may not serve two (2) successive terms in the same position. In the event a vacancy occurs in the office of President, the Vice President shall assume that position for the remainder of the unexpired term, which assumption of office shall not be considered in determining successive terms.

3. Executive Committee Meetings. The Executive Committee shall fix a time and place for its regular meetings and shall hold at least one regular meeting each calendar quarter. If at any time a regular meeting falls on a holiday, such regular meeting shall be held on the next business day. Special meetings may be called at any time by either member of the Executive Committee. Notices of all Executive Committee shall be provided in accordance with the Brown Act (Government Code Sections 54950 et seq.).

Except for closed session meetings conducted in accordance with California law, all Executive Committee meetings shall be open to the public. The Executive Committee acting by and through its designated agent shall keep full and complete minutes of all meetings which, except as provided by California law with respect to closed session meetings, shall be public documents and available for inspection at the office of the Administrative Officer.

4. Appointment of Administrative Officer, Treasurer and Implementation Team. The Executive Committee shall by majority vote designate the Agency's Administrative Officer and Treasurer, to carry out the respective duties specified in Sections 5 and 6, below. The Administrative Officer and Treasurer shall serve at the pleasure of the Executive Committee, until such time as the designated officer resigns, is replaced by the Executive Committee or is otherwise not able to continue to serve in his or her position.

The Executive Committee shall also select the members of the Agency's Implementation Team from the Member Agencies' respective staffs to carry out the duties specified in Section 7, below, in accordance with the MOA. The members of the Implementation Team shall serve at the pleasure of the Executive Committee, until such time as such Implementation Team member resigns, is replaced by the Executive Committee or is otherwise not able to continue to serve in that position.

5. Administrative Officer's Duties. The Administrative Officer of the Agency shall be responsible for the day-to-day conduct of the Agency's business and shall:

a. Report regularly to the Executive Committee at its meetings;
b. Supervise all personnel and activities in support of the Agency;
c. Direct the general operation and business affairs of the Agency;
d. Coordinate with other public agencies any activities that affect operation of the Agency;
e. Recommend to the Executive Committee any financial and operational

needs for the effective operation of the Agency;

f. Prepare the Agency's operating budget, subject to Executive Committee approval and adoption;
g. Provide an administrative employee to attend Executive Committee meetings and perform secretarial services related thereto;
h. Prepare Executive Committee documents, including minutes of Executive Committee meetings, notices, reports, agendas and resolutions; and
i. Maintain the records and files of the Agency.

While providing the above services, the Administrative Officer shall be an employee of his or her Member Agency, and not an employee of the Agency.

6. Treasurer's Duties. The Treasurer of the Agency shall have the following duties and be responsible:

a. To receive monies for deposit in the Agency's accounts;
b. To invest surplus funds as permitted by California Law;
c. To transfer funds into the Agency's checking account as necessary to pay warrants;
d. To accurately maintain the Agency's accounting books, records and financial files;
e. To post monthly financial activity to ledgers and journals;
f. To maintain accounts payable, accounts receivable and financial files;
g. To provide information for the annual audit on or before August 1 each year;
h. To prepare financial statements as directed by the Administrative Officer;
i. To prepare and send any billings to any person or entity;
j. To assist the Administrative Officer in preparation of the Agency's operating budget; and
k. To attend meetings of the Executive Committee and prepare such reports in connection therewith as may be appropriate or as directed by the Executive Committee or the Administrative Officer.

While providing the above services, the Treasurer shall be considered an employee of his or her Member Agency, and not an employee of the Agency.

7. Implementation Team's Duties. The Implementation Team shall oversee and coordinate the development of the Groundwater Sustainability Plan for the Spadra Basin (the "GSP"), and shall coordinate the stakeholder participation plan in connection with the development of the GSP. The Implementation Team shall meet at least quarterly. Further details regarding the Implementation Team are set forth in Section 4(B), 4(C) and 5(F) of the MOA, which are incorporated herein by this reference.

8. Budget. On or before June 30 of each year, the Executive Committee shall approve and adopt an annual budget for the Agency for the coming July 1-June 30 fiscal year. The Treasurer shall oversee the preparation of the budget for the Executive Committee's review and approval.

9. Amendments. These bylaws may be amended at any time, and from time to time, by the unanimous vote of the Executive Committee's members.

Appendix D

Beneficial Uses and Users of Groundwater in Spadra Basin

SPADRA BASIN
GROUNDWATER SUSTAINABILITY AGENCY

LIST OF ALL BENEFICIAL USES AND USERS OF GROUNDWATER

In accordance with Water Code Sections 10723.2 and Section 10723.8 (a) (4), the following parties have or will be contacted to determine how best to consider and protect their interests throughout the formation of the GSA, development of a GSP, and implementation of the GSP. These interests include, but are not limited to, the following:

(a) **Holders of overlying groundwater rights, including (1) agricultural users and (2) domestic water-well owners:** The City of Pomona (City), Walnut Valley Water District (WVWD), California Polytechnic University, Pomona (Cal Poly Pomona), and (we believe) Walnut Hills Mobile Home Community. Cal Poly Pomona and Walnut Hills Mobile Home Community will be invited to join the Spadra Basin GSA Advisory Committee.

(b) **Municipal Well Operators:** The City, WVWD and Cal Poly Pomona.

(c) **Public Water Systems:** The City, WVWD and Cal Poly Pomona.

(d) **Local Land Use Planning Agencies:** The City.

(e) **Environmental Users of Groundwater:** None.

(f) **Surface Water Users:** Not applicable.

(g) **Federal Government:** None.

(h) **California Native American Tribes:** None.

(i) **Disadvantaged Communities:** Portions of the City are considered Disadvantaged Communities by DWR.

(j) **Entities Listed in SGMA Section 10927 that are monitoring groundwater elevations in all or part of the WMA managed by the GSA:** None.

Appendix E

Public Notices

Inland Valley Daily Bulletin
(formerly the Progress Bulletin)
9616 Archibald Avenue Suite 100
Rancho Cucamonga, CA 91730
909-987-6397
legals@inlandnewspapers.com

(Space below for use of County Clerk Only)

RECEIVED
CITY CLERK

2017 MAR -2 PM 4:20

PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA
County of Los Angeles

I am a citizen of the United States, I am over the age of eighteen years, and not a party to or interested in the above-entitled matter. I am the principal clerk of the printer of INLAND VALLEY DAILY BULLETIN, a newspaper of general circulation printed and published daily for the City of Pomona, County of Los Angeles, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Los Angeles, State of California, on the date of June 15, 1945, Decree No. Pomo C-606. The notice, of which the annexed is a true printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to wit:

2/13, 2/20/17

I declare under the penalty of perjury that the foregoing is true and correct.

Executed at Rancho Cucamonga, San Bernardino Co. California

This 20 Day of February, 2017

Signature

NOTICE OF PUBLIC HEARING TO CONSIDER FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SPADRA BASIN

Notice is hereby given that the City of Pomona ("City") will hold a public hearing regarding the adoption of a Resolution of Intent to form a Groundwater Sustainability Agency ("GSA") pursuant to the Sustainable Groundwater Management Act, Part 2.74 of Division 6 of the California Water Code (commencing with Section 10720). The boundaries of the proposed GSA are the boundaries of the Spadra Sub-basin of the San Gabriel Valley Groundwater Basin (Basin No. 4-013), as described in California Department of Water Resources Bulletin 118 (2016 update). The public hearing is for the purpose of reviewing and providing explanation of the proposal, and allowing public input on the formation of the proposed GSA.

The public hearing will be held on the following date and time, and at the following location:

Monday, February 27, 2017
6:45 p.m.
City of Pomona,
Council Chamber
505 S. Garey Avenue,
Pomona, CA 91766

Individuals with a disability requiring a modification or accommodation, including auxiliary aids or services, or require the services of an interpreter in order to participate in the public meeting may make these requests to the City Clerk's Office at (909) 620-2341. The City Clerk's Office will make every effort to accommodate requests for assistance. Requests should be made as soon as possible, and at a minimum 24 hours in advance of the public hearing.

Please Note: If you challenge this matter in court, you may be limited to raising only those issues you or someone else raised concerning this matter either at the public hearing, or in writing delivered to the City of Pomona City Clerk at, or prior to, the public hearing.

Para información en Español, llame (909) 620-2191.

DATE: February 2017

Darron Poulsen,
Water and Waste Water Operations Director

Eva Buice, City Clerk

Publication Dates: February 13, 2017, and February 20, 2017 #896790

San Gabriel Valley Tribune
Affiliated with SGV Newspaper Group
605 E. Huntington Dr., Suite 100
Monrovia, CA 91016
626-962-8811 ext. 40891

(Space below for use of County Clerk Only)

5040767

WALNUT VALLEY WATER DISTRICT
271 S. BREA CANYON RD.
WALNUT, CA 91789

Legal No. **0010898252**

NOTICE OF PUBLIC HEARING TO CONSIDER FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SPADRA BASIN

Notice is hereby given that the Walnut Valley Water District ("District") will hold a public hearing regarding the adoption of a Resolution of Intent to form a Groundwater Sustainability Agency ("GSA") as set forth in the Sustainable Groundwater Management Act, Part 2.74 of Division 6 of the California Water Code (commencing with Section 10720). The boundaries of the proposed GSA are the boundaries of the Spadra Sub-basin of the San Gabriel Valley Groundwater Basin (Basin No. 4-013), all as described in California Department of Water Resources Bulletin 118 (2016 update). The public hearing is for the purpose of reviewing and providing explanation of the proposal to form the GSA, and allowing public input on that formation process.

The public hearing will be held on the following date and time, and at the following location:

Tuesday, February 28, 2017 6:30 p.m.
Walnut Valley Water District - Board Room
271 South Brea Canyon Road
Walnut, California 91789

Individuals with a disability requiring a modification or accommodation, including auxiliary aids or services, or require the services of an interpreter in order to participate in the public meeting may make these requests to Donna DiLaura, the District's Board Secretary at (909) 595-1268. The Board Secretary will make every effort to accommodate requests for assistance. Requests should be made as soon as possible, and at a minimum 24 hours in advance of the public hearing.

Published: San Gabriel Valley Tribune Feb 13, 20, 2017 Ad#898252

PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA
County of Los Angeles

I am a citizen of the United States, and a resident of the county aforesaid; I am over the age of eighteen years, and not a party to or interested in the above-entitled matter. I am the principal clerk of the printer of SAN GABRIEL VALLEY TRIBUNE, a newspaper of general circulation which has been adjudicated as a newspaper of general circulation by the Superior Court of the County of Los Angeles, State of California, on the date of September 10, 1957, Case Number 684891. The notice, of which the annexed is a true printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to wit:

02/13/2017, 02/20/2017

I declare under the penalty of perjury that the foregoing is true and correct.

Executed at West Covina, LA Co. California
On this 8th day of March, 2017.

Carla Asmundson

Signature

Appendix F

Spadra Basin GSA Stakeholder Engagement Plan

PROTECTING RESOURCES
PARTNERING IN SOLUTIONS

SPADRA BASIN

GROUNDWATER SUSTAINABILITY AGENCY

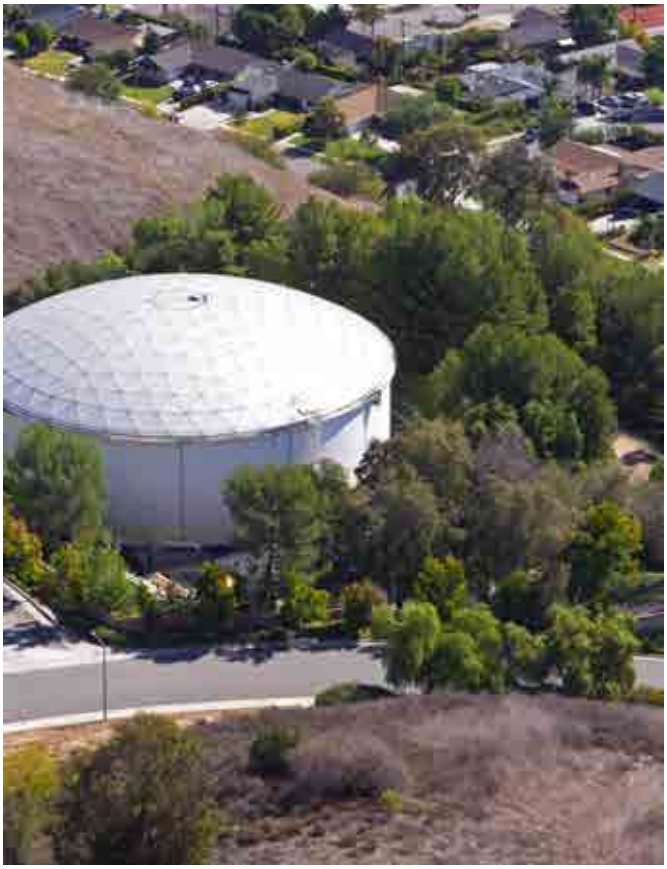
STAKEHOLDER ENGAGEMENT PLAN

JULY 2019

Overview

In 2014, the State of California enacted the Sustainable Groundwater Management Act (SGMA). The intent of the SGMA is to promote the sustainable use and management of groundwater resources without causing undesirable results over a 50-year planning horizon.

The SGMA empowers local public agencies to form Groundwater Sustainability Agencies (GSAs) to manage groundwater basins sustainably, and requires those GSAs to prepare and adopt Groundwater Sustainability Plans (GSPs) for all important groundwater basins in California. The SGMA requires that basins designated by the California Department of Water Resources (DWR) as "high" or "medium" priority will be managed under a GSP. The DWR designated the Spadra Basin as a "very low" priority basin.

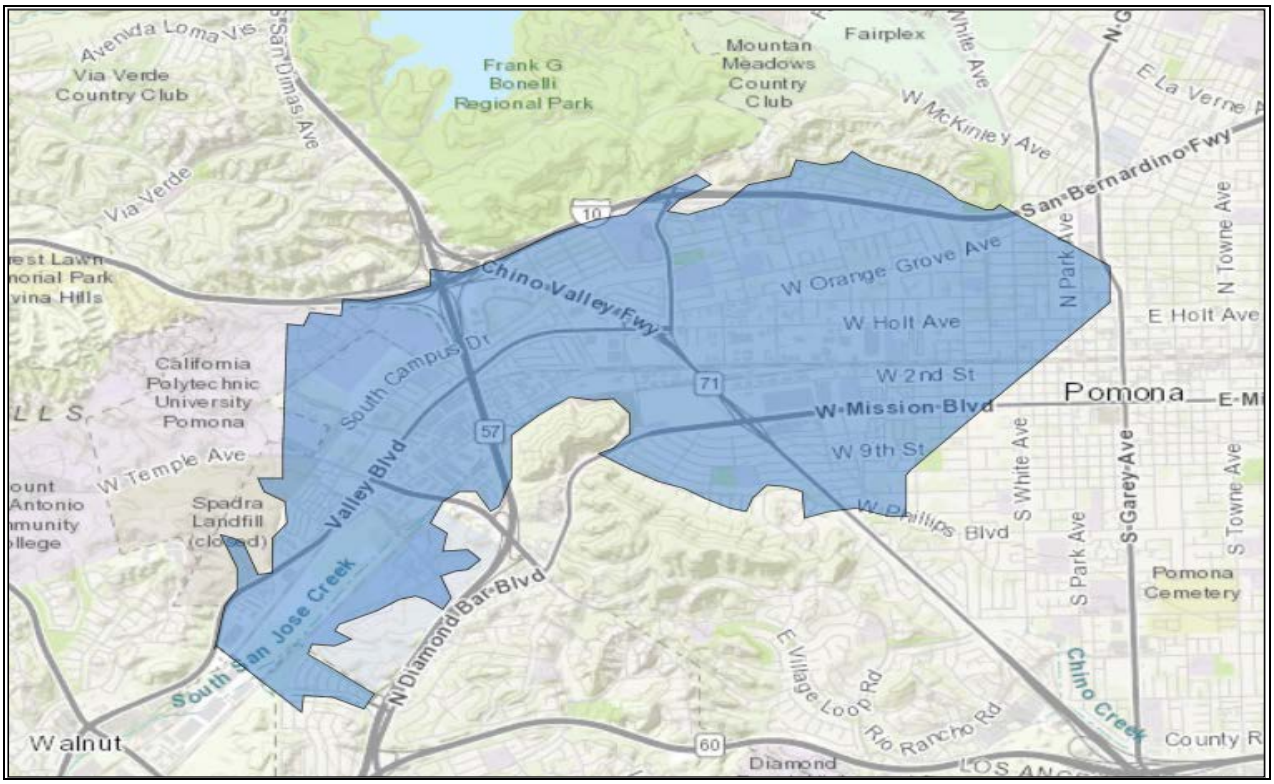


Background on Spadra Basin GSA

The Spadra Basin is a relatively small groundwater subbasin of the San Gabriel Valley Basin (DWR Basin 4-013) located in the City of Pomona in eastern Los Angeles County. The groundwater rights within most portions of the San Gabriel Valley Basin have been adjudicated (e.g. the Main San Gabriel Basin, Six Basins, and Puente Basin), but the Spadra Basin was not included in those adjudications. The Spadra Basin serves as a groundwater supply to the City of Pomona, Walnut Valley Water District, Cal Poly Pomona, and other private pumpers. Water from the basin is used by local residents and for industrial and irrigation purposes.

Although it is not a strict requirement of the SGMA, the Spadra Basin Groundwater Sustainability Agency (Spadra GSA) was formed in February 2017 under a Memorandum of Agreement between the City of Pomona (City) and the Walnut Valley Water District (District) and elected to prepare and adopt a GSP for the Spadra Basin with the objectives of maximizing its beneficial use while ensuring long-term sustainability. The Spadra GSA secured a State grant to fund the development of a portion of the GSP. The GSP must be submitted to the DWR by January 2022.

Figure 1: Spadra Basin GSA Boundaries Map



Purpose

The SGMA requires that a GSA must consider the interests of all beneficial uses and users of groundwater in the development of the GSP. Hence, the GSA needs to consider the effect of the GSP on stakeholders located within or around the groundwater basin and document the opportunities for public engagement and active involvement of diverse social, cultural, and economic elements of the population within the basin. The Spadra GSA has prepared this Stakeholder Engagement Plan to satisfy these requirements of the SGMA, encourage public participation, and describe the ways that the public and interested stakeholders can

participate in the development and implementation of the Spadra Basin GSP.

This Stakeholder Engagement Plan has been developed pursuant to California Water Code Section 10723.2. in consideration of the interests of all beneficial uses and users of groundwater in the Spadra Basin. The Plan describes the GSA's program to:

- Identify stakeholders who have an interest in the Spadra Basin
- Understand and involve stakeholders and their concerns in the decision-making and activities of the Spadra GSA
- Inform the stakeholders of the communication and engagement process, and the anticipated schedule for providing information to the stakeholders and receiving feedback during GSP development and its implementation.
- Evaluate the success of stakeholder engagement methods and education.

This engagement plan will be updated as necessary

Spadra GSA Roles and Responsibilities

Executive Committee

The Spadra GSA Executive Committee is the governing body for the Spadra GSA and is responsible for the overall management of the GSA including the development of the Spadra GSP. All meetings will be noticed 72 hours in advance, are open to the public and will include a public comment period. Agendas, minutes, and meeting materials will be available on the Spadra Basin GSA's website (www.spadrabasin.com). The Spadra GSA Executive Committee members are listed in Appendix A.

Implementation Team

The Spadra GSA Implementation Team is comprised of staff from each of the participating Spadra GSA agencies and provides the administrative and technical support necessary to manage the Spadra GSA, including coordination of the GSP process. The Spadra GSA Implementation Team members are listed in Appendix A.

Advisory Committee

Comprehensive stakeholder involvement includes the establishment of an Advisory Committee to aid in the development of the GSP. All meetings will be noticed and will be open to the public. Agendas, minutes, and meeting materials will be posted on the Spadra GSA website (www.spadrabasin.com).

Project Schedule

The final GSP must be submitted to the California DWR by January 2022. The project schedule is designed to solicit, consider, and address public and stakeholder input regarding the important planning elements, including Basin conditions, groundwater modeling, sustainability goals, sustainability criteria, management actions, implementation plan, and the draft and final GSP.

The GSP will be based on hydrologic and hydrogeologic data, modeling, and evaluation of surface water and groundwater conditions, water uses, and water management options. Public outreach and engagement will be an important element of efforts to collect, review, validate, and refine the data and evaluation that will form the basis of the GSP and future management actions.

Listed below are the major phases of the development and adoption GSP process and the estimated timeline for completion of each phase.

- Phase I – Develop Hydrogeologic Conceptual Model and Groundwater Model for the Spadra Basin (May, 2019 through June, 2020)
- Phase II – Develop Sustainable Management Criteria for the Spadra Basin (March, 2020 through May, 2020)
- Phase III – Evaluate the Sustainability of Future Baseline Conditions (May, 2020 through December, 2020)
- Phase IV – Evaluate Basin Optimization Scenarios to Achieve Sustainability (January, 2021 through September, 2021)
- Phase V - Develop Groundwater Sustainability Plan (GSP) (July, 2021 through December, 2021)

This phased approach to preparing the GSP includes the development of five key Technical Memorandums (TMs) as interim milestones within the schedule:

1. Conceptual Model of the Spadra Basin
2. Construction and Calibration of the Spadra Basin Groundwater Model
3. Sustainable Management Criteria for the Spadra Basin
4. Sustainability of Future Baseline Conditions
5. Basin Optimization Scenario to Achieve Sustainability

These TMs will allow for efficient and focused review by GSA staff and the planned stakeholder Advisory Committee of the complex information that will form the foundation of the GSP. The schedule for review and feedback on these TMs will be posted on the GSA website (www.spadrabasin.com).

Key Messages

- Walnut Valley Water District and City of Pomona formed the Spadra Basin Groundwater Sustainability Agency in February of 2017 to comply with the Sustainable Groundwater Management Act of 2014 (SGMA).
- The Spadra Basin GSA is currently crafting a Groundwater Sustainability Plan, which is designed to protect and manage the Spadra Basin.
- Spadra Basin provides water to local residents for industrial and irrigation uses.
- Primary stakeholders include Walnut Valley Water District, City of Pomona, Cal Poly Pomona, and Rowland Water District.
- Spadra Basin GSA is dedicated to keeping stakeholders informed by providing educational tools and resources.
- Public input will be sought and considered throughout the Groundwater Sustainability Plan process.
- A Stakeholder Advisory Committee including primary stakeholders will be created to provide the GSA with feedback through the major stages of the plan.
- Safeguarding our local groundwater basins is vital to the long-term health and sustainability of our current water supply and ensures a reliable water source for future regional needs.

Opportunities for Public Involvement

Spadra Basin GSA is committed to frequent, transparent communication with stakeholders and interested parties. The following opportunities outline the numerous ways Spadra Basin GSA will work to engage the public and provide updates in a timely manner:

Public Notices

To ensure that the general public is apprised of local activities and allow stakeholders to access information, SGMA specifies several public notice requirements for GSAs. Refer to Appendix B for a summary of statutory

requirements. In addition, although not required by statute, certain additional notices will be published in local newspapers and distributed in an effort to ensure potential stakeholders are advised of important information during the GSP process.

Stakeholder Identification

According to Water Code section 10723.3, the GSP development process will consider the interests of holders of overlying groundwater rights (including agricultural users and domestic well owners), municipal well operators, public water systems, local land use planning agencies, environmental users of groundwater, surface water users, the federal government, Native American tribes, disadvantaged communities, and other local agencies that were monitoring and managing groundwater usage in the GSP area. The Spadra Basin GSA has compiled an initial list of stakeholders and interested persons for this purpose. The initial list has been included in Appendix C.

Public Meetings

Spadra Basin GSA Executive Committee Meetings, and Advisory Committee meetings will be regularly scheduled throughout the GSP development process. All meetings will be open to the public, will be noticed at least 72 hours prior, and will include a scheduled time for public comments.

Spadra Basin GSA Website (www.spadrabasin.com)

A Spadra Basin GSA website has been established and will be the central repository for all information related to the Spadra Basin GSA and the GSP process. All scheduled meetings and agendas, notices, press releases, project reports and other related information will be available on the website. In addition, the website provides options for contacting the Spadra Basin GSA, and interested parties can sign-up to receive all GSA and GSP related notifications.

Interested Persons Database

To distribute information about the Spadra Basin GSA and GSP development, an email list has been compiled into a database of interested persons and stakeholders. The database will be updated regularly to add names of attendees at public meetings along with those requesting information via email or the through the Spadra Basin GSA website. Regular mail will be used for any person(s) that does not have access to email. Subscribers will also receive news and updates about the GSA process. Spadra Basin GSA will explore additional opportunities to grow the email subscription list and the type of information distributed.

Evaluation

To determine the level of success of the Engagement Plan, the Spadra Basin GSA will implement the following measures:

Attendance/Participation

A record of those attending public meetings will be maintained throughout the GSP development process. The Spadra Basin GSA will utilize sign-in sheets and request feedback from attendees to determine adequacy of public education and engagement in the GSP development and implementation process.

Adherence to Schedule

Public participation in the GSP process is instrumental to the success of the project. Keeping the project and related tasks on schedule will help promote and ensure active stakeholder involvement. The Spadra Basin GSA will make every effort to ensure the GSP project and related tasks are completed on schedule.

Communication with Spadra Basin GSA

The following personnel will serve as contacts for the public during preparation of the GSP or information related to the Spadra Basin GSA.

General Information
For general information about the Spadra Basin GSA contact:
Brian Teuber, Administrative Officer, Telephone: 909-348-8202
Email: bteuber@wvwd.com.

GSP Project Manager
Stakeholders and any public seeking specific information about the GSP may contact:
Sherry Shaw, P.E., Telephone: 909-595-1268 Ext. 234
Email: sshaw@wvwd.com

Spadra Basin Website
For additional information and resources, please visit the website at www.spadrabasin.com.

APPENDIX A

Spadra Basin GSA Committee and Implementation Team Members

Executive Committee Members

Two each from the City of Pomona and Walnut Valley Water District:

Vacant	President, Walnut Valley Water District
Victor Preciado	Vice President, City of Pomona
Nora Garcia	Alternate, City of Pomona
Jerry Tang	Alternate, Walnut Valley Water District

The Executive Committee have appointed the following positions:

Brian Teuber	Administrative Officer
Jim Ciampa	Legal Counsel

Implementation Team Members

Joshua Byerrum	Walnut Valley Water District
Chris Diggs	City of Pomona
Erik Hitchman	Walnut Valley Water District
Damian Martinez	City of Pomona
Sherry Shaw	Walnut Valley Water District
Brian Teuber	Walnut Valley Water District

Advisory Committee

Bob Bowcock/Kevin Sage	Forest Lawn
Rick Hansen/George Lwin	Cal Poly Pomona
Timothy Kellet/Carlos Goytia	Three Valleys Municipal Water District
Dave Warren/Tom Coleman	Rowland Water District

APPENDIX B

Summary of Statutory Requirements for Stakeholder Engagement

During GSA Formation:	
"Before electing to be a groundwater sustainability agency… the local agency or agencies shall hold a public hearing."	Water Code Sec. 10723 (b)
"A list of interested parties [shall be] developed [along with] an explanation of how their interests will be considered."	Water Code Sec. 10723.8.(a)(4)
During GSP Development and Implementation:	
"A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing".	Water Code Sec. 10728.4
"Prior to imposing or increasing a fee, a groundwater sustainability agency shall hold at least one public meeting".	Water Code Sec. 10730(b)(1)
"The groundwater sustainability agency shall establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents".	Water Code Sec. 10723.4
"Any federally recognized Indian Tribe… may voluntarily agree to participate in the preparation or administration of a groundwater sustainability plan or groundwater management plan… A participating Tribe shall be eligible to participate fully in planning, financing, and management under this part".	Water Code Sec. 10720.3(c)
"The groundwater sustainability agency shall make available to the public and the department a written statement describing the manner in which interested parties may participate in the development and implementation of the groundwater sustainability plan".	Water Code Sec. 10727.8(a)
Throughout SGMA Implementation:	
"The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater".	Water Code Sec. 10723.2
"The groundwater sustainability agency shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin".	Water Code Sec. 10727.8(a)

Source: Community Water Center. *Collaborating for Success: Stakeholder Engagement for Sustainable Groundwater Management Act Implementation.* July 2015.

APPENDIX C
Initial Stakeholder List

Name

Frank G. Bonelli Park
CA Department of Fish and Wildlife
California Department of Water Resources
Cal Poly Pomona
California Department of Transportation - District 7
Chino Basin Watermaster
City of Diamond Bar
City of Diamond Bar City Council
City of Industry
City of Industry City Council
City of Pomona
City of Pomona Office of the Mayor and City Council
City of Walnut
City of Walnut City Council
County Board of Supervisors
Dyett and Bhatia Urban and Regional Planners
Inland Empire Utilities Agency
County of LA Department of Public Works - Water Resources
Los Angeles County Flood Control District
LA County Sanitation District
LA Regional Water Quality Control Board
Main San Gabriel Basin Watermaster
Metropolitan Water District of Southern California
Historical Society of Pomona Valley
Puente Basin Watermaster
Rowland Heights Community Coordinating Council
Six Basins Watermaster
Southern California Association of Governments (SCAG)
Three Valleys Municipal Water District
Upper San Gabriel Valley Municipal Water District
U.S. Fish and Wildlife Service
Walnut Hills Mobile Home Community

Appendix G

Comments and Responses on the Draft TMs 1 through 5

G1: TM 1 - Comments and Responses on the November 6, 2019
Draft Technical Memorandum 1 (TM 1): Conceptual Model of the Spadra Basin

G2: TM 2 - Comments and Responses on the May 18, 2020
Draft Technical Memorandum 2 (TM 2): Construction and Calibration of the Spadra Basin Groundwater Model

G3: TM 3 - Comments and Responses on the July 31, 2020
Draft Technical Memorandum 3 (TM 3): Sustainable Management Criteria

G4: TM 4 - Comments and Responses on the December 22, 2020
Draft Technical Memorandum 4 (TM 4): Sustainability of Future Baseline Conditions

G5: TM 5 Part 1 - Comments and Responses on the June 2021
Draft Technical Memorandum 5 (TM 5) PART 1: Sustainability of Basin Optimization Scenarios

G6: TM 5 Part 2 - Comments and Responses on the September 2021
Draft Technical Memorandum 5 (TM 5) Part 2: Sustainability of Basin Optimization Scenarios

G1: TM 1 - Comments and Responses on the November 6, 2019 Draft Technical Memorandum 1 (TM 1): Conceptual Model of the Spadra Basin

COMMENTS AND RESPONSES ON THE NOVEMBER 6, 2019 DRAFT TECHNICAL MEMORANDUM 1 (TM 1): CONCEPTUAL MODEL OF THE SPADRA BASIN

December 2, 2019 comment letter from the State of California Department of Fish and Wildlife

The Department is writing to support ecosystems preservation in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science. In consideration of these SGMA regulations and provided the presence of conserved lands in the Spadra Basin, the Department submits the following comments on the Spadra Basin TM1 for the GSP. The Department requests that the Spadra Basin Groundwater Sustainability Agency address these comments before submitting the GSP to the Department of Water Resources for evaluation.

Comment No. 1. Existing Monitoring and Management Plans, starting page 11; 2.1.3.3 Disposal of Water. The CDFW comment reads: "The description of water use does not incorporate the recent wastewater change petition (SWRCB 2019) from the Pomona Water Reclamation Plant (Pomona WRP) by the Sanitation Districts of Los Angeles County (LA Sanitation Districts).

a. *Issue: According to the TM1 (pp 11): Surface-water monitoring is conducted by the LA Sanitation Districts at the Pomona WRP for discharge and water quality. The TM1 also describes how the recycled water from Pomona WRP is directly reused in the Spadra Basin (TM1 pp 17). The LA Sanitation Districts has filed a wastewater change petition with the State Water Resources Control Board (SWRCB), Division of Water Rights pursuant to Water Code section 1211 (SWRCB 2019). LA Sanitation Districts requested authorization to reduce the discharge of treated wastewater down to zero from the Pomona WRP to the upper watershed of San Jose Creek during the months of the year based on the reduced water demand.*

b. *Recommendation: The Department recommends the final GSP analyze how LA Sanitation Districts' wastewater change petition will affect the surface-water monitoring of San Jose Creek and how the change petition will impact current water use within the Spadra Basin.*

Response. In Section 2.1.3.3 Disposal of Water (page 16), the text was revised to include a description of the LA Sanitation Districts' change petition. The text now reads:

"In 2019, the LA Sanitation Districts filed a wastewater change petition with the State Water Board to reduce the discharge of treated wastewater to South San Jose Creek from the Pomona WRP to zero during all months of the year based on recycled water demand. A notice of the wastewater change petition (WW0104) was published on October 15, 2019 by the State Water Board with a public protest period through November 14, 2019."

The final GSP will analyze how LA Sanitation Districts' wastewater change petition will affect the surface-water monitoring of San Jose Creek and how the change petition will impact current water use within the Spadra Basin.

Comment No. 2. Basin Setting, Section 2.2.5 Surface Water and Groundwater-Dependent Ecosystems, page 42. The CDFW comment reads: *"GDE identification, required by 23 CCR § 354.16(g), is not adequately identified within the Spadra Basin.*

a. *Issue: According to the TM1 (pp 42), "there are no groundwater-dependent ecosystems (GDEs) in the Spadra Basin." After review of the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset as well as GDE Pulse (Kiausmeyer et al. 2019) data, it appears that there is one GDE located within the Spadra Basin. The NC Dataset Viewer identifies California Sycamore as a GDE vegetation community. Mapping GDEs and other beneficial uses/users is an essential component in the consideration, development and implementation of GSPs (Water Code §10723.2) and in assessing if conditions are having potential effects on beneficial uses and users of groundwater.*

b. *Recommendations: The Department recommends the inclusion of additional references for the evaluation of GDEs. The Department recognizes that NCCAG (Kiausmeyer et al. 2018) provided by California Department of Water Resources (CDWR) is a good starting reference for GDE's; however, the Department recommends the final GSP include additional resources (including local knowledge) for evaluating GDE locations. The Department recommends consulting other references, including but not limited to the following tools and other resources: the California Department of Fish and Wildlife (CDFW) Vegetation Classification and Mapping Program (VegCAMP) (CDFW 2019A); the CDFW California Natural Diversity Database (CNDDB) (2019B); the California Native Plant Society (CNPS) Manual of California Vegetation (CNPS 2019A); the CNPS California Protected Areas Database (CNPS 2019B); the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (2018); the USFWS online mapping tool for listed species critical habitat (2019); the United States Forest Service CALVEG ecological grouping classification and assessment system (2019); and other publications by Klausmeyer et al. (2019), Rohde et al. (2018), The Nature Conservancy {TNC) (2014, 2019), and Witham et al. (2014)."*

Response. In Section 2.2.5 Surface Water and Groundwater Dependent Ecosystems (page 42), the text was revised to include a description of the vegetated area identified in the NCCAG dataset, the continued research of potential GDEs, and the consideration of GDEs in the final GSP. The text now reads:

"The GSP Regulations require that GSPs identify groundwater dependent ecosystems (GDEs), and where appropriate, consider the potential impacts on GDEs. GDEs are defined in the GSP Regulations as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." Figure 2-29 is a map of depth-to-groundwater in the Spadra Basin in 2008, a period of highest recorded groundwater levels. Depth-to-groundwater in 2008 ranged from a maximum of about 220 ft-bgs in the eastern portion of the Spadra Basin to a minimum of about 40 ft-bgs at the western margin of the basin. Maximum rooting depths for vegetation in GDEs is typically less than 30 ft-bgs. Because depth-to-groundwater is greater than 40 ft-bgs, and because all stream channels in Spadra Basin are concrete-lined, there appears to be no areas of interconnected groundwater and surface-water or shallow groundwater in the Spadra Basin that are supporting GDEs in the Spadra Basin.

On the DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset map viewer of GDEs[1] there is one small area mapped as a vegetation type commonly associated with the sub- surface presence of groundwater (mapped vegetated area). The mapped vegetated area is shown on Figure 2-29 and includes the dominant species California Sycamore (*Platanus racemose*). The NCCAG data set is to be used as a starting point to identify GDEs with a groundwater basin and should be researched and verified using local knowledge.

The Sycamore trees in mapped vegetated area are located on the northern side of the concrete-lined San Jose Creek and appear to be part of the irrigated urban landscaping along both sides of Campus Drive between Temple Avenue and Kellogg Drive. The estimated depth to groundwater in this mapped vegetated area is greater than 40 ft-bgs, which is likely too deep to support the Sycamores that typically have rooting depths of less than 10 ft-bgs. Additionally, San Jose Creek is concrete-lined along its entire reach within the Spadra Basin and therefore cannot provide recharge to support riparian vegetation. These observations indicate that the mapped vegetative area is not a GDE.

Notwithstanding the above observations, the Spadra GSA will continue to refer to additional resources and local knowledge to identify potential GDEs in the Spadra Basin, and if appropriate, consider the impacts to GDEs in the final GSP.

Comment No. 3. Groundwater Monitoring Section, starting page 13, the CDFW comment reads:

"Shallow groundwater monitoring wells are lacking.

a. *Issue: The current monitoring network lacks a sufficient number and representative distribution of shallow groundwater monitoring wells to monitor impacts to environmental beneficial uses and users of groundwater and interconnected surface waters [23 CCR § 354.34(2)]. Few wells are near the location of the California Sycamore GDE; and therefore, there are few data points on shallow groundwater level trends. These data are critical to understanding groundwater management impacts on fish and wildlife beneficial uses and users of groundwater, including GDEs and interconnected surface water habitats, that are impacted disproportionately by shallow groundwater trends.*

b. *Recommendation: Install additional shallow groundwater monitoring wells near the GDE, ideally upgradient of the GDE location for improved understanding of groundwater quality flowing toward the California Sycamore vegetation. Also, ideally pair multiple-completion wells with streamflow gauges for improved understanding of surface water-groundwater interconnectivity and subsurface recharge channels."*

Response. Figure 2-29 is a map of depth-to-groundwater in the Spadra Basin in 2008, a period of highest recorded groundwater levels. Depth-to-groundwater in 2008 ranged from a maximum of about 220 ft-bgs in the eastern portion of the Spadra Basin to a minimum of about 40 ft-bgs at the western margin of the basin. Maximum rooting depths for vegetation in GDEs is typically less than 30 ft-bgs. Because depth-to-groundwater is greater than 40 ft-bgs, and because all stream channels in Spadra Basin are concrete-lined, there appears to be no areas of interconnected groundwater and surface-water or shallow groundwater in the Spadra Basin that are supporting GDEs or other environmental beneficial uses in the Spadra Basin.

[1] The NCCAG data set (https://gis.water.ca.gov/app/NCDatasetViewer/) is a compilation of 48 publicly available State and federal agency dataset that map vegetation, wetlands, springs, and seeps in California, developed through a screening process by a working group comprised of DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy.

The Sycamore trees in mapped vegetated area are located on the northern side of the concrete-lined San Jose Creek and appear to be part of the irrigated urban landscaping along both sides of Campus Drive between Temple Avenue and Kellogg Drive. The estimated depth to groundwater in this mapped vegetated area is greater than 40 ft-bgs, which is likely too deep to support the Sycamores that typically have rooting depths of less than 10 ft-bgs. Additionally, San Jose Creek is concrete-lined along its entire reach within the Spadra Basin and therefore cannot provide recharge to support riparian vegetation. These observations indicate that the mapped vegetative area is not a GDE, and hence, installation of shallow monitoring wells may not be an appropriate use of resources to implement a GSP.

Notwithstanding the above observations, the Spadra GSA will continue to refer to additional resources and local knowledge to identify potential GDEs in the Spadra Basin, and if appropriate, consider the appropriateness of new shallow monitoring wells in the final GSP.

Comment No. 4. Section 2.2.2.7 Groundwater Recharge starting on page 28. The CDFW comment reads:

"The description of groundwater recharge lacks details of future projects actions that may capture unallocated stream flows or that may divert excess surface water for groundwater recharge.

a. *Issue #1: The implementation of SGMA does not alter or determine surface or groundwater rights (Water Code §10720.5). It is the intent of SGMA to respect overlying and other proprietary rights to groundwater, consistent with Water Code Section 1200 (Section 1(b)(4) of Assembly Bill (A.B.) 1739). The capture of unallocated stream flows to artificially recharge groundwater aquifers are subject to appropriation and approval by the State Water Resources Control Board (SWRCB) pursuant to Water Code Section 1200 et seq. The Department, as Trustee Agency, is consulted by SWRCB during the water rights process to provide terms and conditions designed to protect fish and wildlife prior to appropriation of the State's water resources. Certain fish and wildlife are reliant upon aquatic and riparian ecosystems, which in turn are reliant upon adequate flows of water. The Department therefore has a material interest in assuring that adequate water flows within streams for the protection, maintenance, and proper stewardship of those resources.*

b. *Issue #2: The diversion of excess surface water for underground storage to advance the SGMA goals are subject to SWRCB pursuant to Water Code § 1433 (A.B. 658). The Department, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species (Fish& G. Code § 1802). Similarly, for the purposes of the California Environmental Quality Act (Public Resources Code § 21070), the Department is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources. The Department, as a Responsible Agency, may need to exercise regulatory authority as provided by the Fish and Game Code. Projects that propose to divert surface water for underground storage, for example, may be subject to the Department's lake and streambed alteration regulatory authority (Fish & G. Code§ 1600 et seq.).*

c. *Recommendation: The Department recommends the final GSP identify future projects that may capture unallocated stream flows or divert excess surface water for underground storage that will help the basin achieve long-term groundwater sustainability."*

Response. Future projects will be conceptualized and evaluated in a subsequent phase of GSP development: *Phase IV – Evaluate Basin Optimization Scenarios to Achieve Sustainability*. In this phase of the work, various projects, and combinations of projects, will be described. The objectives of these projects will be to achieve sustainability and maximize the utilization of the Spadra Basin. It is likely that these projects will include managed artificial recharge of storm, imported, and/or recycled waters. Modeling of surface water and groundwater will be the method to quantitatively evaluate and determine sustainability and the hydrologic impacts of the projects.

Comment No.5. Basin Setting, Section 2.2.2.11 Groundwater Levels and Storage and Section 2.2.2.12 Initial Estimate of Developed Yield: 1977-2018, starting page 31. The CDFW comment reads:

"Projected water budget assumptions may risk overestimating surface water availability and sustainable yield by not relying on best available information [23 CCR § 354.18(e)].

a. *Issue: Projected surface water budget assumptions may risk overestimating water availability. Overestimation of water availability can result in the over allocation of both surface and groundwater water resources, unnecessarily jeopardizing environmental beneficial users. One water budget assumption that does not rely on best available information and that underscores current sustainable yield estimations is a climate change analysis that predicts a net depletion of aquifer storage. This analysis is not reflected in the projected water budget or estimated sustainable yield, rather it is presented as a separate analysis.*

b. *Recommendation: Amend the water budget and sustainable yield to apply climate change estimates to the projected water budget and scale the sustainable yield accordingly. This adjustment provides a better understanding of project water availability and underscore a more conservative sustainable yield."*

Response. TM1 described the analysis of historical conditions and an estimate of the "developed yield" of the basin over a historical time period (1977-2018). TM1 did not include future projections of the water budget or sustainable yield of the Spadra Basin that may be subject to the influence of climate change. Therefore, the estimate of historical "developed yield" of the basin has not been amended in TM1 to account for climate change.

In the evaluation of future conditions in the Spadra Basin, computer-simulation models of surface-water and groundwater will be used to predict the basin response to various groundwater-management scenarios. The surface-water model will be updated first to account for future land-use and other changes that will impact surface-water flows. A daily projection will be prepared over the planning period of precipitation, applied water, and ET for each surface-water model sub-area incorporating DWR guidance for representing climate change. The surface-water model will estimate future deep infiltration of precipitation and applied water, sub-surface boundary inflows, streambed infiltration (if any), and surface-water inflows/outflows. The output from the surface-water modeling will provide input data for the groundwater model. Other input files for the groundwater model will be prepared, including estimated future groundwater pumping and managed artificial recharge of storm, imported, and recycled water. The results of the groundwater modeling will represent the groundwater basin response to the groundwater-management scenarios. The model output files will be used to describe the water budget and the developed yield of the basin, including the effect of climate change.

Comment No.6*. Sustainable Management Criteria, 2.2.3 Groundwater Quality, starting pp 34.* The CDFW comment reads:

"The TM1 states that understanding 'areas in the basin where groundwater may be impaired from a beneficial use standpoint, and hence, poses current and future challenges that the pumpers may face in using the groundwater for certain end uses' (TM1 pp 34).

a. *Issue: The TM1 recognizes water quality constituents of concern and generally poor groundwater quality in the Spadra Basin. However, the TM1 only mentions the necessity for a "more robust groundwater monitoring program" (TM1 pp.43).*

b. *Recommendation: Draft a plan to investigate the relationship between groundwater pumping and the presence, movement, and concentration of constituents in the Spadra Basin and include the plan in the final GSP. Develop sustainability criteria for constituents of concern accordingly and in partnership with existing regulatory programs*."

Response. As indicated, the groundwater-quality analysis in TM1 was not based on a robust data set regarding the number of monitoring locations, the frequency of sample collection, the constituents analyzed, and the laboratory detection limits used. Hence, one of the preliminary data gaps identified in TM1 is the need for a more robust groundwater-quality monitoring program to better characterize regulated and emerging contaminants. A groundwater-quality monitoring program will be developed, implemented, and included as part of the monitoring network in the final GSP. The groundwater-quality monitoring program will help: characterize the presence, spatial distribution, concentrations, and trends in groundwater contaminants; assess sustainability criteria developed for groundwater quality; and assess the efficacy of projects and management actions developed and implemented to achieve groundwater-quality sustainability.

Comment No.7. 2.6 Data Gaps, starting pp. 42. The CDFW comment reads: *"The Department looks forward to reviewing the proposed actions to resolve data gaps.*

a. *Issue: The Department appreciates the identification of the data gaps in the TM1 However, the TM1 does not identify a specific plan or additional resources that will be used to resolve the data gaps.*

b. *Recommendation: The Department recommends the final GSP utilize the Monitoring Networks and Identification of Data Gaps Best Management Practice (CDWR 2016) document to collect data of sufficient accuracy and quantity to demonstrate that the basin is being sustainably managed. The Department looks forward to the forthcoming Technical Memorandums that will identify actions to address: i) Where '[a] new monitoring well(s) in this area may be needed to fill the data gap' (pp 43); ii) Where '[a] more robust groundwater-quality monitoring program is necessary to characterize TDS, nitrate, regulated contaminants, and emerging contaminants in the Spadra Basin; assist in the identification of the sources of the contaminants; and assist in the development and evaluation of future treatment and cleanup projects' (pp 43); iii) How 'a program to collect and compile groundwater data from the private wells may be recommended as part of the GSP monitoring program' (pp 44); iv) How to implement a surface-water monitoring program 'to better characterize the availability and magnitude of these potential sources of recharge' (pp 44); and, v.) How to consider future subsidence monitoring efforts in the entire basin."*

Response. The final GSP will utilize the *Monitoring Networks and Identification of Data Gaps Best Management Practice* document prepared by the California Department of Water Resources in 2016 when developing monitoring programs to fulfill data gaps and aid in the evaluation of GSP implementation.

G2: TM 2 - Comments and Responses on the May 18, 2020 Draft Technical Memorandum 2 (TM 2):Construction and Calibration of the Spadra Basin Groundwater Model

COMMENTS AND RESPONSES ON THE MAY 18, 2020 DRAFT TECHNICAL MEMORANDUM 2 (TM 2): CONSTRUCTION AND CALIBRATION OF THE SPADRA BASIN GROUNDWATER MODEL

Comments by Tim Kellett, Chief Water Resources Officer, Three Valleys Municipal Water District

Comment. *My question is on Figures 4-3(a-d). All of the Measured vs Simulated models show a large difference from about 1987 – 1992. Is there any explanation that can be provided as to why all fours graphs have the same pattern? Is the something that the calibrated model is missing during that period (e.g. precipitation data, production data, etc.)? Can you determine the effect that this period of data is affecting the overall calibration of the model?*

Response. There are several things to understand and consider related to this comment—some of which were discussed in *Section 4.7 Model Limitations and Recommendations* of TM2:

- *"All of the Measured vs Simulated models show a large difference from about 1987 – 1992."* It is true that the model over-predicts groundwater elevations at these four calibration points during the mid-1980s to the mid-1990s. However, we do not consider these differences between measured and simulated groundwater elevations (~5-20 ft) as relatively "large" differences. There are other instances during the calibration period where the model under-predicts or over-predicts the measured groundwater elevations by similar magnitudes.
- *"Is there any explanation that can be provided as to why all fours graphs have the same pattern? Is the something that the calibrated model is missing during that period (e.g. precipitation data, production data, etc.)?"* A groundwater-flow model is a simplified mathematical representation of a complex natural system, and hence, will never perfectly simulate the natural system. Model errors can stem from the inaccuracies in the conceptual model, inaccuracies in recharge and discharge terms (e.g. precipitation, applied water, pumping); errors in calibration data (e.g. measurement errors for groundwater-elevation data); too little calibration data both spatially and temporally; practical limitations of grid spacing and time discretization; and the effects of processes not simulated by the model. In this case, a possible explanation for the model over-predictions of groundwater elevations during the mid-1980s to the mid-1990s is missing or inaccurate groundwater pumping data for this time period, but at this point, we simply do not know if this is the case. In Section 4.6 of TM 2 text now reads "This suggests that there may be a data gap in pumping records for this early period, but at this point, we simply do not know if this is the case."
- *"Can you determine the effect that this period of data is affecting the overall calibration of the model?"* You could compute the calibration statistics with and without the period and compare the statistics. However, we do not see the usefulness in performing this evaluation. First, we are not certain there is missing or inaccurate data during the time

period. Second, the calibration results indicate that the model does a "very good" job of simulating the groundwater system during the calibration period with a small residual mean error, especially for a "first-generation" model (see Section 4.6 of TM2).

- The calibration results indicate that the model is a useful tool for informing sustainable groundwater management in the Spadra Basin. We suggest the best path forward for the Spadra Basin GSA is to develop and implement its monitoring program to enhance understanding of hydrogeologic conditions in the basin and add high-quality hydrologic data to the database (e.g. pumping and groundwater-level data). Model error and uncertainty can be reduced in the future by using the new hydrogeologic understanding and calibration data to refine the model.

Comments by Jim Ciampa, legal counsel for the Spadra Basin Groundwater Sustainability Agency

Comments. *Mr. Ciampa suggested v*arious editorial changes and grammatical fixes*.*

Response. All suggested changes and fixes have been incorporated into the final TM2.

G3: TM 3 - Comments and Responses on the July 31, 2020 Draft Technical Memorandum 3 (TM 3): Sustainable Management Criteria

COMMENTS AND RESPONSES ON THE JULY 31, 2020 DRAFT TECHNICAL MEMORANDUM 3 (TM 3): SUSTAINABLE MANAGEMENT CRITERIA

Comments by Jim Ciampa, legal counsel for the Spadra Basin Groundwater Sustainability Agency

Comment No. 1. Add some clarifying language in Section 2.2 – Sustainability Indicators Applicable to the Spadra Basin. The second sentence in that section currently reads: "Based on the hydrogeologic conceptual model, current and historical groundwater, and the water budget of the Spadra Basin, the four Sustainability Indicators that are applicable to the Spadra Basin are: . . ."
I suggest clarifying that sentence to first clarify that only four of the Sustainability Indicators apply in the Spadra Basin. I suggest that sentence be changed to read as follows with the added language highlighted: "Based on the hydrogeologic conceptual model, current and historical groundwater, and the water budget of the Spadra Basin, **only** four Sustainability Indicators ~~that~~ are applicable to the Spadra Basin. The **four applicable Sustainability Indicators** are: . . ."

Response. The suggested language in Section 2.2 has been incorporated into the final TM3.

Comments by Sherry Shaw, Director of Engineering, Walnut Valley Water District

Comment No. 1. Section 2.3.1 Chronic Lowering of Groundwater Levels on page 10 and Section 2.3.2 Reduction in Groundwater Storage on page 13 have exactly the same paragraphs below them verbatim. Is that how it's supposed to be (repeated)?

Response. Yes, the first three paragraphs of these sections are intended to be exactly the same. This is a description of the beneficial uses and the components of recharge and discharge of Spadra Basin that sets up the discussion of the Undesirable Results for these two stand-alone sections for the Sustainability Indicators of Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage.

Comment No. 2. There are two Sections 2.3; "2.3 Undesirable Results, Minimum Thresholds and Measurable Objectives for the Spadra Basin Sustainability Indicators" on Page 10 and "Sustainability Goal" on Page 24. Should Sustainability Goal on Page 24 be Section 2.4?

Response. Yes. The Sustainability Goal section number was changed to Section 2.4 in the final TM3.

Comments by Felicia Silva, Environmental Scientist, California Department of Fish and Wildlife

Comment No. 1. Section 2.3.3.2 Minimum Thresholds (pg. 13) states, "Monitoring of groundwater quality at the seven representative monitoring sites will be conducted by collecting annual samples for the six constituents of concern (at a minimum). The data will be used to

calculate a two-year moving average concentration at each well." We're curious as to the decision of the frequency of monitoring. Annually does not appear to be a large sample size when calculating a two-year average.

Response. In our experience, changes in water-quality occur relatively slowly in groundwater basins, and annual monitoring frequencies are typically sufficient to capture long-term trends and variability in water quality. This is especially true in groundwater basins that do not receive large volumes of stormwater recharge during wet years or periods, like the Spadra Basin. The two-year moving average is intended to "smooth out" any anomalously high or low individual results, but still capture the recent trends in water quality. The stakeholders will evaluate and finalize the required sampling frequency for the six constituents of concern and the averaging period in the Monitoring Network section of the Final GSP.

Comment No. 2. We see from the figure from the *DWR Best Management Practices guidance document for Sustainable Management Criteria* that the SGMA benchmark date is 2015. CDFW is concerned that this date was within a historic drought period. Can you explain how this unique benchmark will impact the minimum threshold of undesirable results (other than degraded water quality)?

Response. The SGMA benchmark date of 2015 was not used to set Minimum Thresholds in the Spadra Basin for the Sustainability Indicators for groundwater levels, groundwater storage, and land-subsidence. A long-term historical period (1978 to 2018), inclusive of wet and dry periods, was evaluated and used to establish the Minimum Thresholds for these Sustainability Indicators. The Minimum Thresholds are based on the lowest groundwater elevations during the 1978-2018 period, and the fact that they did not cause Undesirable Results. To avoid Undesirable Results in the future, groundwater elevations at the representative monitoring sites should remain above the Minimum Thresholds.

G4: TM 4 - Comments and Responses on the December 22, 2020 Draft Technical Memorandum 4 (TM 4): Sustainability of Future Baseline Conditions

COMMENTS AND RESPONSES ON THE DECEMBER 22, 2020 DRAFT TECHNICAL MEMORANDUM 4 (TM 4): SUSTAINABILITY OF FUTURE BASELINE CONDITIONS.

Comments by Jim Ciampa, legal counsel for the Spadra Basin Groundwater Sustainability Agency

Comments. Mr. Ciampa suggested various editorial changes and grammatical fixes.

Response. All suggested editorial changes and fixes have been incorporated into the final TM4.

Comment No. 1 *Sections 2.3.2.1 City of Pomona and 2.3.2.2 Walnut Valley Water District,* second paragraph in both sections. I am surprised by such a significant projected increase in water demands for both Pomona and WVWD, especially in light of the state-mandated cutbacks on urban water use and the built-out nature of their service area.

Response. Comment noted and documented herein.

Comments by Kelly Gardner, Main San Gabriel Basin Watermaster

Comment No. 1. *Section 2.3.1.6 Main San Gabriel Basin Groundwater* on page 11, second paragraph, first sentence. The report references 85% of all demands in the Main Basin is groundwater - would you be able to share your data on this determination, my numbers vary some and I want to make sure the correct number is reported.

Response. The references that 85 percent of the water demand in the Main San Gabriel Basin is satisfied by local groundwater is referenced from the *Main San Gabriel Watermaster Annual Report for 2019*-2020 in *Appendix B Main San Gabriel Basin Overview* (page B4 in the paragraph under *Management Strategies*). A response to this question was provided to Ms. Gardner via email on January 19, 2021, and a reference for the *Main San Gabriel Watermaster Annual Report for 2019*-2020 was already included with this sentence in draft TM4.

Comment No. 2. *Section 2.3.1.6 Main San Gabriel Basin Groundwater* on page 11, second paragraph, last sentence. This sentence references imported water suppliers to the Main Basin, and it should be clarified that San Gabriel Valley Municipal Water District is not a MWD Member Agency but rather a direct State Water Project Contractor.

Response. A footnote was added after "San Gabriel Valley Municipal Water District" in this sentence to read "The San Gabriel Valley Municipal Water District is a direct State Water Project Contractor, and the TVMWD and Upper San Gabriel Valley Municipal Water District are Metropolitan Member Agencies."

Comment No. 3. *Section 2.3.2.2 Walnut Valley Water District* on page 18, third paragraph from the top. This paragraph lists three projects to increase the use of more local supplies – including Main Basin Water through Cal Domestic. Can you add language to this bullet to note that the water from this project comes from water stored by Puente Basin Water Agency and not additional groundwater pumping from the Main Basin.

Response. The following sentence was added to the third bullet describing the Main Basin Water projects with California Domestic Water Company: "Water delivered from this project comes from water stored by Puente Basin Water Agency and not additional groundwater pumping from the Main San Gabriel Basin."

Comments by Sherry Shaw, Director of Engineering, Walnut Valley Water District

Comments. Ms. Shaw suggested various editorial changes and grammatical fixes.

Response. All suggested editorial changes and fixes have been incorporated into the final TM4.

Comments by Erik Hitchman, Administrative Officer, Puente Basin Water Agency

Comments. The Puente Basin Water Agency (PBWA), a Joint Powers Authority between Walnut Valley Water District and the Rowland Water District, was formed in part, to govern subsurface flow from the Puente Basin to the Main San Gabriel Basin. In 1972, the Puente Narrows Agreement was entered into between the PBWA and the Upper San Gabriel Valley Municipal Water District (USGVMWD).

The intent of the agreement was to assure USGVMWD "that no activity within Puente Basin will hereafter be undertaken which will (1) interfere with surface flows in San Jose Creek, or (2) impair the subsurface flow from Puente Basin to the Main San Gabriel Basin. To accomplish the second goal, the agreement established a base underflow requirement of 580-acre feet per year from the Puente Basin to the Main San Gabriel Basin as calculated pursuant to Engineering Criteria.

Over the last five years, the calculated base underflow from the Puente Basin to the Main Basin has averaged 987-acre feet per year and has ranged from 970 to 1,010-acre feet. We note however that Technical Memorandum 4 under baseline conditions shows a potential decrease of subsurface flow from the Spadra Basin to the Puente Basin of approximately 625-acre feet per year. The PBWA applauds the efforts of the Spadra GSA, and is supportive of ensuring the long-term sustainability of the Spadra Basin provided the sustainability plan addresses the potential impacts on the Puente Basin, as well as Chino Basin, and in particular the PBWA's underflow obligation is considered and not adversely impacted.

Response. Comment noted and included herein. The Spadra GSA will continue to evaluate and address potential impacts to the adjacent Puente and Chino Basins during the evaluation of Basin Optimization Scenarios of projects and management actions to help achieve sustainability and maximize the beneficial use of the Basin, and during the preparation of the final GSP.

Comments by Erinn Wilson-Olgin, Environmental Program Manager 1, California Department of Fish and Wildlife (CAFWS)

The Department is writing to support ecosystem preservation in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science.

In consideration of these SGMA regulations, the Department submits the following comments on the Spadra Basin TM4 for the GSP. The Department requests that the Spadra Basin Groundwater Sustainability Agency address these comments before submitting the GSP to the Department of Water Resources for evaluation and assessment**.**

Comment No. 1. (Pumping and Artificial Recharge over the Planning Period, *Section 2.3.3 Aggregate Water-Supply Plan for the Spadra Basin Pumping* starting pp 19): Over the Planning Period, pumping from the Spadra Basin is planned to increase.

Issue #1: According to TM4 (pp 19): "Collectively, the total water demands of the Spadra Basin purveyors are projected to increase from 39,100 acre-feet per year (afy) in 2019 to about 46,600 afy by 2035 and remain constant thereafter to 2070. The purveyors plan to meet the increase in demands with an increase in groundwater pumping from Spadra Basin and other local groundwater basins (Puente, Chino, Main San Gabriel, Central, and Six Basins). In aggregate, the Spadra Basin water purveyors plan to increase pumping from the Spada Basin from about 800 afy in 2019 to about 1,800 afy by 2030, and that pumping will remain constant through 2070." CDFW is concerned over the projected increase in pumping in the Spadra Basin and the lack of identifying factors as to why this will occur. In addition, there is no indication as to how these factors will be addressed in TM4. This lack of specificity on how pumping factors will be managed may lead to deprioritization or delayed implementation of demand management actions. This, in turn, can undermine a basin's ability to achieve sustainable goals.

Issue #2: According to TM4 (pp 20): "There are no plans for artificial recharge in the Spada Basin, and therefore, there is no artificial recharge included in the Baseline Scenario." Given that pumping is anticipated to increase, CDFW is concerned that there are no plans for artificial recharge in the Spadra Basin. Recommendation: The final GSP should identify specific factors that would increase pumping and how these factors can be mitigated. The GSP should add specific triggers, timing, and expected outcomes of demand-management actions.

Response. In the Baseline Scenario it is the desire of the water purveyors in the Spadra Basin to increase pumping in the Spadra Basin from the current of about 800 afy (2018) to 1,800 afy through most of the 60-year planning horizon (2019-2079), in part to rely more on local water supplies to meet water demands. Note that the current pumping of 800 afy is lower than historical pumping in the Spadra Basin over the previous 40 years (1977 -2018) which averaged 1,280 afy and ranged from 700 afy to 2,200 afy.

The evaluation of the Baseline Scenario with the Spadra Basin groundwater model, presented in TM4, indicates that groundwater levels are projected to decline to levels that are below the Minimum Thresholds at many wells indicating that the Baseline Scenario is not sustainable for the Spadra Basin GSP. This circumstance is a factor considered by the water purveyors for their future water demand and supply plans, including the assumed volume of Spadra Basin groundwater in their water-supply portfolios. If there are no projects or management actions developed to avoid declining water levels, then the water purveyors will need to pump less than the Baseline Scenario to sustain the groundwater levels above the Minimum Thresholds and avoid Undesirable Results. The stakeholders in the Spadra Basin have begun to process to develop and consider projects to increase recharge and basin yield, and support groundwater

elevations above the Minimum Thresholds to avoid Undesirable Results and achieve and maintain sustainability. The groundwater model will be utilized to evaluate the recharge projects and the pumping that would achieve and maintain sustainability (i.e. Basin Optimization Scenarios).

Comment No. 2 (Groundwater Level Response, *Section 3.1.2.1 Pumping Sustainability*, pp 22): Groundwater sustainability is evaluated by comparing groundwater elevations to the pumping sustainability metric for active pumping wells.

Issue: According to the TM4 (pp 22): "The pumping sustainability metric is the lowest water-level elevation that enables the well owner to produce groundwater at a desired pumping rate, given the well construction and pumping equipment. Groundwater pumping at a well is presumed to be sustainable if the water level at that well remains above the pumping sustainability metric." The Department is concerned how this metric would be considered sustainable given that it is below the Minimum Threshold at wells CPP-4, P-28, CPP-1, and P-19.

Recommendation: The Department recommends the final GSP clarify how the pumping sustainability metric is useful to determine sustainability and how it can be used to avoid Undesirable Results.

Response: The groundwater levels of the Baseline Scenario were compared to both the pumping sustainability metric and the Minimum Threshold set at each well. The pumping sustainability metric is set as some distance above the well pump bowl by the well owners, and is considered the lowest water-level elevation that enables the well owner to produce groundwater at a desired pumping rate The Minimum Thresholds for water levels set at wells throughout the basin to avoid Undesirable Results are considered the primary metrics to assess sustainability of the basin in regard to groundwater levels, groundwater storage, and land subsidence. As part of the development of the proposed Minimum Thresholds in TM3 it was checked that these Minimum Thresholds set at the pumping wells were above the elevation of the pump bowl at the well to ensure pumping, and it was determined that all the Minimum Thresholds are 32 feet or more above the pump bowl. Except for the Industry well along the western boundary of the Spadra Basin, the pumping sustainability metrics are below the Minimum Threshold, and hence the Minimum Thresholds are protective of pumping sustainability at each well. The GSA will continue to evaluate and adjust the proposed Minimum Thresholds set at wells in the Spadra Basin throughout the process to develop the Final GSP to ensure that they are set to avoid Undesirable Results within the basin and in adjacent basins. The GSA will consider adjusting the Minimum Threshold at the Industry well to be equal to or above the pumping sustainability metric to avoid the Undesirable Result that the well owner could no longer pump their well at the desired rate.

Comment No. 3 (Groundwater Level Response, *Section 3.1.2.2 Sustainable Management Criteria*, pp 22): Minimum Thresholds and Measurable Objectives have been established at six wells.

Issue: According to the TM4 (pp 22), "The wells in Figure 2-12a through 2-12i where the Minimum Thresholds and Measurable Objectives have been established are: Industry, CPP-4, P- 28, CPP-1, P-19, and OMW-3." The Department is concerned that Minimum Thresholds have not been established for all the wells presented in Figures 2-12a through 2-12i. Minimum Thresholds are used to prevent Undesirable Results, including impacting downgradient groundwater basins that

may have aquatic and riparian ecosystems. In particular, the Department is concerned with reduced subsurface outflow to the Puente Basin, which has a number of riparian mixed hardwood habitats. These habitats are groundwater dependent ecosystems that depend on subsurface flow for continued survival (USDAFS, 2014). Certain fish and wildlife are reliant upon aquatic and riparian ecosystems, which in turn are reliant upon adequate flows of water.

Recommendation #1 - Establish Minimum Thresholds: The Department recommends the final GSP resolve areas of uncertainty in order to utilize the model-predicted groundwater elevations at OMW-3. This is especially crucial as OMW-3 is the only well on the east side of the groundwater divide to characterize groundwater elevation change and flow patterns flowing east. The Department also recommends establishing Minimum Thresholds for all wells. Having these Minimum Thresholds established at all wells is important to prevent exceedance of Thresholds for each well, which may cause Undesirable Results in the basin. In addition, establishing Minimum Thresholds at P-31, CPP-2, and CPP-3 provides a metric to assess the sustainability of wells and avoid Undesirable Results such as impacts to beneficial uses of downgradient groundwater basins.

Recommendation #2 – Undesirable Results: The Department recommends specifying 'effects of Undesirable Results' for environmental beneficial users of groundwater as they impact Puente Basin. The GSP should also specify Undesirable Result indicators for depletions of subsurface flows that are relevant to beneficial users of groundwater. Finally, the GSP should identify Undesirable Result indicators for dry and critically dry water years for all sustainability indicators. Specific indicators provide clear and measurable objectives to prevent Undesirable Results for groundwater dependent ecosystems and other beneficial uses downgradient of the Spadra Basin.

Response As described in TM3, seven wells were selected as representative sites to establish Minimum Thresholds for the Sustainability Indicators based on their location and historical record of groundwater-level data. One well was selected at each boundary for the adjacent Puente and Chino Basins (Industry and MW-5, respectively) and five wells were selected along the center axis of the Basin (CPP-4, P- 28, CPP-1, P-19, and OMW-3). Collectively these seven wells are considered representative of groundwater conditions throughout the basin. Minimum Thresholds have not been set at pumping wells P-31, CPP-2, and CPP-3. Well P-31 is about 500 feet from well P-19 with a Minimum Threshold, and well CPP-2 is about 650 feet from well CPP-4 with a Minimum Threshold, and these nearby wells with a Minimum Threshold are considered representative of groundwater conditions at these respective locations. The Spadra GSA has set the proposed Minimum Thresholds at the representative wells to be protective of the beneficial uses and avoid Undesirable Results for the Spadra Basin and adjacent basins. And the Measurable Objective were set such that there is reasonable margin of operation flexibility within the operating band between the Minimum Thresholds and the Measurable Objective that will accommodate the influences of droughts and dry years on the Sustainability Indicators. The GSA will continue to evaluate and adjust as needed the representative monitoring sites and proposed Minimum Thresholds and Measurable Objective throughout the process to develop the Final GSP, and during implementation as new data and information is available, to ensure that they are appropriate to monitor groundwater conditions in the Basin and avoid Undesirable Results

within the Basin and in adjacent basins. This could include adding additional wells as indicted herein as representative sites.

The Minimum Thresholds and Measurable Objectives for wells OMW-3 and MW-5 closest to the Chino Basin boundary were set based on model-estimated water levels for the historical period. This area of the Spadra Basin has been identified as the greatest area of uncertainly in the calibration of the groundwater model. The Spadra GSA is currently preparing a well siting study to construct a new monitoring well in this area of uncertainty and fill a data gap in the hydrogeologic conceptual model. Data from the new monitoring well will be used to improve the understanding of the aquifer, groundwater flow, and groundwater levels in this boundary area and can be used to update the model, and if needed the Minimum Thresholds and Measurable Objectives for wells OMW-3 and MW-5 can be adjusted The new monitoring well will become part of the monitoring network where high-frequency groundwater elevation data will be collected, and will likely become a representative monitoring site with set Minimum Thresholds and Measurable Objectives for Sustainability Indicators.

The Minimum Threshold and Measurable Objective set at the Industry well is intended to be protective of beneficial uses in the adjacent Puente Basin and to avoid Undesirable Results such as reduced subsurface outflow to the Puente Basin that would impact groundwater dependent ecosystems or the Puente Basin Water Agency's base underflow requirement to the Main San Gabriel Basin (see comment from Puente Basin Water Agency above). As noted in our response to the CAFWS Comment No. 2 above, the GSA will continue to evaluate and adjust the proposed Minimum Thresholds set at wells in the Spadra Basin throughout the process to develop the Final GSP to ensure that they are set to avoid Undesirable Results within the basin and in adjacent basins.

Additionally, the Spadra GSA will continue to evaluate and address potential impacts to the adjacent Puente and Chino Basins during the evaluation of Basin Optimization Scenarios of projects and management actions to help achieve sustainability and maximize the beneficial use of the Basin, and during the preparation of the final GSP.

Comment No. 4 (*Section 4.0 Conclusions and Recommendations*, starting pp. 25) The Department looks forward to reviewing the proposed Basin Optimization Scenarios.

Issue: TM4 indicates that the Baseline Scenario is unsustainable over the planning period.

Recommendation #1: The Department recommends the final GSP utilize the Monitoring Networks and Identification of Data Gaps Best Management Practice (CDWR 2016) document to collect data of sufficient accuracy and quantity to demonstrate that the basin is being sustainably managed. The Department looks forward to the forthcoming Technical Memorandum that will identify actions to address:

i. How to address pumping sustainability challenges (pp25).

ii. How to consider future subsidence monitoring efforts in the entire basin (pp 25).

iii. How to consider impacts to beneficial uses of downgradient groundwater basins (pp 25).

iv. How to increase recharge to the basin, such as artificial recharge of storm water and/or supplemental waters (pp 26).

Recommendation #2: The Spadra Basin GSP as developed under SGMA is exempt from the California Environmental Quality Act (CEQA). However, project and management actions needed to achieve basin sustainability, such as artificial recharge from storm water capture, are subject to CEQA. The Department will likely have a CEQA review and permitting nexus with groundwater project and management actions (e.g., Lake and Streambed Alteration Agreements). Accordingly, the Department will expect CEQA lead agencies to thoroughly address proposed groundwater management project impacts (i.e., 'significant effects') to streambed, groundwater dependent ecosystems, interconnected surface waters, as well as fish and wildlife resources. The Department recommends including this information in the basin optimization scenarios to ensure project budgets and timelines consider the regulatory process in the implementation of potential projects.

Response. Comment noted. The final GSP will include a description of the monitoring network to collect sufficient data to monitor groundwater conditions in the basin and evaluate sustainability and progress of plan implementation. The CEQA process that is required for a proposed project or management action will be included in the cost analysis for the Basin Optimization Scenarios and included as part of the GSP implementation plan.

G5: TM 5 Part 1 - Comments and Responses on the June 2021 Draft Technical Memorandum 5 (TM 5) Part 1: Sustainability of Basin Optimization Scenarios

COMMENTS AND RESPONSES ON THE JUNE 2021

DRAFT TECHNICAL MEMORANDUM 5 (TM 5) PART 1: SUSTAINABILITY OF BASIN OPTIMIZATION SCENARIOS

Comments by Erinn Wilson-Olgin, Environmental Program Manager 1, California Department of Fish and Wildlife (CDFW)

The CDFW is writing to support ecosystem preservation in compliance with SGMA and its implementing regulations based on CDFW expertise and best available information and science.

In consideration of these SGMA regulations, the CDFW submits the following comments on the Spadra Basin TM5 for the GSP. The CDFW requests that the Spadra Basin Groundwater Sustainability Agency address these comments before submitting the GSP to the Department of Water Resources for evaluation and assessment**.**

Comment No. 1. Development of the Basin Optimization Scenarios, 2.2 Basin Optimization Scenarios (starting pp 4).

Issue: CDFW is concerned that a proposal to use surplus recycled water from the Pomona Wastewater Reclamation Plant (WRP) may be ineffective to meet the objectives of the Basin Optimization Scenario. These objectives include achieving long-term sustainability and maximizing its beneficial use. This is because recycled water may not be available for the GSA's use. Currently, surplus recycled water from the Pomona WRP is discharged to South San Jose Creek, where it flows downstream out of Spadra Basin and recharges "about 15 miles downstream, at the Montebello Forebay or is consumed by riparian vegetation at the Montebello Forebay." In October 2020, a wastewater change petition (WW0104) was approved to allow for surplus recycled water to be utilized instead of discharged to South San Jose Creek. As a condition of approval, the Los Angeles County Sanitation Districts (LACSD) must monitor, in perpetuity, the effects of reduced discharge on riparian vegetation supporting Least Bell's vireo (Vireo bellii pusillus), an endangered species under the California Endangered Species Act. If specific impact triggers are reached, remedial actions must be taken by LACSD, which will include resumed discharges of surplus recycled water into South San Jose Creek1. If LACSD resumes surplus recycled water discharge, this will remove some or all of the available surplus recycled water for use in the Spadra Basin. This, in turn, can undermine the Basin's ability to achieve sustainable goals if all the Basin Optimization Scenarios are dependent on the recycled water from Pomona WRP

Recommendation #1: LACSD may require some or all of the surplus recycled water to be discharged back to South San Jose Creek instead of allowing its use within Spadra Basin. Thus, the final GSP should determine if some or all of the surplus recycled water would be reclaimed for discharge back to South San Jose Creek.

Recommendation #2: The final GSP should develop specific triggers in the event LACSD/Pomona WRP no longer provides some or all of the surplus recycled water. Based on these specific triggers, management actions should be developed to account for a reduction in recycled water supply.

Response. We recognize that some or all the surplus recycled water from the Pomona WRP may not be available in the future. If a project selected and described in the Final GSP utilizes the surplus recycled water from the Pomona WRP, the GSP implementation plan will include a description of a contingency plan for the future uncertainty of the availability of the recycled water for recharge/reuse in the Spadra Basin. The contingency plan will include a description of the options for alternative water sources for recharge and projects and management strategies if the recycled water is no longer available.

As you described, the LACSD's Final Environmental Impact Report for the San Gabriel River Watershed Project to Reduce River Discharge in Support of Increased Recycled Water Reuse (FEIR) includes the implementation of an Adaptive Monitoring Plan (AMP) as a mitigation measure to ensure the quantity and quality of the riparian and wetland habitat downstream is maintained during reduced flow from multiple upstream treatment plants including the Pomona WRP. The AMP will be a component of implementing any project where there is increased use of the surplus recycled water for reuse/recharge and will be described in the Final GSP implementation plan.

The AMP will provide guidance on if there is an impact to the downstream habitat from reduced discharge from the Pomona WRP and the other LACSD treatment plants and will ultimately be used to determine if some or all of the surplus recycled water would be reclaimed for discharge back to the South San Jose Creek, and/or other mitigation measures.

Comment No. 2. Development of the Basin Optimization Scenarios, 2.2 Basin Optimization Scenarios, 2.2.2 Bain Optimization Scenario 2 – Sustainability through Recharge (starting pp 5) & 2.2.3 Basin Optimization Scenario 3 – Maximum Beneficial Use (starting pp 6).

Issue: According to TM 5, "Scenario 2 increases artificial recharge to the Spadra Basin from 0 afy [acre feet per year] to 500 afy via the construction of new recharge facilities for the recharge of recycled water from the Pomona WRP." In addition, TM 5 states, "Scenario 3 increases artificial recharge to the Spadra Basin from 0 afy to 3,500 afy via the construction of new recharge facilities for the recharge of recycled water from the Pomona WRP." Under these scenarios, it seems that surplus recycled water is the only means of artificial recharge. CDFW is concerned that this singular source of water may limit recharge efforts to what is only available via surplus water released from the Pomona WRP.

Recommendation: CDFW recommends the final GSP consider other methods of recharge in addition to artificial recharge with recycled water. These methods may include alternative ways to increase recharge, such as stormwater collection, urban runoff collection, drip irrigation systems, or groundwater treatment without the use of surplus recycled water from Pomona WRP. CDFW recommends the final GSP encourage projects and management actions needed to achieve basin sustainability to incorporate Low Impact Development (LID) design principles. These design principles should include those adopted by the City of Pomona (Ordinance 4185) to aid in sustainable stormwater management. Such LID designs that may increase stormwater use include on-site infiltration/biofiltration, bioretention and/or rainfall harvest and use. These types of designs may also decrease the need for groundwater pumping while also contributing to artificial recharge. As a note, CDFW will likely have a CEQA review and permitting nexus with groundwater projects such as those that capture stormwater (e.g., Lake and Streambed Alteration Agreements).

Response. The Basin Optimization Scenarios 2 & 3 assume artificial recharge projects ranging from 500 afy to 3,500 afy at potential locations that are conceptual at this time. The Basin Optimization Scenarios contemplate the use of recycled water for this artificial recharge, however, it is also possible that imported water, storm water, dry weather flow, or a combination of waters could be recharged at some of the potential locations. Recycled water is considered the primary source of recharge for the Basin Optimization Scenarios because of the stakeholder interest to utilize this local available source of water that is currently not being used in the Spadra Basin. Storm water recharge is not being considered at this time for the Basin Optimization Scenarios because of its infrequent availability, and it requires facilities with a larger storage capacity then those proposed and feasible in the Spadra Basin. If a project selected and described in the Final GSP utilizes the surplus recycled water from the Pomona WRP, the GSP implementation plan will include a description of a contingency plan that describes the potential utilization of source waters for recharge other than the recycled water.

The final GSP implementation plan will include an element to encourage the implementation of MS4 projects in the Spadra Basin that recharge storm-water runoff produced by land development, such as projects that incorporate the Low Impact Development (LID) design principles that the City of Pomona has adopted to comply with the Regional Board's MS4 permit (Ordinance 4185).

The following text was added in *Section 2.2 Basin Optimization Scenarios* of TM 5 part 1 (pages 4-5) to address Comments #1 and #2:

> *"The LA Sanitation Districts completed a final Environmental Impact Report (FEIR) for the reduced discharge to the San Gabriel River Watershed envisioned in the wastewater change petition for the Pomona WRP and three other treatment plants in the watershed (ESA, 2019). The FEIR includes a mitigation measure for the LA Sanitation Districts to implement an Adaptive Monitoring Plan (AMP) in coordination with the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) to ensure the quantity and quality of the riparian and wetland habitat downstream is maintained during reduced flow from the upstream treatment plants. A draft AMP was developed and included as an attachment to the FEIR (Wood, 2019) and includes the monitoring of various vegetation parameters and trigger levels to implement responsive measures that could include resumed discharges to the river and tributary channels in sufficient volumes to support the habit sustained by historical discharges. If the final GSP includes the utilization of the surplus recycled water from the Pomona WRP, the GSP implementation plan will include a contingency plan to address the uncertainty of the future availability of all or part of the surplus recycled water. The contingency plan will include a description of the options for alternative water sources for recharge and projects and management strategies if the surplus recycled water is no longer available.*
>
> *Recycled water is considered the primary source of recharge for the Basin Optimization Scenarios 2 & 3 because of the stakeholder interest to utilize this local available source of water that is currently not being used in the Spadra Basin. Basin Optimization Scenarios 2 & 3 contemplate the use of recycled water for artificial recharge ranging from 500 afy to 3,500 afy at locations that are conceptual at this time. However, it is also possible that imported water, storm water, dry weather flow, or a combination of waters could be recharged at some of the potential locations."*

Comment No. 3. Figure 2-1 Location Map of Proposed New Projects for the Spadra Basin (pp 9) and Figure2-2 Location Map of Wells and Facilities for Basin Optimization Scenarios (pp 11).

Issue: According to Figure 2-2, there are several potential locations sited for underground recharge galleries in the northern part of the basin. While these locations were identified because they are along and/or near the main Pomona WRP pipeline, CDFW is concerned about the construction activities associated with these new facilities and their impacts on wildlife. A search of the California Natural Diversity Database (CNDDB) indicates several occurrences of merlin (Falco columbarius) on site and within the vicinity of the western most recharge gallery. Raptors, such as merlins, are protected under Fish and Game Code section 3503.5. Construction activities may disturb the foraging habitat of over-wintering individuals in the area. According to Figure 2-1, the area sited for a recharge gallery is adjacent to or potentially overlapping agricultural land, which is the foraging area for merlins. In addition to merlins, a rare plant was recorded in the vicinity of the western gallery location. The San Bernardino aster (Symphyotrichum defoliatum) has a California Rare Plant Rank (CRPR) ranking of 1B.2. Plants with a CRPR of 1B.2 are rare, threatened, or endangered in California and elsewhere (CNPS 2020). CNDDB also indicated the occurrences of several other species near the eastern galleries. The species found in this area include, southern California legless lizard (Anniella stebbinsi), western yellow bat (Lasiuris xanthinus), and big free-tailed bat (Nyctinomops macrotis), all of which are considered California Species of Special Concern (SSC)

Recommendation #1 - CEQA: The Spadra Basin GSP as developed under SGMA is exempt from the California Environmental Quality Act (CEQA). However, project and management actions needed to achieve basin sustainability, such as artificial recharge, are subject to CEQA. CDFW will likely have a CEQA review and permitting nexus with groundwater project and management actions (e.g., Lake and Streambed Alteration Agreements). CDFW will expect CEQA lead agencies to thoroughly address proposed groundwater management project impacts (i.e., significant effects) to streambed, groundwater dependent ecosystems, interconnected surface waters, as well as fish and wildlife resources that may be within project areas. CDFW recommends including this information in the basin optimization scenarios to ensure project budgets and timelines consider the regulatory process in the implementation of potential projects.

Recommendation #2 – Impacts to rare plants: CDFW recommends impacts to CRPR ranked species as well as locally and regionally sensitive species should be analyzed during preparation of environmental documents relating to CEQA. In preparation of the final GSP, CDFW recommends budgets and timelines include the need for a qualified botanist conduct multiple late summer and fall surveys for San Bernardino aster. In preparation of an environmental document, CDFW recommends the final GSP require projects to submit a rare plant survey according to CDFW's Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities (CDFW 2018). The environmental document should provide full disclosure of the presence/absence of rare plant species so CDFW may assist the project applicant during the public comment period in identifying and mitigating for potential impacts on rare plants. The Project and environmental document should be conditioned to avoid and/or mitigate for potential impacts on rare plants and habitat if rare plants are present.

Recommendation #3 – Impacts to SSC: CDFW considers impacts to SSC a significant direct and cumulative adverse effect without implementing appropriate avoid and/or mitigation measures. Therefore, CDFW

recommends the final GSP budget and timeline include the need for focused and timely surveys for SSCs. These focused surveys include but are not limited to the following species, merlin, southern California legless lizard, western yellow bat, and big free-tailed bat. All surveys should be conducted by qualified biologists familiar with each of these species. In preparation of an environmental document, CDFW recommends the final GSP require survey reports to determine the presence/absence of merlin, southern California legless lizard, western yellow bat, big free-tailed bat, and their habitat. Surveys should be conducted during a time of day and year when these species are more likely to be detected. Depending on the survey results, the environmental document should provide measures to avoid and/or mitigate for potential impacts on individuals of these species as well as habitat

Recommendation #4 – Consideration of biological baseline assessment and impact analysis: DFW recommends the final GSP include in the budget and timeline that projects will need to provide a complete assessment and impact analysis of the flora and fauna within and adjacent to project areas. This assessment should emphasize upon identifying endangered, threatened, sensitive, regionally, and locally unique species, and sensitive habitats. Impact analysis will aid in determining any direct, indirect, and cumulative biological impacts, as well as specific mitigation or avoidance measures necessary to offset those impacts.

Response. Thank you for providing guidance on the types of biological resources monitoring that may be necessary pursuant to CEQA. The projects implemented for the Spadra Basin GSP will be evaluated through the appropriate CEQA analyses, including the necessary analyses for potential impacts to biological resources. The cost and schedule to perform CEQA analyses will be considered in the project budgets and timelines.

G6: TM 5 Part 2 - Comments and Responses on the September 2021 Draft Technical Memorandum 5 (TM 5) Part 2: Sustainability of Basin Optimization Scenarios

Comments and Responses on the September 2021 Draft Technical Memorandum 5 (TM 5) Part 2: Sustainability of Basin Optimization Scenarios

Comments by Erinn Wilson-Olgin, Environmental Program Manager, California Department of Fish and Wildlife (Department)

The Department appreciates the opportunity to provide comments on the Spadra Basin Groundwater Sustainability Agency (GSA) Spadra Basin (Basin) Draft Groundwater Sustainability Plan (GSP) Draft Technical Memorandum No. 5 Part 2: Sustainability of Basin Optimization Scenarios (TM5) prepared pursuant to the Sustainable Groundwater Management Act (SGMA). The Basin must be managed under a GSP by January 31, 2022.

The Department is writing to support ecosystem preservation and enhancement in compliance with SGMA and its implementing regulations based on Department's expertise and best available information and science. As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of GSPs under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems, species, and public trust resources depend on groundwater and interconnected surface waters (ISWs), including ecosystems on Department-owned and managed lands within SGMA-regulated basins.

There are two major streams that flow through the Basin, San Jose Creek and South San Jose Creek. These streams are a resource that supports wildlife within the Basin. Projects proposed as part of the Basin Optimization Scenarios plan to divert stormwater from streams. These activities may be subject to Fish and Game Code section 1602. In addition, pertaining to the protection of these resources, the Department provides comments to the consideration of impacts to wildlife as a result of the reduction of water availability from stormwater diversion.

[End Letter]

Attachment A: CDFW COMMENTS ON THE GSA/BASIN TECHNICAL MEMORANDUM FOR THE GROUNDWATER SUSTAINABILITY PLAN

The following comments are applicable to what is only presented in Part 2 "Sustainability of Basin Optimization Scenarios" of TM5. The

Comment No. 1. Potential Projects and Management Plan Concepts, Table 2-1 Proposed Projects and Management Actions for the Spadra Basin (pp3).

Issue: Table 2-1 in TM5 identifies potential projects for the Basin. One project will redirect stormwater flows to new spreading grounds while another project will construct rubber dams in the San Jose Creek to divert storm water for recharge (projects numbers 3 and 12 respectively). The Department is concerned over the projected stormwater diversion projects. Fish and Game Code section 1602 requires any person, State or local governmental agency, or public utility to notify Department prior to beginning any activity that may do one or more of the following:

I. Divert or obstruct the natural flow of any river, stream, or lake;

II. Change the bed, channel, or bank of any river, stream, or lake;

III. Use material from any river, stream, or lake; or

IV. Deposit or dispose of material into any river, stream, or lake.

In addition, the Department is concerned that project activities may prevent and/or impede fish passage during low flow conditions and may not allow sufficient water to pass over, around or through a dam any fish that may be planted or exist below the dam (Fish & Game Code, §§ 5901, 5937). The project may adversely affect the existing hydrologic pattern in the proposed project areas that allow water to flow into San Jose Creek. This may occur through the alteration of the bank, bed, or channel of the stream, which could result in permanent alteration of the Creek function. This permanent impact may impact wildlife species that may utilize this stream area and will require compensatory mitigation. Additionally, associated riparian plant communities are present downstream of the project site that may be impacted by changes to the stream. Accordingly, impacts to sensitive or rare riparian plant communities may occur.

Recommendation #1: The Spadra Basin GSP as developed under SGMA is exempt from the California Environmental Quality Act (CEQA). However, project and management actions needed to achieve basin sustainability, such as artificial recharge from storm water capture, are subject to CEQA. The Department will likely have a CEQA review and permitting nexus with groundwater project and management actions (e.g., Lake and Streambed Alteration Agreements). Accordingly, the Department will expect CEQA lead agencies to thoroughly address proposed groundwater management project impacts (i.e., 'significant effects') to streambed, groundwater dependent ecosystems, interconnected surface waters, as well as fish and wildlife resources. The Department recommends including this information in the basin optimization scenarios to ensure project budgets and timelines consider the regulatory process in the implementation of potential projects.

Recommendation #2: The Department recommends the final GSP require projects to comply with Fish and Game code sections 5901 and 5937. The GSP should require projects provide a thorough discussion of direct, indirect, and cumulative impacts expected to adversely affect biological resources, especially fish species, with specific measures to offset such impacts.

Response. The three Basin Optimization Scenarios developed and evaluated in TM 5 do not include any of the potential stormwater diversion projects listed in Table 2-1 in TM 5. The preferred Basin Optimization Scenario in TM 5 and ultimately in the GSP is Scenario 3. Therefore, at this time there are no envisioned projects for storm water diversion projects for recharge GSP, and the GSP will not discuss any impacts expected to adversely affect biological resources for these projects. If the GSA decides to pursue projects that include stormwater diversion for recharge, it will consider all impacts as noted in these recommendations, acquire all required permits, and comply Fish and Game code sections 5901 and 5937.

The projects in Basin Optimization Scenarios 3 are conceptual at this time, and further planning and studies are required to analyze project feasibility and environmental impacts, and move towards project implementation. All projects to be implemented for the Spadra Basin GSP will be evaluated through the appropriate CEQA analyses, including the necessary analyses for potential impacts to biological resources. The cost and schedule to perform CEQA analyses is considered in the project budgets and timelines.

Comment No. 2. Potential Projects and Management Plan Concepts, Table 2-1 Proposed Projects and Management Actions for the Spadra Basin (pp3)

Issue: The Department is concerned over the impact to water availability for avian species in San Jose Creek specifically for project numbers 3 and 12 as identified in Table 2-1. Aerial photography indicates the presences of algal mats downstream of the proposed projects. Changes to the availability of water may

impact biotic resources in the area of and downstream of the proposed projects. The current hydrology in San Jose Creek allows phytoplankton (algae and cyanobacteria), microorganisms, and herbaceous vegetation to establish. The algae provide habitat and a food source for benthic invertebrates, a vital food source for wading birds. In addition, wading birds also feed on herbaceous vegetation. Changes to hydrology by diverting water from the creek are reasonable potential direct and indirect physical changes in the environment.

Recommendation: The Department recommends the final GSP require projects to submit an analysis of potential impacts on biological resources within the creek resulting from proposed projects. At a minimum, an analysis should include:

I. A map of plant communities and important bird foraging habitat occurring in the project area, namely within and around San Jose Creek and South San Jose Creek. Plant communities should be mapped at the alliance/association level using the Manual of California Vegetation, second edition (Sawyer et al. 2009);

II. A comprehensive list of sensitive and special status plant and wildlife species, and sensitive plant communities, occurring in the project site. For each biological resource, provide:

    1. A summary of species-specific habitat requirements;

    2. A discussion as to how the species or plant community may be significantly impacted directly or indirectly through habitat modification, as result of changes to hydrology (reduced flow), hydraulics (water depth, wetted perimeter, velocity), and sunlight exposure (photosynthetic ability of plants and algae); and

    3. A quantitative analysis and/or adequate discussion to evaluate whether the project would result in those significant impacts.

III. A discussion of whether construction, operations, and maintenance of the new park would have direct and/or indirect, permanent or temporal impact on biological resources;

IV. A discussion of project-related impacts on biological resources in relation cumulative changes to the hydrologic regime; and

V. Avoidance and/or mitigation measures that would be implemented for potential impacts on biological resources if they are present.

Response. The three Basin Optimization Scenarios developed and evaluated in TM 5 do not include the potential projects 3 and 12 listed in Table 2-1 that would modify flow in San Jose Creek. The preferred Basin Optimization Scenario in TM 5 and the GSP is Scenario 3. Therefore, at this time the final GSP will not include projects for the submission of an analysis of potential impacts on biological resources within the creek resulting from proposed projects.

All projects to be implemented for the Spadra Basin GSP will be evaluated through the appropriate CEQA analyses, including the necessary analyses for potential impacts to biological resources. The cost and schedule to perform CEQA analyses is considered in the project budgets and timelines in the GSP.

Comment No. 3. Basin Optimization Scenarios (pp7)

Issue: According to the TM5: "If the final GSP includes the utilization of the surplus recycled water from the Pomona WRP, the GSP implementation plan will include a contingency plan to address the uncertainty of the future availability of all or part of the surplus recycled water. The contingency plan will include a description of the options for alternative water sources for recharge and projects and management strategies if the surplus recycled water is no longer available." The Department looks forward to reviewing the contingency plan in the final GSP.

Recommendation: The Department looks forward to the forthcoming final GSP and included contingency plan that will identify actions to address:

I. Uncertainty of the future availability of all/part of the surplus recycled water.

II. Identifying alternative water sources for recharge.

III. Identifying projects and management strategies if the surplus recycled water is no longer available.

Response. *Section 6 Plan Implementation* of the GSP includes a description of how the projects in Basin Optimization Scenario 3 will be taken from the concepts described in the GSP to final design and then through construction in a phased approach of implementation. The development of a contingency plan to address the uncertainty of the future availability of surplus recycled water will be developed during the planning phases (Phases 1 and 2) of the project implementation. Updates have been made to TM 5 on Page 7 to describe the development of the contingency plan.

Conclusion

The Department appreciates the opportunity to comment on the draft TM5 GSP. The Department also appreciates the ongoing coordination and collaboration with the GSA. Though the Spadra Basin thoroughly addresses the benefits of each of the Basin Optimization Scenarios presented, the Department recommends that Spadra Basin GSA address the above comments. This is to avoid a potential 'incomplete' or 'inadequate' future GSP determination per SGMA Regulations, as assessed by the Department of Water Resources.

Comments by Monica Sanchez, Supervising Engineer, Reuse and Compliance Section, Los Angeles County Sanitation Districts

Comment No. 1. General comment: As noted in an earlier TM, recycled water from the Pomona WRP is already apportioned out to multiple users. Utilizing any "surplus" water for recharge would need to be conducted under one of the existing recycled water contracts and potentially discussed with all current contract holders. Additionally, some of the purveyors have discussed plans to capture and utilize additional recycled water flows via storage reservoirs which is not mentioned in the TM. If these plans come to fruition, less "surplus" water may be available than considered in this analysis.

Response. The Spadra Basin GSA is the proponent for these projects that will use surplus recycled water. The two parties of the Spadra Basin GSA are the WVWD and Pomona, which are also the two contractual holders for the recycled water from the Pomona WRP. Section 6 Plan Implementation of the GSP includes a description of how the projects in Basin Optimization Scenario 3 will be taken from the concepts described in the GSP to final design and then through construction in a phased approach of implementation. During this implementation process, WVWD and Pomona will work together and with the LACSD on their preferred use of surplus recycled water.

Comment No. 2. The critical point of the entire GSP effort is found on page 4 of TM-5 Part 1 which states, *"All three Basin Optimization Scenarios include the use of surplus recycled water from the Pomona WRP to achieve the objectives of the scenarios."* It then identifies *"about 3.3 million gallons per day (mgd) or about 3,500 AFY"* of Pomona WRP effluent discharged to the concrete-lined South Fork of San Jose Creek that can be reduced to zero based on the SWRCB October 2020 approval of the Change Petition filed by the LACSD. If the entire GSP hinges on the use of the unused Pomona WRP recycled water discharged to the San Jose Creek, then the Spadra Basin GSA should include a discussion of the significant impediments that would need to be addressed and overcome prior to the use of recycled water for their intended purposes. Some of the more important impediments are listed as follows:

- For Optimization Scenario 1, groundwater production at CPP would be replaced with 430 AFY of "surplus" water from the Pomona WRP, with no recharge option. While this TM states that such surplus water exists during the demand months, it is generally discharged to the San Jose Creek because there is no opportunity for use at any particular moment on any particular day. The mere fact that there is river discharge occurring even during summer months does not mean that any of it could actually be captured and put to beneficial use at CPP. This is literally what we have been trying to do for quite some time at the Pomona WRP.
- Optimization Scenarios 2 & 3: These options considers recharge of recycled water via injection wells. It should be noted that recharge via injection of recycled water requires the recycled water to be advanced treated, which the Pomona WRP effluent is not. If these options are considered, additional treatment would need to be constructed by the project proponents for the recycled water prior to recharge via injection. It should be noted that the type of advanced treatment required for injection of recycled water typically comes at a high cost. This is not currently mentioned or considered in the analysis. Additionally, it should be noted that dilution water would be required for recharge via spreading basins and available sources would need to be considered.
- Optimization Scenario 2 assumes many of the potential recharge sites can be supplied with existing recycled water distribution lines (i.e., City of Pomona). This arrangement would be difficult to manage in terms of using only "surplus" water for recharge due to how recycled water from the Pomona WRP is currently supplied to the existing purveyors. For example, the basin managers would not only need to know when "surplus" recycled water was available (e.g., discharge from the WRP into San Jose Creek) before they started diversions to recharge but would also have to know precisely when the "surplus" water was no longer available at the same time they were diverting recycled water out of the Pomona transmission system. Invariably, someone would be short-changed in this arrangement, most likely WVWD.

Response. The proposed projects envisioned in the Basin Optimization Scenarios have thus far been described and evaluated at a conceptual level in TM 5 to characterize and assess the basin response and cost of implementation. The preferred Basin Optimization Scenario is Scenario 3. The next steps towards implementing the proposed projects in Scenario 3 is a planning process to take from concept to design and then to construction. This planning process is described in GSP in Section 6 Plan Implementation as four major phases of project planning and implementation. The impediments and challenges listed above are valid. These types of issues and details will be the considered during the planning process as the projects are reviewed, refined, screened, and assessed for feasibility, before completing the final design and construction.

As noted in the second bullet in Comment No. 2, recharge via injection of recycled water requires the recycled water to be advanced treated, which the Pomona WRP effluent is not. In the preferred Basin Optimization Scenario 3, recycled water will be injected in combination with advance treatment of all the extracted groundwater at an expanded RO Plant. The Spadra Basin GSA will work with the regulators on obtaining all required permitting and the possibility of treating the groundwater after extraction, and not prior to injection. During the planning process for Basin Optimization Scenario 3, a project alternative can be considered and evaluated for advance treatment prior to injection.

Comment No. 3. Although the TM does acknowledge that groundwater recharge permitting and perhaps an SNMP would be required, it should not

Response. On page 64, in the Conclusions and Recommendations section where we discuss the recommended Basin Optimization Scenario 3. The following was added to address Comment No. 3: "Scenario 3 will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). The permitting process and the development of an SNMP are both extensive efforts that will require multiple years to complete. These efforts will be completed during Phase 4 of the planning process necessary for the implementation of these projects that is described in the GSP in Section 6 Implementation Plan. Additionally, the costs and schedule for permitting and development of an SNMP are considered in the cost and schedules presented in the GSP in Sections 6.2 and 6.1."

Appendix H

Comments and Responses on the Draft GSP

COMMENTS AND RESPONSES ON THE NOVEMBER 2021 DRAFT GROUNDWATER SUSTAINABILITY PLAN (GSP) FOR THE SPADRA BASIN

Comments by Monica Sanchez, Supervising Engineer, Reuse and Compliance Section, Los Angeles County Sanitation District (LACSD)

Staff of the Los Angeles County Sanitation Districts (LACSD) have reviewed the draft Groundwater Sustainability Plan (GSP) prepared on behalf of the Spadra Basin Groundwater Sustainability Agency (GSA). The following comments support those made in a letter dated November 4, 2021 regarding the various Technical Memoranda that became the basis of the GSP.

Comment No. 1. As a general comment, LACSD has more recent recycled water production and reuse numbers for the Pomona WRP than those contained in the draft GSP (Page 2-14). LACSD staff would be able to supply these numbers upon request. The more recent flow numbers could be important when evaluating and deciding upon Basin Optimization Scenarios contained in Sections 5 and 6 of the GSP. This leads us to our more specific comments.

Response. Thank you for the offer to provided recent numbers on recycled water production and reuse for the Pomona WRP. The GSA requested this recent information from the LACSD via email on January 5, 2022, and the data was received on January 10, 2022. The data received was used to update the numbers on Page 2-14 and Page 2-17 on the reuse and discharge to the creek. The GSA will continue to collect updated data and information for the Pomona WRP to use during the GSA's planning and implementation phases of the conceptual projects described in the GSP.

Comment No. 2. The unused portion of recycled water from the Pomona WRP is stated to be 3,500 AFY (Page 5-51); in reality, this flow has averaged 2,976 AFY over the past three fiscal years and may decrease further as influent flows to the Pomona WRP continue to drop due to water conservation efforts. Furthermore, a significant portion of what the GSP characterizes as "surplus" water is expected to be captured and put to direct use through the construction of a storage tank at the Spadra Landfill site by Walnut Valley Water District (WVWD) over the next 2-3 years. LACSD staff recommends including a discussion of potential in-plant capital improvements at the Pomona WRP or in the tributary sewer system that would increase plant flow for future usage envisioned by the GSP and which could be funded by the GSA.

Response. The volume of 3,500 afy of surplus recycled water used in the GSP and referenced on Page 5-51 is the amount of Pomona WRP discharge to the South San Jose that is reported in the LACSD's October 2019 wastewater change petition to the State Water Board. The rate of discharge reported in the petition is 3.27 million gallons per day (mgd) which is average discharge for water year 2014-2018; 3.27 mgd converts to 3,665 afy which was rounded down to approximately 3,500 afy.

We will provide more information in the Final GSP that indicates the source of the 3,500 afy surplus recycled water used as the basis to develop the Basin Optimization Scenarios. Additionally, we will provide more information on the potential for there to be less surplus water in the future and that this will be considered and evaluated in the planning phases of project implementation during GSP implementation that are described in Section 6.1.5 of the GSP. The following updates were made the Final GSP:

- On page 5-51, *Section 5.3.2 Basin Optimization Scenarios*, fourth paragraph, second sentence – changed and moved this sentence to "The wastewater change petition described the surplus recycled water as 3.2 mgd based on the average discharge that occurred from 2014 to 2018, which is about 3,500 afy."
- On page 5-52, *Section 5.3.2 Basin Optimization Scenarios*, second paragraph from the top – modified paragraph to read:

  "Recycled water is considered the primary source of recharge for the Basin Optimization Scenarios 2 and 3 because of the stakeholder interest to utilize this local available source of water that is currently not being used in the Spadra Basin. Basin Optimization Scenarios 2 and 3 contemplate the use of recycled water for artificial recharge ranging from 500 afy to 3,500 afy at locations that are conceptual at this time. However, there is potential the recycled water available for recharge could be less in the future than the assumed maximum of 3,500 afy in the scenarios. Conditions where less recycled water would be available in the future could include: if the LACSD's AMP implements a response measure to resume some discharge to support the downstream habitat; a decrease in influent and production at the Pomona WRP; or new reuse and storage projects are implemented.

  The GSP implementation includes planning phases for project implementation to take the conceptual projects described in the GSP to design and construction (Section 6.1.5). The planning phases include the identification and characterization of project alternatives, which could include less recycled water recharge, other sources or combinations of water for recharge, projects to increase recycled water availability, among others."

Comment No. 3. Scenario 1 proposes reducing groundwater pumping by 430 AFY through replacement with increased recycled water usage (Page 5-52). The assumption is that there is enough unused recycled water to make up for the pumping reduction, even during summer months. While this may be true on a monthly basis, recycled water demands can vary considerably on a daily, even hourly, basis. In other words, while there may be surplus water during the middle of the day or when it's raining there may be insufficient demand at that time. Conversely, there may be too much competition on any particular day for recycled water during nighttime low flows or on days when it's exceptionally hot and dry. It has been our experience that supply most likely will not match instantaneous demand during much of the time.

Response. Thank you for your experienced input on the intricacies and realities of coordinating recycled water supplies and demands. As mentioned, and as described in the GSP, a monthly analysis was performed to conclude that the amount of available surplus recycled water based on historical data was greater than the monthly non-potable demands for the three CPP wells.

If the GSA decides to implement the project and management actions in Scenario 1, a more detailed and higher frequency analysis will need to be performed on the availability and timing of recycled water supply and demands for the new reuse projects needed in lieu of pumping at the three CPP wells. This analysis would be performed during the planning and implementation phases described in Section 6.1.5 of the GSP to evaluate project feasibility.

Comment No. 4. Both Scenario 2 (Page 5-55) and Scenario 3 (Page 5-56) accurately note that the proposed groundwater recharge with recycled water will require regulatory permitting. Both scenarios include groundwater injection wells; however, the GSP does not consider the fact that the proposed injection, unlike surface spreading, would also require advanced treatment above what is provided by the Pomona WRP. This becomes important in the subsequent Section where costs for the various scenarios are

presented in Table 6-1 (Page 6-6). For the recommended Scenario 3, the total estimated capital cost is $160 million, with $472,000 annual O&M costs. Since the facilities described as being needed for this Scenario did not include advanced treatment of the recycled water prior to injection, it is reasonable to assume that the significant additional capital and O&M costs required for these additional facilities were not considered in the cost projections and, thus, the economic viability of the proposed scenario. The project consultant previously mentioned seeking regulatory approval for the project to not need advanced treatment prior to injection, however, this approval is not guaranteed and, therefore, the full costs of additional treatment should be used in the project estimate to be conservative.

Response. We are aware that current regulatory permits for the injection of recycled water into an aquifer require advance treatment prior to injection. For the GSP, the GSA envisions recycled water recharge via injection without the advance treatment prior to injection but with advance treatment of all the groundwater that is pumped from the Spadra Basin and used for potable supplies. The GSA recognizes that the regulatory environment for recycled water recharge is constantly evolving. In the planning and implementation phases of the projects and management actions described in Section 6.1.5 of the GSP, the GSA will initiate the process to work with regulators to obtain the required permits and review the feasibility of this project as envisioned in the GSP. The planning phases will also include identification and characterization of project alternatives, and their costs, that may include advance treatment of the water prior to injection, among other options. The following updates were made in the Final GSP to provide more description on the required permitting and planning:

- On page 5-55, in Section 5.3.2.2 describing Scenario 2, the following sentence was added in the "Permitting" bullet:

  "The current regulatory permitting framework of the recycled water recharge via injection (subsurface application) requires the advance treatment of water prior to recharge. This scenario does not include advance treatment prior to injection. Permitting will be a regulatory challenge that will need to be addressed with the Regional Board and State Water Board during the planning stages of project implementation as described in Section 6.1.5 of the GSP."

- On page 5-56, in Section 5.3.2.3 describing Scenario 3, the following sentence was added in the "Permitting" bullet:

  "The current regulatory permitting framework of the recycled water recharge via injection (subsurface application) requires the advance treatment of water prior to recharge. This scenario does not include advance treatment prior to injection, but instead, includes advance treatment after groundwater extraction. Permitting will be a regulatory challenge that will need to be addressed with the Regional Board and State Water Board and DDW during the planning stages of project implementation as described in Section 6.1.5 of the GSP."

Comment No. 5. It is understandable that these Scenarios are being treated as "conceptual," with no firm decisions being made at this time. However, LACSD staff believe that it is not only desirable, but imperative, that full consideration to the issues outlined in this letter and the letter of November 4 be included in the GSP so that potential decisions and courses of action are not taken by the GSA without the full understanding of the very real economic, regulatory, and practical challenges that lie ahead.

Response. The GSA appreciates the constructive comments from the LASCD, and recognizes that economic, regulatory, and practical challenges will be encountered and will be addressed during the subsequent planning and implementation phases of the projects and management actions proposed in this GSP in Section 6.1.5.

Appendix I

TM 2 – Construction and Calibration of the Spadra Basin Groundwater Model

Groundwater Sustainability Plan for the Spadra Basin
Technical Memorandum 2—Construction and Calibration of the Spadra Basin Groundwater Model

To: Groundwater Sustainability Agency for Spadra Basin

From: Wildermuth Environmental Inc.

Date: June 23, 2020

Contents

1.0 Introduction 5
2.0 Water Budget (Section 2.2.7 in final GSP) 7
2.1 Recharge Components 7
2.2 Discharge Components 8
2.3. Change in Groundwater Storage 9
3.0 Model Construction 10
3.1 Computer Codes 10
3.1.1 HSPF 10
3.1.2 R4 Model 11
3.1.3 HYDRUS 12
3.1.4 MODFLOW 12
3.1.5 PEST and SENSAN 13
3.2 Model Construction 13
3.2.1 Surface-Water Models 13
3.2.1 Groundwater Model 14
3.2.1 Model Domain and Grid 14
3.2.2 Time Discretization 14
3.2.3 Initial Aquifer Properties and Parameter Zonation 15
3.2.4 Groundwater Elevation Initial Conditions 16
3.2.5 MODFLOW Packages and Boundary Conditions 16
3.2.5 Recharge Package (RCH) 16
3.2.6 Flow and Head Boundary Package (FHB) 16

3.2.6 Flow and Head Boundary Package (FHB) 16
3.2.7 Well Package (WEL) 16
3.2.6 Other MODFLOW Packages 16
3.2.5.1 Preconditioned Conjugate-Gradient Package 16
3.2.5.3 Sensitivity Process (SEN) and Observation Process (OBS) 17
4.0 Model Calibration 18
4.1 Model-Calibration Procedure 18
4.2 Sensitivity Analysis and Covariance Matrix 19
4.3 Selection of Calibration Data 20
4.4 PEST Settings 21
4.5 Model-Calibration Criteria 22
4.6 Evaluation of Model Calibration 23
4.6.1 Residual Analysis 24
4.7 Calibrated Water Budget 24
4.7 Model Limitations and Recommendations 25
References 27

List of Figures

2-1 Total Recharge, Discharge, and Change in Storage in the Chino Basin During the Calibration Period (1978-2018)
3-1 Surface Water Models and Groundwater Model Domains
3-2 Spadra Basin Model Domain and Mode Grid
3-3 Model Zonation
4-1 Calibration Wells
4-2 Comparison of Simulated vs. Measured Water-Level Elevation at Calibration Wells
4-3a Measured vs. Simulated Groundwater Elevations at Well P-28 in Model Calibration
4-3b Measured vs. Simulated Groundwater Elevations at Well P-31 in Model Calibration
4-3c Measured vs. Simulated Groundwater Elevations at Well CPP-1 in Model Calibration
4-3d Measured vs. Simulated Groundwater Elevations at Well 1002811 in Model Calibration
4-4 Residual Relative Frequency Histogram for Spadra Basin Calibration
4-5 Mean Residual Error of Calibration Wells
4-6 Groundwater Elevation and Flow Directions: *End of Calibration Period - July 2018*

List of Tables

2-1 Methods/Data/Information Used to Estimate the Water Budget for the Spadra Basin
2-2 Water Budget for the Spadra Basin – Fiscal Year 1978-2018
3-1 Initial Parameter-Zone Coefficients and Aquifer Property Estimates
3-2 Boundary Conditions for Model Calibration in the Spadra Basin
4-1 Model Parameter Sensitivity
4-2 Spadra Basin Calibration Wells
4-3 Calibrated Parameter-Zone Coefficients and Aquifer Property Estimates

List of Acronyms, Abbreviations, and Initialisms

afy	acre-feet per year
CPP	California State Polytechnic University of Pomona
CVM	Chino Valley Model
DIPAW	deep infiltration of precipitation and applied water
DWR	California Department of Water Resources
ET	Evapotranspiration
ft-amsl	feet above mean sea level
ft-bgs	feet below ground surface
GDE	groundwater dependent ecosystems
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HSA	Hydrologic sub area
Pomona	City of Pomona
NSE	Nash-Sutcliffe efficiency
SCS	Soil Conservation Services
SGMA	Sustainable Groundwater Management Act
TM	technical memorandum
WEI	Wildermuth Environmental, Inc.
WVWD	Walnut Valley Water District

1.0 Introduction

The Spadra Basin is a small, non-adjudicated subbasin of the San Gabriel Valley Basin (Basin 4-013 as defined by the California Department of Water Resources [DWR]). Pursuant to the Sustainable Groundwater Management Act of 2014 (SGMA), the DWR has designated the San Gabriel Valley Basin as a "low-priority" basin. The San Gabriel Valley basin is considered low-priority because the groundwater rights in most of the basin have been adjudicated; hence, the development of a Groundwater Sustainability Plan (GSP) for San Gabriel Valley Basin is not required under SGMA. Although it is not a requirement of the SGMA, the Walnut Valley Water District (WVWD) and the City of Pomona (Pomona) collectively formed a groundwater sustainability agency (GSA) for the Spadra Basin (Spadra Basin GSA) and decided to prepare and adopt a GSP with the objectives of maximizing the beneficial use of the Spadra Basin while ensuring long-term sustainability.

The Spadra Basin GSA contracted Wildermuth Environmental Inc. (WEI) to help prepare the GSP. WEI's scope of work is to prepare five technical memorandums in sequence. Each technical memorandum (TM) constitutes an interim milestone in the development of the final GSP for the Spadra Basin. The five technical memorandums include:

- *Technical Memorandum 1* (TM 1) – *Conceptual Model of the Spadra Basin*
- *Technical Memorandum 2* (TM 2) – *Construction and Calibration of the Spadra Basin Groundwater Model*
- *Technical Memorandum 3* (TM 3) – *Sustainable Management Criteria for the Spadra Basin*
- *Technical Memorandum 4* (TM 4) – *Sustainability of Future Baseline Conditions*
- *Technical Memorandum 5* (TM 5) – *Basin Optimization Scenarios to Achieve Sustainability*

TM 1 through TM 5 will ultimately become sections in the final GSP for the Spadra Basin and will be used to help prepare the GSP implementation plan in the final GSP. The outline of the final GSP for the Spadra Basin and mapping to each TM is as follows:

- Executive Summary
- Section 1: Introduction
- Section 2: Plan Area and Basin Setting (TM 1 and TM 2)
- Section 3: Sustainable Management Criteria (TM 3)
- Section 4: Projects and Management Actions to Achieve Sustainability (TM 4 and TM 5)
- Section 5: GSP Implementation
- Section 6: References

As described in the Basin Setting section of TM 1, the Chino Basin is just east of and adjacent to the Spadra Basin, and review of geologic, groundwater-elevation, and chemistry data from

Spadra and adjacent Chino Basin wells have demonstrated a hydraulic connection, meaning that future groundwater management activities in the Chino Basin will impact the yield of the Spadra Basin and vice versa. The sustainable yields of both basins are interdependent and depend on the management of each basin. There may be a similar relationship between the Spadra Basin and Six Basins. The Spadra Basin GSA has therefore decided to consider its neighboring basins in the development and evaluation of its GSP through the integration and use of surface-water and groundwater models that cover the neighboring basins and their tributary watersheds.

There are existing surface-water and groundwater models of the watersheds and groundwater basins that are up-gradient and adjacent to the Spadra Basin. These groundwater basins and tributary watersheds include the Six Basins, Cucamonga Basin, Temescal Basin, Chino Basin and the tributary watersheds in the surrounding mountains and hills. Recently, these models were integrated and expanded to include the Spadra Basin and its tributary watershed and re-named to the Chino Valley Model (CVM). The CVM has been extensively calibrated and used for planning purposes in the Chino Basin (WEI, 2020).

In this effort, the Spadra Basin portion of the CVM was updated using the hydrogeologic information in the Basin Setting section of TM1 and recalibrated to refine the aquifer-system properties in the Spadra Basin.

This *TM 2 – Construction and Calibration of the Spadra Basin Groundwater Model* describes:

1. The water budget of the Spadra Basin pursuant to the DWR's GSP Regulations for the "Basin Setting" section of the GSP (California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2, §354.18). The description of the water budget is derived from both measured data and modeling estimates. The Water Budget section in this TM 2 will become a subsection of *Section 2: Plan Area and Basin Setting* in the final GSP and will be used in the development of the Sustainable Management Criteria in TM 3.

2. The construction and calibration of the numerical groundwater-flow model, which was performed consistent with the requirements in the DWR's GSP Regulations (California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 3, §352.4[f]). The model was to estimate various terms of the water budget, and will assist in subsequent tasks to develop the GSP.

2.0 Water Budget (Section 2.2.7 in final GSP)

The water budget for a groundwater basin is an accounting of the specific components of recharge to and discharge from the groundwater system, and the resultant changes in the volume of groundwater in storage. When total recharge is equal to total discharge, there is no change in groundwater storage, indicating that the aquifer system is at equilibrium or steady state. When total recharge does not equal the total discharge, there is either an increase in storage or a decrease in storage, which results in a change in groundwater levels.

The water budget is transient over time, and can be affected by weather events, climate, overlying land uses, outdoor water uses, water disposal practices, groundwater pumping, groundwater management activities in adjacent basins, and artificial recharge activities. Understanding of the water budget for a groundwater basin is key to the development of sustainable management criteria and management practices.

This section describes the historical water budget for the Spadra Basin for the period of 1978-2018, the calibration period for the Spadra Basin Groundwater Model (see Sections 3 and 4 below). Table 2-1 lists the various methods that were used to estimate the historical water budget for the Spadra Basin, which include measured data, model estimates, information from prior investigations, or a combination of these methods. Table 2-2 lists the annual volumes of each water-budget component and the annual change in groundwater storage. The measured data that were used to estimate certain water-budget components, such as groundwater pumping, were described in the Basin Setting section of TM1. The models used to estimate other water-budget components are described in Sections 3 and 4 below.

2.1 Recharge Components

The recharge components for the Spadra Basin are listed in Table 2-2 for the calibration period and are characterized below:

Deep infiltration of precipitation and applied Water (DIPAW). The HSPF and R4 watershed models were used to estimate surface water discharge from precipitation throughout the Spadra Basin watershed and the DIPAW from the soil (root) zone. The data requirements of these models include the following: land use and associated properties (imperviousness, irrigation practices), hydrologic soil type, topography, surface water drainage system (channel alignment, hydraulic properties and operating scheme), surface water discharge measurements (boundary inflows and for calibration), precipitation, and evapotranspiration (ET) and evaporation. Recharge from DIPAW ranged from about 1,475 to 3,430 acre-feet per year (afy) and averaged about 2,374 afy over the calibration period.

Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose and Puente Hills). The model-estimated DIPAW for watersheds that are tributary to and not overlying the groundwater basin was assumed to be the subsurface inflow from these areas to the Spadra Basin proximate to the discharge point of the watershed to the groundwater basin. Surface water discharges estimated by these

models were routed through the stream systems that overlie the active Spadra Basin domain. Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills ranged from about 549 to 1,665 afy and averaged about 1,100 afy over the calibration period.

Subsurface inflow from the Six Basins across the San Jose Fault. Subsurface inflow from the Six Basins across the San Jose Fault is a possible source of recharge to the Spadra Basin. Eckis (1933) speculated that this inflow could be, at least in part, responsible for the existence of the groundwater divide that separates the Spadra Basin from the Chino Basin. However, the gap between the San Jose Fault and San Jose Hills, where such subsurface inflow could occur, is small. And, there is a paucity of hydrogeologic data in this area to characterize how such inflow occurs. For these reasons, subsurface inflow from the Six Basins was assumed to be negligible in this modeling effort.

Deep infiltration of septic tank discharge. Wastewaters generated within the Spadra Basin are almost entirely conveyed to the Pomona Water Reclamation Plant for treatment. Therefore, the deep infiltration of septic tank discharge was assumed to be negligible in this modeling effort.

Table 2-2 shows that average recharge to the Spadra Basin was estimated to be about 3,474 afy over the calibration period 1978-2018.

2.2 Discharge Components

The discharge components for the Spadra Basin are listed in Table 2-2 for the calibration period and are characterized below:

Groundwater pumping from wells. This discharge component was estimated based on the records of major groundwater producers in the Spadra Basin (Pomona, WVWD, and the California State Polytechnic University of Pomona [CPP]). Pumping by Walnut Hills Mobile Home Park was ignored because information was not available. Groundwater pumping ranged from about 602 to 2,159 afy and averaged about 1,259 afy over the calibration period.

Subsurface outflow to the Puente Basin. Subsurface outflow to the Puente Basin occurs through the saturated sediments in the bedrock narrows at the southwestern boundary of the Spadra Basin. The outflows were estimated by the Spadra Basin Groundwater Model based on a historical time series of groundwater elevations at a well located near the boundary and the calibrated hydraulic conductivities in the Spadra Basin adjacent to the boundary as described in Section 4 herein. The boundary was treated as a variable-head boundary during model calibration. Subsurface outflow to the Puente Basin ranged from about 1,060 to 2,019 afy and averaged about 1,487 afy over the calibration period.

Subsurface outflow to the Chino Basin. Subsurface outflow to the Chino Basin occurs within the saturated sediments across the eastern boundary of the Spadra Basin, which is the adjudicated Chino Basin boundary. The outflows were estimated by the Spadra

Basin Groundwater Model during model calibration. Subsurface outflow to the Chino Basin ranged from about 238 to 950 afy and averaged about 555 afy over the calibration period.

Rising Groundwater Outflow and Evapotranspiration. Measured groundwater levels and model-simulated groundwater levels (during model calibration) never rise to closer than 30 ft from the ground surface in the Spadra Basin, so there is no discharge due to rising groundwater outflow. In addition, there are no groundwater dependent ecosystems (GDEs)within the Spadra Basin, so there is no discharge due to evapotranspiration.

Table 2-2 shows that average discharge from the Spadra Basin was estimated to be about 3,300 afy over the calibration period 1978-2018.

2.3. Change in Groundwater Storage

When total recharge is equal to total discharge, no change in groundwater storage occurs. When total recharge does not equal total discharge, an increase or decrease in storage occurs.

Table 2-2 lists the annual change in groundwater storage over the calibration period as estimated from the water budget, and the cumulative change in storage. Figure 2-2 is a time-history chart that shows annual recharge, annual discharge, and the cumulative change in storage for 1978-2018. The cumulative change in storage over this period was +7,089 af. This table and figure indicate that the water budget, and hence the changes in storage, were primarily driven by climatic conditions and changes in groundwater production. For example, groundwater storage increased by about 8,000 af during the 1978-83 wet period, primarily because recharge (DIPAW and subsurface inflow from the surrounding mountains and hills) was higher than discharge (pumping and subsurface outflow). From 1984 to 2018, recharge was approximately equal to discharge, annual changes in storage were relatively small, and total groundwater in storage remained relatively stable. This relative balance persisted even during the long-term dry period from 1999-2018, primarily because of reduced groundwater pumping. These model-estimated changes in storage are consistent with the measured changes in groundwater elevations across the Spadra Basin as described in TM 1 (see Figure 2-19 and 2-20 in TM 1).

3.0 Model Construction

This section describes: (i) the computer codes used in the surface-water and groundwater modeling of the Spadra Basin and (ii) how the Spadra Basin conceptual model described in TM 1, was translated into the surface-water and groundwater models to simulate the hydrologic processes.

3.1 Computer Codes

This section describes the computer codes used and addresses the selection criteria, assumptions, limitations, and governing equations relative to each computer code. The computer codes used in the development of the Spadra Basin Groundwater Model included:

- San Gabriel Mountain Hydrology: HSPF (Bicknell, et al., 2005).
- Runoff, surface water flow, stormwater recharge, agricultural pumping, applied water and soil zone process: R4 (WEI, 2007).
- Vadose zone flow: HYDRUS-2D (Simunek, et al., 1999).
- Groundwater flow: MODFLOW (McDonald, et al., 1988; Mehl, et al., 2001) and MODFLOW-NWT (Niswonger, et al., 2011).
- Parameter estimation and calibration: PEST and SENSAN (Doherty, 2019)

3.1.1 HSPF

The Hydrological Simulation Program-FORTRAN, known as HSPF, is a numerical model that was developed to simulate hydrologic and water quality processes in natural and man-made water systems. It is used in the planning, design, and operation of water-resources systems. HSPF uses the time history of precipitation, temperature, evaporation, evapotranspiration and parameters related to land-use patterns, soil characteristics, and agricultural practices to simulate the processes that occur in a watershed. The initial result of an HSPF simulation is a time history of the quantity and quality of water transported over the land surface and through various soil zones to streams. Runoff flow rate, sediment loads, nutrients, pesticides, toxic chemicals, and other quality constituent concentrations can be predicted. The model uses these results and stream channel information to simulate instream processes. From this, HSPF produces a time history of water quantity and quality at any point in the watershed.

The HSPF model for the San Gabriel Mountain streams was initially developed for the Six Basins Model in 2014 (WEI, 2014) and was extended and improved to support the recent update and recalibration of the Six Basins Model in 2019 and the CVM in 2020 (WEI, 2020).

3.1.2 R4 Model

The R4 Model[1] is a comprehensive suite of hydrologic simulation modules that were developed by WEI to support hydrologic decision-support processes and groundwater modeling. The R4 Model was used in the CVM and in this effort to estimate areal recharge from precipitation and outdoor irrigation, to estimate storm water recharge that occurs along pervious stream bottoms and in stormwater management basins, and to estimate agricultural pumping when pumping records were unavailable.

The origin of this model can be traced to the Chino Basin Water Conservation District and Chino Basin Watermaster. These agencies wanted to estimate the volume of stormwater recharge that occurred in recharge basins, flood retention basins, and unlined streams in the Chino Basin. WEI developed a daily simulation model to estimate runoff from daily precipitation, route runoff through the Chino Basin drainage systems, calculate daily recharge, and produce reports that summarize recharge performance. This model was initially developed in 1994 for the western portion of the Chino Basin (Wildermuth, 1995) and was expanded to the entire Chino Basin in 1996 (WEI, 1998). Subsequently, it was used in the Chino Basin to estimate the recharge performance of proposed flood control and conservation basin improvements and the recharge benefits of improved basin maintenance (Black & Veatch, 2001). The model was expanded to include water-quality simulations and applied to the Wasteload Allocation Investigation for the Santa Ana Watershed (WEI, 2002). The root zone simulation module is used to estimate irrigation applied to land surface based on variable vegetation types, evapotranspiration, and irrigation practices using a soil moisture model, and DIPAW.

The model has been used for groundwater models developed by WEI, including several models of the Chino Basin for the period 2003 through 2020 (WEI, 2003; 2007; 2008; 2009; 2015; 2018; 2020), the Beaumont Basin (WEI, 2008b), the Arlington Basin (WEI, 2007), Six Basins (WEI, 2017; 2020), and the Temescal Basin (WEI, 2013). The R4 model has also been used in recharge master plan investigations in the Chino and Temescal Basins (WEI, 2002; 2010; 2013); in indirect potable reuse investigations in the Beaumont Basin, Chino Basin, and the San Bernardino Basin Area (WEI, 2006a; 2008b; 2010a); and in wasteload allocation investigations for the Santa Ana River Watershed (WEI, 2002; 2008c).

The rainfall module consists of several procedures that prepare hydrologic data, including precipitation, evaporation, evapotranspiration, and land surface feature data, such as land use, hydrologic soil type, and vegetation, etc. The study area is subdivided into sub-watersheds called hydrologic sub areas (HSA) delineated based on topography, land use, hydrologic soil group, vegetation, drainage features, and urban stormwater management plans.

[1] Documentation for the R4 Model is included as Appendix A in the report entitled: "2007 CBWM Model Documentation and Evaluation of the Peace II project Description (WEI, 2007). The model is in the public domain and can be downloaded from https://github.com/weiwater/R4

The runoff module calculates daily runoff from precipitation data for each HSA using a modified Soil Conservation Service (SCS) method. The runoff module summarizes data and prepares two files: runoff for the router module and the infiltration of precipitation to the soil zone for the root-zone module.

The router module collects stormwater runoff from each HSA, point discharge data (e.g. wastewater discharge from treatment plants), and boundary inflow data, and routes these combined flows through drainage systems. This module, using natural and improved channel geometry data, calculates infiltration through pervious stream bottoms, simulates operation of flood control/conservation basins using the Modified Pulse method, calculates the infiltration of water in flood control/conservation basins, and calculates evaporation from the free-water surface of streams and flood control/conservation basins.

The root-zone module is a soil moisture accounting model that is integrated with the runoff module. It estimates the evapotranspiration requirements for vegetation types and uses the estimated precipitation infiltration provided by the runoff module to estimate the irrigation water requirement. Infiltrated precipitation and applied irrigation water, after abstraction by evapotranspiration, are then routed through the root zone on a daily time step. When the volume of water in the root zone exceeds the field capacity, the water in excess of the field capacity is discharged from the root zone to the vadose zone.

3.1.3 HYDRUS

HYDRUS-2D (Simunek, et al., 1999) is a Microsoft Windows-based modeling environment for the analysis of water flow and solute and heat transport in variably saturated porous media. The HYDRUS-2D model was used to simulate unsaturated flow in the vadose zone in the Spadra Basin. This program numerically solves the Richards equation for saturated-unsaturated flow and the Fickian-based advection-dispersion equations for heat and solute transport. This program can be used to analyze water and solute movement in unsaturated, partially saturated, or fully saturated porous media.

3.1.4 MODFLOW

The USGS has developed a wide range of computer models to simulate saturated and unsaturated subsurface flow, solute transport, and chemical reactions in groundwater systems. The most widely used of these models is MODFLOW, which simulates three-dimensional groundwater flow using the finite-difference method. Although it was conceived solely as a groundwater flow model in 1984 and released in 1988 (McDonald, et al., 1988), MODFLOW's modular structure has provided a robust framework for the integration of additional simulation capabilities that build on and enhance its original scope. The family of MODFLOW-related models now includes capabilities for simulating coupled groundwater/surface water systems and solute transport.

MODFLOW-NWT (Niswonger, et al., 2011) was chosen for this project because (i) it has extensive publicly available documentation, (ii) it has sustained rigorous USGS and academic peer review, (iii) it has a long history of development and use, (iv) it is widely used around the world in public

and private sectors, and (v) it can easily operate with additional simulation tools published by others.

HSPF, R4 and HYDRUS-2D are used to create recharge and discharge stresses on the groundwater basin. MODFLOW is used to estimate the groundwater basin's response to these stresses.

3.1.5 PEST and SENSAN

PEST[2] (Doherty, 2019), an acronym for Parameter ESTimation, is a computer code for model calibration and predictive analysis. During the calibration process, PEST applies the Gauss-Marquardt-Levenberg algorithm to adjust model parameter values for which the sum of weighted squared deviations between model-calculated and observed values is reduced to a minimum. PEST has been successfully applied in many fields of the geophysical sciences, including groundwater modeling. It has been proven to be a robust tool and was therefore applied to the CVM and the Spadra Basin Groundwater Model.

SENSAN (Doherty, 2019), an acronym for SENSitivity ANalysis, is a command-line program that provides the ability to carry out multiple model runs in parallel. WEI operates a parallel computer system with several processors where key model output from each run are recorded for later analysis. This allows for very complex multiple parameter sensitivity analyses to be completed in a much shorter time period.

PEST and SENSAN were chosen for this project because (i) they reduce modeling time and significantly improve the calibration results, (ii) the software has extensive publicly available documentation, (iii) it has a strong history of development, and (iv) it is considered a standard in the groundwater industry and has been incorporated into most MODFLOW model processors.

3.2 Model Construction

The surface-water and groundwater models for the Spadra Basin and its tributary watershed areas were initially developed as part of the development of the CVM (WEI, 2020). The groundwater model was refined in this effort. This section describes how the hydrogeologic conceptual model described in TM 1 and the hydrologic data described in Section 2 were translated into the numerical surface and groundwater models of the CVM. The topics discussed in this section include the model domain and grid, the assignment of hydraulic properties to the model grid, the initial conditions, the boundary conditions, and the specific MODFLOW packages used to simulate recharge/discharges stresses and to evaluate parameter sensitivity.

3.2.1 Surface-Water Models

Figure 3-1 also shows the HSPF and R4 model domains for the CVM (WEI, 2020). The HSPF model was used to estimate daily discharge from precipitation in the San Gabriel Mountains to the valley floor. The estimated surface-water discharge became inflow to the R4 domain over the valley floor. Figure 3-1 shows the hydrologic sub-areas (HSAs) for the HSPF and R4 models.

[2] PEST is in the public domain and can be downloaded from http://www.pesthomepage.org/

There are 39 HSAs for the San Gabriel Mountain watersheds and 344 HSA for the rest of the CVM surface water domain, 21 of which overlie the Spadra Basin. The refined HSA delineation was developed to accurately represent the drainage system and capture the historical and projected changes in land use and associated cultural conditions. Seventeen land-use types were used in the in the surface-water models to accurately estimate storm-water discharge, irrigation demands, and DIPAW.

The HSPF and R4 models were used to estimate stormwater discharge and route these discharges through the stream systems that overlie the active model domain and to estimate stormwater recharge in streams and flood-control/conservation basins. The R4 model was used to estimate DIPAW in HSAs that overlie the groundwater basins. The model-estimated DIPAW for HSAs that are tributary to and not overlying the groundwater basin was assumed to be the subsurface inflow from these areas to the groundwater-flow model. The hydrologic data required by these models are described in Table 2-1.

3.2.1 Groundwater Model

3.2.1 Model Domain and Grid

Figure 3-2 shows the groundwater model domain for the Spadra Basin and the model grid within the domain. The model grid of the Spadra Basin model consists of 123 rows, 72 columns, and two layers. There is a total of 3,964 active cells. Horizontally, each cell has a dimension of 60 by 60 meters (196 by 196 feet). This fine cell size was selected to model the curvature of drawdown near wells, recharge basins and streams. The grid cells are designated as “inactive” outside the model domain and as “active” inside the domain.

The spatial extent of the model domain was determined by the saturated extent and thickness of the aquifer system: the extent was limited to regions where the saturated thickness was greater than about 40 feet. The saturated thickness was determined based on groundwater levels at the start of the calibration period (1977) and the elevation of the bottom of the aquifer.

The aquifer system in the Spadra Basin is represented by one layer as described in TM 1.[3] Layer 1 is treated as an unconfined aquifer ranging from about 50-feet thick along the edges of the basin to about 600-feet thick along its eastern boundary with the Chino Basin.

3.2.2 Time Discretization

The transient stress period of the model is one month. The calibration period chosen for the development of the model was July 1, 1977 through June 30, 2018. The July 1, 1977 start date was selected because the hydrologic data available for use in the calibration starts in fiscal year 1978.

[3] A thin 10-ft layer was added to the bottom of the model to characterize the vertical hydraulic conductivity of the main layer (Layer 1) and to connect with the Chino Basin model.

3.2.3 Initial Aquifer Properties and Parameter Zonation

The hydraulic properties used in the model include horizontal hydraulic conductivity, vertical hydraulic conductivity, and specific yield for an unconfined aquifer. In TM 1, the hydraulic properties of the Spadra Basin and their spatial distribution were estimated based on a lithological model that was developed from borehole sediment descriptions. However, other factors, such as sorting and compaction can also affect the values of hydraulic properties. Sorting is the process by which sediment grains are selected and separated according to the grain size by the agents of transportation. Sediment sorting is directly related to the environment of deposition. For example, well-sorted sands or gravels in a river channel typically have higher porosity and higher hydraulic conductivity than found in overbank deposits. And, compaction with depth reduces the pore space resulting in lower hydraulic conductivity and lower specific yield. In the Spadra Basin, the depositional environment is thought to be a prograding alluvial fan, and its stream channels and floodplains.

To represent sediment sorting and compaction and to reduce the number of parameters to a manageable level, the model domain was subdivided into a number of parameter zones. Parameter zonation is a way to reduce the number of estimated parameters and thus make inverse modeling computationally tractable. Hydraulic parameter zonation is based on 1) geologic and geomorphologic conditions, 2) hydrogeological conditions, 3) the location of calibration wells, and 4) the capability of the numerical tools and computer resources. Figure 3-3 shows the Spadra Basin parameter zones.

The hydraulic property values in each cell of the model were then calculated by MODFLOW based on the following equations:

$$K_h(i,j,k) = XK_h(zone) \times KH(i,j,k)$$

$$K_v(i,j,k) = XK_v(zone) \times KV(i,j,k)$$

$$S_y(i,j,k) = XS_y(zone) \times SY(i,j,k)$$

Where,

$K_h(i,j,k), K_v(i,j,k), S_y(i,j,k)$ are cell-specific model estimates of horizontal hydraulic conductivity, vertical hydraulic conductivity, and specific yield.

i, j, and k represent the row, column, and layer of the cell in the model domain.

$XK_h(zone)$, $XK_v(zone)$, and $XS_y(zone)$ are the parameter-zone coefficients used to scale the cell-specific estimates of horizontal hydraulic conductivity, vertical hydraulic conductivity, and specific yield derived from the lithologic model.

KH, KV, and SY are cell-specific estimates of horizontal hydraulic conductivity, vertical hydraulic conductivity, and specific yield derived from the lithologic model.

The parameters-zone coefficients $XK_h(zone)$, $XK_v(zone)$, and $XS_y(zone)$ are adjusted in the calibration processes. This allows for the model to have a heterogeneous K_h, K_v, and S_y that is based on the lithologic information acquired from well boreholes.

Table 3-1 lists the initial estimates of the aquifer properties based on the lithologic model and the initial (pre-calibration) parameter-zone coefficients.

3.2.4 Groundwater Elevation Initial Conditions

The initial condition for the saturated zone is the groundwater elevation at the beginning of calibration period (July 1, 1977). For the Spadra Basin portion of the model domain, the initial condition was based on the groundwater-elevation contour map for Fall 1977 that was included in TM 1 (Figure 2-18b). This map was drawn from measured groundwater-elevation data collected from six wells across the basin.

3.2.5 MODFLOW Packages and Boundary Conditions

Boundary conditions are necessary in solving numerical groundwater-flow problems. Ideally, the model domain is bound by identifiable hydrogeologic features that can be quantified relative to the groundwater system. These boundaries can also occur within the active model domain (e.g. wells and creeks). Table 3-2 lists the model boundaries, the boundary condition type, the methods used to estimate the boundary conditions, and the MODFLOW packages used to simulate the boundary conditions.

3.2.5 Recharge Package (RCH)

The RCH Package (McDonald, et al., 1988) was designed to simulate areally-distributed recharge to the groundwater system. Most commonly, areal recharge occurs as a result of precipitation and irrigation water that percolates past the root zone to the groundwater system (i.e. DIPAW). The recharge values represent the volumes of water that percolate to groundwater, not the amount of precipitation. Three recharge options are supported by MODFLOW: "Recharge only at the top layer", "Recharge at specified vertical cells", and "Recharge at highest active cells." The RCH Package was used to simulate the DIPAW with the option “Recharge at highest active cells."

3.2.6 Flow and Head Boundary Package (FHB)

The FHB Package (Leake, et al., 1997) can be used to simulate specified-flow or specified-head boundary conditions that vary with time. In the Spadra Basin Groundwater Model, the FHB Package was used to simulate the subsurface inflows from the mountain fronts (variable flux) and the subsurface outflows to the Puente Basin and Chino Basin (variable head).

3.2.7 Well Package (WEL)

The Well Package (McDonald, et al., 1988) was used to simulate the withdrawal of groundwater by wells. The Well Package can also be used to simulate any other source of withdrawal or recharge that occurs at a known rate, including specified flow boundaries. This package uses a constant flow rate for each stress period.

3.2.6 Other MODFLOW Packages

3.2.5.1 Preconditioned Conjugate-Gradient Package

The Preconditioned Conjugate-Gradient package (PCG) was selected as the numerical solver in the MODFLOW model during most of the calibration effort, as it runs faster than other solvers

under the same convergence criteria and it was necessary due to the thousands of simulations required for sensitivity analyses and parameter estimation. The Newton Solver was used for final calibration simulations and all planning simulations.

3.2.5.3 Sensitivity Process (SEN) and Observation Process (OBS)

The Sensitivity Process (Hill, et al., 2000) was used to calculate the sensitivity of hydraulic heads throughout the model with respect to specified parameters using the accurate sensitivity-equation method. These are called grid sensitivities.

The Observation Process uses the grid sensitivities to calculate sensitivities for the simulated values associated with the observations. These are called observation sensitivities. Observation sensitivities are used to calculate a number of statistics that can be used (1) to diagnose inadequate data, (2) to identify parameters that probably cannot be estimated by regression using the available observations, and (3) to evaluate the utility of proposed new data.

4.0 Model Calibration

The purpose of model calibration is to estimate the best set of the model parameters and validate the water budget. Calibration is the process of adjusting model parameters to produce the best match between simulated and observed system responses that include time series of surface-water discharge and groundwater levels at wells. During the process of calibration, model parameters are adjusted (subject to reasonable bounds) with manual methods and/or automatic parameter estimation techniques to match observed surface-water discharge at gaging stations and water levels at wells.

The HSPF and R4 models were calibrated manually to match surface-water discharges at gaging stations and estimated recharge at flood-control and water-conservation basins. After the R4 model was calibrated for surface water, the R4 root zone module was manually calibrated to match urban irrigation demands. The model-calibration statistics for the surface-water models are described in the CVM documentation (WEI, 2020).

For the Spadra Basin Groundwater Model, MODFLOW-2000 (Harbaugh et al, 2000), UCODE_2014 (Poeter, et al., 2014), and PEST (Doherty, 2019b) were used to automate parameter estimation and evaluate the resulting model. Automatic parameter estimation is referred to as inverse modeling. Numerical inverse methods are widely used in hydrology and are discussed in numerous scientific publications and books, Carrera, et al. (1986a; 1986b; 1986c), Doherty (2015), Neuman (1973), and Yeh (1986). The calibration of the Spadra Basin Groundwater Model involved both manual calibration and inverse modeling with PEST. This section describes the procedure for calibrating the groundwater-flow model; defines the objective function, minimization algorithm and sensitivity analysis; discusses calibration data selection, calibration and residual analysis; and presents the historical water budget for the calibration period.

4.1 Model-Calibration Procedure

The major steps in the model calibration process included:

1. **Numerical Formulation of the Conceptual Model**. Calibration starts with the development of model conceptualization and mathematical-numerical descriptions of relevant physical processes. First, the conceptual model is converted to a numerical model in MODFLOW-2000. The numerical conversion includes the definition of the model aquifer geometry, the assignment of initial conditions and boundary conditions, discretization in space and time, and the assignment initial aquifer properties and hydraulic parameter zonation. (Model construction is described in Section 3). Next, forward modeling using MODFLOW-2000 is conducted to check the water balance and for possible errors caused in the process of conceptual model conversion. Modeling results are checked to see whether the numerical model can simulate the measured groundwater-system behavior. All the model parameters, including the model inputs that can be parameterized, are then set at their best estimates.

2. **Sensitivity Analysis**. The next step is to determine which model parameters should be calibrated. Model parameters include the hydraulic properties of the aquifer, boundary conditions, and other features of the model that can be parameterized. The parameters that are subjected to inverse modeling should be selected based on the importance of the parameters, which can be measured by parameter sensitivity. The model parameters with high sensitivity coefficients should be determined as accurately as possible. For this reason, a sensitivity analysis is conducted to determine the importance of model parameters before inverse modeling commences. Because parameter sensitivities vary in each iterative optimization process, sensitivity analyses are conducted in all steps of the calibration process.

3. **Selection of Calibration Data**. Calibration data include measured groundwater elevations at wells and surface-water discharge at gages. Model output and measured data are compared only at discrete points in space and time—the calibration data points.

4. **Forward Modeling**. A MODFLOW simulation is carried out with current parameter values to obtain the simulated groundwater levels that correspond to calibration data points (e.g., measured water levels).

5. **Parameter Estimation**. PEST uses the Marquardt-Levenberg method to minimize the objective function by iteratively updating the model parameters until a user-specified maximum number of iterations is reached or when the objective function can no longer be reduced. At the end of the parameter estimation process, a forward modeling run is carried out with updated parameters. Details of the Marquardt-Levenberg method are given in the PEST book (Doherty, 2015) and the PEST user's manual (Doherty, 2019; 2019b).

6. **Analysis of Residuals.** The difference between the measured and model-simulated system responses at the calibration points are termed residuals. The sum of the squared-weighted residuals is the objective function used in this calibration effort. Calibration is a numerically guided iterative process that adjusts estimates of model parameters to minimize this objective function. Residuals are analyzed geographically at individual wells to determine bias, systematic errors and model validity.

4.2 Sensitivity Analysis and Covariance Matrix

Parameter sensitivity measures the impact of a small parameter change on the calculated system response and objective function. If a small model parameter change results in a significant change in the objective function, the parameter is regarded as highly sensitive. PEST calculates sensitivities for values of hydraulic head throughout the model using the Jacobian matrix. Certain parameter values, such as those related to storage coefficients and hydraulic conductivity, differ greatly in orders of magnitude, and their parameter sensitivities are not directly comparable. PEST scales the elements of the Jacobian matrix by the magnitude of the parameter value to

make the parameter sensitivities comparable with one another. This feature allows for measuring the sensitivity of a calibration point and measuring the importance of the parameters.

The sensitivity analysis was conducted in two steps. At the beginning, all model parameters were selected to compute their sensitivities. This is called the primal sensitivity analysis. The purpose is to exclude insensitive parameters from the final adjusted parameter set. During this process, the covariance matrix from the sensitivity analysis was checked. The covariance matrix of model parameters describes the statistical correlations between pairs of parameters. If two parameters show a strong correlation, they cannot be determined independently. For example, if two parameters are negatively (inversely) correlated, a similar system response is obtained by concurrently increasing one and decreasing the other parameter. In the Spadra Basin, the parameters appeared relatively independent from each other.

A total of six parameters were selected through a primal sensitivity analysis. The results of the primal sensitivity analysis indicated that the hydraulic conductivity of Zone 41 plays an important role for the Spadra Basin model. Table 4-1 lists the model parameter sensitivities, their relative sensitivities, and their sensitivity rankings (from most to least sensitive) for the six model parameters in the Spadra Basin at the start of parameter estimation. Table 4-1 shows that the horizontal hydraulic conductivity parameters are more sensitive than the specific yield parameters. Based on the sensitivity analysis, the hydraulic conductivity of Zone 41, which starts at the boundary with the Puente Basin, is the most sensitive parameter of the Spadra Basin Groundwater Model.

4.3 Selection of Calibration Data

As noted in Section 3, the calibration period is July 1, 1977 through June 30, 2018. This period was chosen primarily based on the availability of groundwater-elevation and groundwater-production records. The 42-year period includes some land use transitions and the wettest and driest periods in the instrument record.

The Spadra Basin portion of the model was calibrated by comparing measured and model-estimated groundwater-levels. Groundwater-level measurements were selected based on the following criteria:

- Wells used in calibration should be geographically distributed to evenly weight the calibration across the model domain.
- Wells used in calibration should be screened across the most of the saturated aquifer system.
- Water-level measurements at wells should be temporally distributed over the calibration period to evenly weight the calibration over time.

Figure 4-1 shows the locations of the selected calibration wells. Table 4-2 lists the owner, name, coordinates, and the depth intervals of the well screens (if known). A total of 446 water-level measurements from four wells were used in calibration. Ideally, more wells and data distributed

across the Spadra Basin would have assisted in model calibration, but such wells and historical data do not exist.

4.4 PEST Settings

The efforts taken within the calibration process are ultimately evaluated on the success or failure of meeting three conditions: (1) the groundwater system processes and geometry are adequately represented and simulated, (2) weighted true errors are independent, and (3) errors in the observation data used for calibration are independent (Hill, et al., 2005). As to condition 3, it was assumed that the water-level measurements were taken by numerous personnel, representing numerous agencies, and that these measurements would therefore have random errors. It was also assumed that there are no natural processes that might make these observations biased. In this report, only conditions 1 and 2 are addressed.

Forward simulation of the flow model for the calibration period requires about 40 minutes of computational time. Since the model output, as it corresponds to the calibration points, depends on the estimation of parameters and the fit can be improved by appropriately changing model parameters, several strategies were used to find a parameter set that iteratively yields smaller values of the objective function. These strategies resulted in good matches between simulated and measured data and reasonable parameter estimates, not only in their values but also in comparison to other parameters in space. The major steps used in PEST inverse modeling are described below.

The Levenberg-Marquardt algorithm was used to minimize the objective function. It is necessary to note how to make the best choice for the Marquardt parameter (λ), as it is referred to in PEST. The choices for this value depend on how well-scaled the initial problem is. Marquardt recommends starting with a value λ and a factor v>1 (Marquardt, 1963). When λ becomes large, this algorithm acts as the steepest-descent algorithm. When λ is zero, it is reduced to the Gauss-Newton method, which is better suited for small residuals. During iteration, the algorithm decreases or increases the parameter λ value through multiplication or division by v to accelerate convergence. Based on theoretical study of the algorithm as well as trial and error, the initial λ value was set to 10.0 and v was fixed at 2.0.

The parameter-updated step size was limited in PEST's settings. During any optimization iteration, the objective function reduction rate was set to be less than 30 percent. This setting prevented the minimization algorithm from moving too far beyond the region in which the linearity assumption is justified. The parameter maximum relative and factor change limits were also set to prevent the parameter adjustment from overshooting.

Upper and lower parameter bounds were set to limit the parameters to a reasonable range. These bounds were chosen based on published literature (Freeze, et al., 1979; Fetter, 2001). The upper and lower bounds, combined with the step size limitation and parameter selection (discussed below), made the calibration process stable and the results reasonable.

Error analyses for several trial inverse modeling runs revealed that some of the hydraulic parameters are highly correlated with others. To settle this correlation challenge, the correlation

coefficients among parameters were examined after primal sensitivity, and some of the parameters that were strongly correlated to others were excluded.

4.5 Model-Calibration Criteria

Calibration concluded when the objective function could no longer be practically minimized. One estimate of the goodness of fit for model calibration is the coefficient of determination (R^2 or R-square) statistic. The coefficient of determination is the fraction of the observed variance that is explained by the model.

Another estimate of the goodness of fit for model calibration is the Nash-Sutcliffe efficiency (NSE) index (Nash, et al., 1970). The NSE index is a normalized statistic that determines the relative magnitude of the residual variance (*noise*) compared to the measured data variance (*information*). The NSE index indicates how well the plot of measured versus simulated data fits the *perfect-fit* line. Servat, et al. (1991) found the NSE index to be the best objective function for reflecting the overall fit of a hydrograph.

The NSE index is computed as shown below:

$$NSE = 1 - \frac{\sum_{i=1}^{n}(h_m - h_s)_i^2}{\sum_{i=1}^{n}(h_m - \bar{h}_m)_i^2}$$

Where,

h_m is the measured head or discharge value,

h_s is the simulated counterpart, and

n is the number of measured values.

Nash-Sutcliffe efficiencies range from $-\infty$ to 1 (inclusive), with the NSE index equal to 1 being the optimal value. Values between 0.0 and 1.0 are generally viewed as acceptable levels of performance, whereas values < 0.0 indicate that the mean observed value is a better predictor than the simulated value, indicating unacceptable performance. Moriasi, et al. (2007) provided a thorough literature review of reported model performance ratings for NSE and recommended following performance ratings for models with monthly time steps: $-\infty$ to 0.5 as unsatisfactory; 0.5 to 0.65 as satisfactory; 0.65 to 0.75 as good; 0.75 to 1.0 as very good.

The NSE index was used herein for two major reasons: (1) it is recommended for use by the ASCE (1993) and Legates et al. (1999), and (2) it is commonly used, which provides extensive information on reported values. Sevat et al. (1991) also found the NSE index to be the best objective function for reflecting the overall fit of a hydrograph.

Because the range in groundwater-levels in the Spadra Basin is relatively small—the groundwater elevation at the calibration wells ranges between about 610 to 680 ft-amsl (70-foot range)—the Normalized Root Mean Squared (Normalized RMS) was used in conjunction with the R^2 and NSE to determine the performance of the model because it takes into account the scale of the potential range in groundwater-elevations. The Normalized RMS is the Root Mean Squared

divided by the maximum difference in the observed head values. The Normalized RMS is computed as shown below:

$$Normalized\ RMS = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(h_m - h_s)_i^2}}{(h_{m_{max}} - h_{m_{min}})}$$

Thus, the Normalized RMS is expressed as a percentage, with values closer to zero representing a better fit.

4.6 Evaluation of Model Calibration

The model calibration was performed iteratively with PEST by adjusting the parameter-zone coefficients, which adjusted the aquifer properties by cell across the model domain. Upper and lower bounds were set for the parameter-zone coefficients to limit the aquifer properties to a reasonable range. These bounds were carefully chosen based on past modeling studies and published literature. The upper and lower bounds, combined with the step-size limitation and parameter-selection technology, made the calibration process stable and the results reasonable.

Calibration concluded when the objective function could no longer be practically minimized. The final calibration-based estimates for the aquifer parameters are listed in Table 4-3 for the parameter-zone coefficients and the aquifer properties.

Figure 4-2 is a scatter plot of simulated versus measured water levels for the calibration wells in the Spadra Basin. All points are distributed closely around the diagonal best-fit line, indicating good inverse modeling performance and model calibration. The figure shows that the coefficient of determination, R^2, is 0.83. An R^2 value of 0.83, meaning that the model can explain 83 percent of the variance in measured groundwater levels. By this criterion the calibration is considered "very good." And the NSE index is 0.82, which is considered a "very good" model performance, and the Normalized RMS is 0.01, suggests a good fit.

The relatively high values for the coefficient of determination and NSE index indicate that the model parameterization and the water budget for the Spadra Basin model are accurate: it would not be possible to achieve good calibration in the groundwater basin, as indicated by the high values for the coefficient of determination and NSE index, if the model parameterization and the water budget were not accurate.

Figures 4-3a through 4-3d are time-history charts of simulated and measured water levels for the calibration wells during the calibration period. These time-history charts are useful indicators of the quality of calibration as they show model-simulated water levels compared to measured water levels at a single location over time. In general, the time-history charts show a good match between the simulated and measured values and that trends in groundwater-level changes are being simulated well. Further exploration of the charts show that simulated water levels are consistently higher than measured water levels from about 1987 to 1992. This suggests that there may be a data gap in pumping records for this early period, but at this point we simply do not know if this is the case.

4.6.1 Residual Analysis

Residual analysis is critical in evaluating the performance of calibration. Minimizing the objective function using the Levenberg-Marquardt algorithm may lead to the best-estimate parameters for a given groundwater flow model. However, this does not imply that a real groundwater system is properly represented by a model. If a conceptual model fails to reproduce the salient features of a system, the given calibrated model may not be able to match the observed data as expected. Residual analysis can reveal potential trends in residuals, indicating a systematic error in a model or the data, and can point out aspects of a model that require modification.

Statistics on hydraulic head residuals aid in the evaluation of model calibration. Figure 4-4 shows the frequency residual distribution in the model domain, and the following table shows the hydraulic head residual statistics.

Residual Statistics

Statistic	Value
Mean	1.22
Median	1.68
Median Absolute Deviation	2.77
Standard Deviation	6.99
Sample Variance	49.00
Kurtosis	4.91
Skewness	-1.63
Range	55.82
Minimum	-37.93
Maximum	17.89

The mean of the residuals is around 1.22 ft, which is close to zero, with a standard deviation of about 7 ft. The value of skewness is -1.64 indicating that the residual distribution is concentrated in values higher than the mean. The Kurtosis for a standard normal distribution is 3. The Kurtosis of the residuals is 4.98, indicating that the residual distribution is normally distributed with a strong peak, which suggests there are many outliers in the residuals. The residual distribution shown in Figure 4-4 is statistically random with normal distribution.

Figure 4-5 is a map of each calibration well and its mean residual. The map shows that the mean residuals of the individual wells ranged from -1.1 ft (well 1002811) to 2.3 ft (well CPP-1) and do not display a geographical trend.

4.7 Calibrated Water Budget

Table 2-2 is the final calibrated water budget for the Spadra Basin, which is the annual accounting of recharge to and discharge from the groundwater system and the resultant changes of groundwater in storage over the calibration period. The table also shows the annual developed yield of the Spadra Basin. Developed yield is equal to groundwater production plus the change in

storage. Developed yield is an estimate of net inflow to a basin. Over a representative hydrologic period and under similar conditions of overlying land and water uses, developed yield is an estimate of the sustainable yield from the groundwater basin. The average developed yield over the calibration period was about 1,430 afy. This is about 170 afy greater than the average pumping from the Spadra Basin over the same period, suggesting that higher sustainable pumping rates are possible within the Spadra Basin.

4.7 Model Limitations and Recommendations

The Spadra Basin is located in a narrow valley and was formed by a prograding alluvial fan emanating from the San Gabriel Mountains. The aquifer system is composed of sediments that range in size from cobbles to clays with complex heterogeneity at small spatial scales. The complexity of the aquifer system and its hydraulic and storative properties cannot be completely described with a limited database of borehole and groundwater information.

Groundwater-flow models are simplified mathematical representations of these complex natural systems. The aquifer properties are assumed to be uniform and isotropic within each model grid cell, which does not reflect the true complexity of the hydrogeology. Model errors can stem from the inaccuracies in the conceptual model, parameter structure, and water balance data; insufficient calibration data; practical limitations of grid spacing and time discretization; and the effects of processes not simulated by the model. These factors, along with errors in measured data, limit the accuracy with which groundwater systems can be simulated and result in uncertainty in model predictions. These limitations and uncertainty must be recognized and considered when using models and interpreting model results.

Figure 4-6 is a map that shows the model-simulated groundwater elevations and groundwater-flow directions for the end of the calibration period on June 30, 2018. Measured groundwater elevations at wells for Fall 2018 are also shown on the figure for comparison. The information shown on the map provides a secondary line of evidence to the good model calibration statistics, that the model is successful at simulating the general groundwater-flow system across most of the Spadra Basin. The map indicates that the area of greatest uncertainty appears to be in the eastern portion of the Spadra Basin along its boundaries with the Six Basins and the Chino Basin. The map indicates a steepening of the hydraulic gradient toward the Chino Basin, and the measured groundwater elevations in this area do not match the simulated groundwater elevations as closely as in other areas of the Spadra Basin. These observations deserve additional discussion:

- The steepening of the hydraulic gradient in the model simulation suggests the existence of an unmapped hydraulic barrier along the boundary with the Chino Basin.
- In this version of the calibrated model, the presumed barrier is simulated by very low horizontal hydraulic conductivities in parameter Zone 42. This model conceptualization may not be an accurate representation of the actual hydrogeology of the area.
- Currently, there is not enough hydrogeologic data in this area to understand the exact location and hydraulic properties of the presumed barrier. Additional hydrogeologic data

would need to be acquired in this area to improve the conceptual and numerical models, which may require the construction of new monitoring wells and implementation of a monitoring program.

- The properties of the San Jose Fault and the hydrogeology of the narrow area that separates the Spadra Basin from the Six Basins is not well understood. In addition, there are no wells or water-level observations in this area. This lack of data and hydrogeologic understanding limits the ability to model the subsurface flows between the Six Basins and Spadra Basin with any confidence. Additional hydrogeologic data would need to be acquired in this area to improve the conceptual and numerical models, which may require the construction of new monitoring wells and implementation of a monitoring program.

Even with the limitations and uncertainty described above, the calibration results indicate that the model does a reasonable job of simulating the groundwater system during the calibration period with a small residual mean, and that the model is a useful tool for informing sustainable groundwater management in the Spadra Basin. That said, the numerical results of the model, when used for future projections, will have an associated but un-quantified uncertainty. A sense of model uncertainty will develop as groundwater conditions are monitored in the future and compared to model projections. Continued monitoring and enhanced understanding of hydrologic conditions in the basin is necessary to improve the model and reduce uncertainty. Monitoring can identify local anomalies associated with geologic complexity that currently is not represented in the model. Model error and uncertainty can be reduced in the future by using new hydrogeologic and calibration data to refine the model. The GSA should maintain an adaptive approach to project development and implementation, whereby management strategies can change if observations differ from model projections.

References

ASCE. 1993. *Criteria for evaluation of watershed models*. J. Irrigation Drainage Eng. 119(3): 429-442. 1993.

Bicknell, B. R., et al. 2005. *Hydrological Simulation Program - Fortran (HSPF). User's Manual for Release 12.2. s.l.*: U.S. EPA National Exposure Research Laboratory Athens, GA, in cooperation with U.S. Geological Survey, Water Resources Division, Reston,VA., 2005.

Black & Veatch. 2001. Phase 2 (Chino Basin) Recharge Master Plan. 2001.

Carrera, Jesus and Neuman, Shlomo P. 1986a. Estimation of Aquifer Parameters Under Transient and Steady State Conditions: 1. Maximum Likelihood Method Incorporating Prior Information. Water Resources Research. 1986a, Vol. 22, 2, pp. 199-210.

—. 1986b. Estimation of Aquifer Parameters Under Transient and Steady State Conditions: 2. Uniqueness, Stability, and Solution Algorithms. Water Resources Research. 1986b, Vol. 22, 2, pp. 211-227.

—. 1986c. Estimation of Aquifer Parameters Under Transient and Steady State Conditions: 3. Application to Synthetic and Field Data. Water Resources Research. 1986c, Vol. 22, 2, pp. 228-242.

Doherty, John. 2015. *Calibration and uncertainty analysis for complex environmental models.* Brisbane, Australia : Watermark Numerical Computing, 2015. p. 227. ISBN-13: 978-0-9943786-0-6.

—. 2019. Model-Independent Parameter Estimation User Manual: 7th Edition published in 2018. Latest additions: May 2019. Brisbane, Australia : Watermark Numerical Computing, 2019.

—. 2019b. Model-Independent Parameter Estimation User Manual: 7th Edition published in 2018. Latest additions: May 2019. Brisbane, Australia : Watermark Numerical Computing, 2019b.

—. 2019. Model-Independent Parameter Estimation Version 17. s.l. : Watermark Numerical Computing, 2019.

Eckis, R. 1934. *Geology and Ground Water Storage Capacity of Valley Fill, South Coastal Basin Investigation: California Department of Public Works, Division of Water Resources Bulletin No. 45*, 273 p.

Fetter, C. W. 2001. Applied Hydrogeology. 4th Edition. s.l. : Prentice Hall, 2001.

Freeze, R.A. and Cherry, J.A. 1979. *Groundwater*. Prentice-Hall Inc., Englewood Cliffs, Vol. 7632, 604.

Hill, Mary C. and Tiedeman, Claire R. 2005. Effective Groundwater Model Calibration: With Analysis of Data, Sensitivities, Predictions, and Uncertainty. s.l. : Wiley, 2005. 9780471776369.

Hill, Mary C., et al. 2000. MODFLOW-2000, the U.S. Geological Survey modular ground-water model; user guide to the observation, sensitivity, and parameter-estimation processes and three post-processing programs. Denver, CO. : s.n., 2000.

Leake, Stanley. A. and Lilly, Michael R. 1997. Documentation of a Computer Program (FHB1) for Assignment of Transient Specified-Flow and Specified-Head Boundaries in Applications of the Modular Finite-Difference Ground-Water Flow Model (MODFLOW). Tucson, Arizona : U. S. Geological Survey, 1997.

Legates, D. R. and McCabe , G. J. . 1999. Evaluating the use of "goodness-of-fit" measures in hydrologic and hydroclimatic model validation. Water Resources Res. 1999, Vol. 35, 1, pp. 233-241.

Marquardt, Donald W. 1963. An Algorithm for Least-Squares Estimation of Nonlinear Parameters. Journal of the Society for Industrial and Applied Mathematics. 1963, Vol. 11, 2, pp. 431-441.

McDonald, Michael G. and Harbaugh, Arlen W. 1988. *MODFLOW, A modular three-dimensional finite difference ground-water flow model.* Reston, Virginia : U. S. Geological Survey, 1988.

Mehl, Steffen W. and Mary, Hill C. 2001. *MODFLOW-2000, the U. S. Geological Survey modular ground-water model; user guide to the Link-AMG (LMG) package for solving matrix equations using an algebraic multigrid solver*. Denver, Colorado : U. S. Geological Survey, 2001.

Moriasi, D. N., et al. 2007. Model Evaluation Guidelines for Systematic Quantification of Accuracy in Watershed Simulations. American Society of Agricultural and Biological Engineers. 2007, Vol. 50, 3, pp. 885- 900.

Nash, J. E. and Sutcliffe, J. V. . 1970. River flow forecasting through conceptual models: Part 1. A discussion of principles. J. Hydrology. 1970, Vol. 10, 3, pp. 282-290.

Neuman, S. P. 1973. Saturated-unsaturated seepage by finite elements. 1973, pp. 2233-2251.

Niswonger, Richard G., Panday, Sorab and Ibaraki , Motomu. 2011. *MODFLOW-NWT, A Newton formulation for MODFLOW-2005*: U.S. Geological Survey Techniques and Methods 6-A37, 44 p. Reston, Virginia : U.S. Geological Survey, 2011.

Niswonger, Richard G. and Prudic, David E. 2006. *Documentation of the Streamflow-Routing (SFR2) Package to Include Unsaturated Flow Beneath Streams—A Modification to SFR1*. s.l. : U.S. Geological Survey, 2006.

Poeter, Eileen P., et al. 2014. UCODE_2014, with new capabilities to define parameters unique to predictions, calculate weights using simulated values, estimate parameters with SVD, evaluate uncertainty with MCMC, and More. Report Number: GWMI 2014-02. s.l. : Integrated Groundwater Modeling Center, 2014.

Servat, Eric and Dezetter, Alain. 1991. Selection of calibration objective fonctions in the context of rainfall-ronoff modelling in a Sudanese savannah area. Hydrological Sciences Journal. 1991, Vol. 36, 4, pp. 307-330.

Simunek, J., Sejna, M. and van Genuchten, M. Th. . 1999. *The HYDRUS-2D software package for simulating two-dimensional movement of water, heat, and multiple solutes in variably saturated media.* Version 2.0 IGWMC - TPS - 53. Golden : International Groundwater Modeling Center, Colorado School of Mines, 1999. p. 251.

Wildermuth Environmental, Inc. (WEI). 1998. Phase 1 Recharge Master Plan (Chino Basin). Prepared for the Chino Basin Watermaster and the Chino Basin Water Conservation District. s.l. : Wildermuth Environmental, Inc., 1998.

—. 2002. TIN/TDS Study – *Phase 2B, Wasteload Allocation Investigation, Final Technical Memorandum.* Prepared for the TIN/TDS Task Force. s.l. : Wildermuth Environmental, Inc., 2002.

—. 2003. *Chino Basin Dry-Year Yield Program Modeling Report.* Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency. s.l. : Wildermuth Environmental, Inc., 2003.

—. 2006. *Management Zone 1 Interim Monitoring Program: MZ-1 Summary Report.* Prepared for the MZ-1 Technical Committee. February 2006. s.l. : Wildermuth Environmental, Inc., 2006.

—. 2006a. *Optimum Basin Management Program. Management Zone 1 Interim Monitoring Program. MZ-1 Summary Report*. Prepared for the Chino Basin Watermaster. February 2006.

—. 2007. *Water Quality Impacts of On-Site Waste Disposal Systems in the Cherry Valley Community of Interest*. Prepared for San Timoteo Watershed Management Authority – Project Committee 1. March 2007.

—. 2007. *2007 CBWM Groundwater Model Documentation and Evaluation of the Peace II Project Description*. s.l. : Wildermuth Environmental, Inc., 2007.

—. 2008. *Analysis of Material Physical Injury from the Proposed Expansion of the Dry-Year Yield Program.* Prepared for the Chino Basin Watermaster. s.l. : Wildermuth Environmental, Inc., 2008.

—. 2008b. *Draft Title 22 Engineering Report for Potential GRRPs in the Beaumont Basin. Prepared for the San Timoteo Watershed Management Agency*. s.l. : Wildermuth Environmental, Inc., 2008b.

—. 2008c. *2008 Santa Ana River Wasteload Allocation Model Report. Prepared for the Basin Monitoring Program Task Force*. s.l. : Wildermuth Environmental, Inc., 2008c.

—. 2009. *2009 Production Optimization and Evaluation of the Peace II Project Description. Prepared for the Chino Basin Watermaster*. s.l. : Wildermuth Environmental, Inc., 2009.

—. 2010. *2010 Recharge Master Plan Update. Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency*. s.l. : Wildermuth Environmental, Inc., 2010.

—. 2010a. *Recycled Water Planning Investigation Report.* Prepare for the San Bernardino Municipal Water Department. s.l. : Wildermuth Environmental, Inc., 2010a.

—. 2013. *2013 Amendment to 2010 Recharge Master Plan Update*. Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency. s.l. : Wildermuth Environmental, Inc., 2013.

—. 2015. *2013 Chino Basin Groundwater Model Update and Recalculation of the Safe Yield Pursuant to the Peace Agreement.* s.l. : Wildermuth Environmental, Inc., 2015.

—. 2017. *Strategic Plan for the Six Basins*. Prepared for the Six Basins Watermaster. November 2017.

—. 2019. *2018/19 Final Annual Report of the Ground Level Monitoring Committee.* Prepared for Chino Basin Watermaster. November 2019. s.l. : Wildermuth Environmental, Inc. , 2019.

—. 2019. *Storage Framework Investigation*. Final Report October 2018. Revised in January 2019. s.l. : Wildermuth Environmental, Inc., 2019.

—. 2020. *2020 Safe Yield Recalculation.* Final Report May 15, 2020: Wildermuth Environmental, Inc., 2020.

—. 2020. Unpublished modeling work for the recalibrated Six Basin Model; to be published in 2020. Prepared for the Six Basins Watermaster. s.l. : Wildermuth Environmental, Inc., 2020.

Wildermuth, Mark J. 1995. *Annual Recharge Estimates at the Chino Basin, Water Conservation District Spreading Basins*. s.l. : Water Resource Engineers, 1995.

Table 2-1
Methods/Data/Information Used to Estimate the Water Budget for the Spadra Basin

	Method Used to Estimate Water Budget Component *(Measurement, Model, or Both)*	Data/Information Used in the Development of Recharge and Discharge Components							
		Land use	Hydrologic Soil Type	Surface Water Drainage System	Measured Surface Water Discharge	Measured Precipitation	Measured ET and Evaporation	Metered Groundwater Pumping	Measured Water Level at Wells
Recharge Component									
Subsurface inflow from adjacent hills and mountains	Model	◆	◆	◆	◆	◆	◆		
Deep infiltration of precipitation and applied water	Model	◆	◆	◆	◆	◆	◆		
Discharge Component									
Subsurface outflow to adjacent groundwater basins	Both, and prior information[1]								◆
Groundwater pumping	Measurement							◆	
Evapotranspiration (ET)	Both	◆	◆			◆	◆		

[1] Prior information is derived from prior investigations

Table 2-2
Water Budget for the Spadra Basin -- Fiscal Year 1978-2018

Fiscal Year	Recharge			Discharge				Change in Storage (Recharge - Discharge)		Annual Developed Yield
	DIPAW[1]	Subsurface Inflow from San Jose and Puente Hills	Total Recharge	Pumping	Outflow to Puente Basin	Outflow to Chino Basin	Total Discharge	Annual	Cumulative	
				a				*b*		*a + b*
1978	2,961	1,504	4,465	1,402	1,336	950	3,689	777	777	2,179
1979	3,076	1,527	4,604	937	1,769	446	3,151	1,452	2,229	2,389
1980	3,161	1,636	4,797	1,188	1,819	293	3,300	1,497	3,726	2,685
1981	3,114	1,665	4,779	1,544	1,786	384	3,714	1,066	4,792	2,610
1982	3,107	1,657	4,764	1,344	1,871	434	3,649	1,115	5,907	2,460
1983	3,430	1,621	5,051	1,752	2,019	482	4,253	798	6,706	2,550
1984	3,353	1,545	4,898	1,189	2,000	529	3,718	1,179	7,885	2,369
1985	2,984	1,367	4,351	1,805	1,899	648	4,352	0	7,884	1,804
1986	2,992	1,451	4,442	2,133	1,827	699	4,658	-216	7,668	1,917
1987	2,722	1,337	4,059	2,159	1,774	685	4,617	-559	7,110	1,600
1988	2,827	1,142	3,969	1,934	1,746	655	4,335	-366	6,744	1,568
1989	2,791	1,140	3,931	1,615	1,768	677	4,060	-129	6,615	1,486
1990	2,412	1,085	3,496	1,388	1,785	639	3,812	-316	6,299	1,073
1991	2,315	955	3,270	999	1,721	520	3,240	31	6,330	1,029
1992	2,386	1,078	3,464	910	1,740	449	3,099	365	6,694	1,274
1993	2,429	1,126	3,555	1,129	1,578	434	3,141	414	7,108	1,543
1994	2,374	1,048	3,422	872	1,599	483	2,953	469	7,578	1,341
1995	2,323	1,163	3,485	1,175	1,491	504	3,171	314	7,892	1,490
1996	2,272	1,195	3,467	1,266	1,499	661	3,426	41	7,933	1,307
1997	2,375	1,151	3,527	1,351	1,481	684	3,516	11	7,944	1,362
1998	2,602	1,178	3,780	1,101	1,584	699	3,384	396	8,340	1,497
1999	2,445	1,172	3,617	1,025	1,560	600	3,185	432	8,772	1,457
2000	2,292	1,114	3,406	1,106	1,483	727	3,316	90	8,862	1,196
2001	2,366	1,127	3,493	2,096	1,431	730	4,257	-765	8,097	1,332
2002	2,201	996	3,197	1,735	1,202	633	3,569	-372	7,725	1,362
2003	2,204	823	3,027	1,409	1,062	616	3,086	-59	7,665	1,350
2004	2,087	842	2,929	1,552	1,065	616	3,233	-304	7,361	1,248
2005	2,096	997	3,093	1,496	1,124	554	3,174	-82	7,280	1,415
2006	2,113	950	3,063	1,039	1,271	481	2,791	272	7,551	1,311
2007	1,974	940	2,914	1,177	1,159	238	2,573	341	7,892	1,517
2008	1,938	935	2,873	1,082	1,182	398	2,662	211	8,103	1,293
2009	1,974	940	2,914	834	1,335	558	2,726	188	8,291	1,021
2010	1,977	802	2,779	887	1,272	630	2,789	-10	8,281	877
2011	2,073	884	2,958	788	1,457	561	2,806	151	8,432	939
2012	1,789	891	2,680	764	1,368	459	2,591	90	8,522	854
2013	1,712	819	2,531	1,001	1,253	496	2,750	-218	8,303	783
2014	1,721	766	2,487	1,180	1,060	590	2,829	-342	7,961	838
2015	1,663	669	2,332	865	1,100	609	2,574	-242	7,719	623
2016	1,613	549	2,163	602	1,215	560	2,377	-214	7,505	387
2017	1,625	659	2,284	809	1,208	425	2,442	-158	7,347	651
2018	1,475	653	2,128	986	1,065	335	2,386	-258	7,089	728
Statistics for the Calibration Period 1978 through 2018										
Minimum	1,475	549	2,128	602	1,060	238	2,377	-765		387
Average	2,374	1,100	3,474	1,259	1,487	555	3,301	173		1,432
Maximum	3,430	1,665	5,051	2,159	2,019	950	4,658	1,497		2,685
Total	97,345	45,100	142,445	51,624	60,959	22,774	135,356	7,089		58,713

1 -- Deep infiltration of precipitation and applied water

Figure 2-1
Total Recharge, Discharge, and Change in Storage in the Spadra Basin
During the Calibration Period (1978-2018)

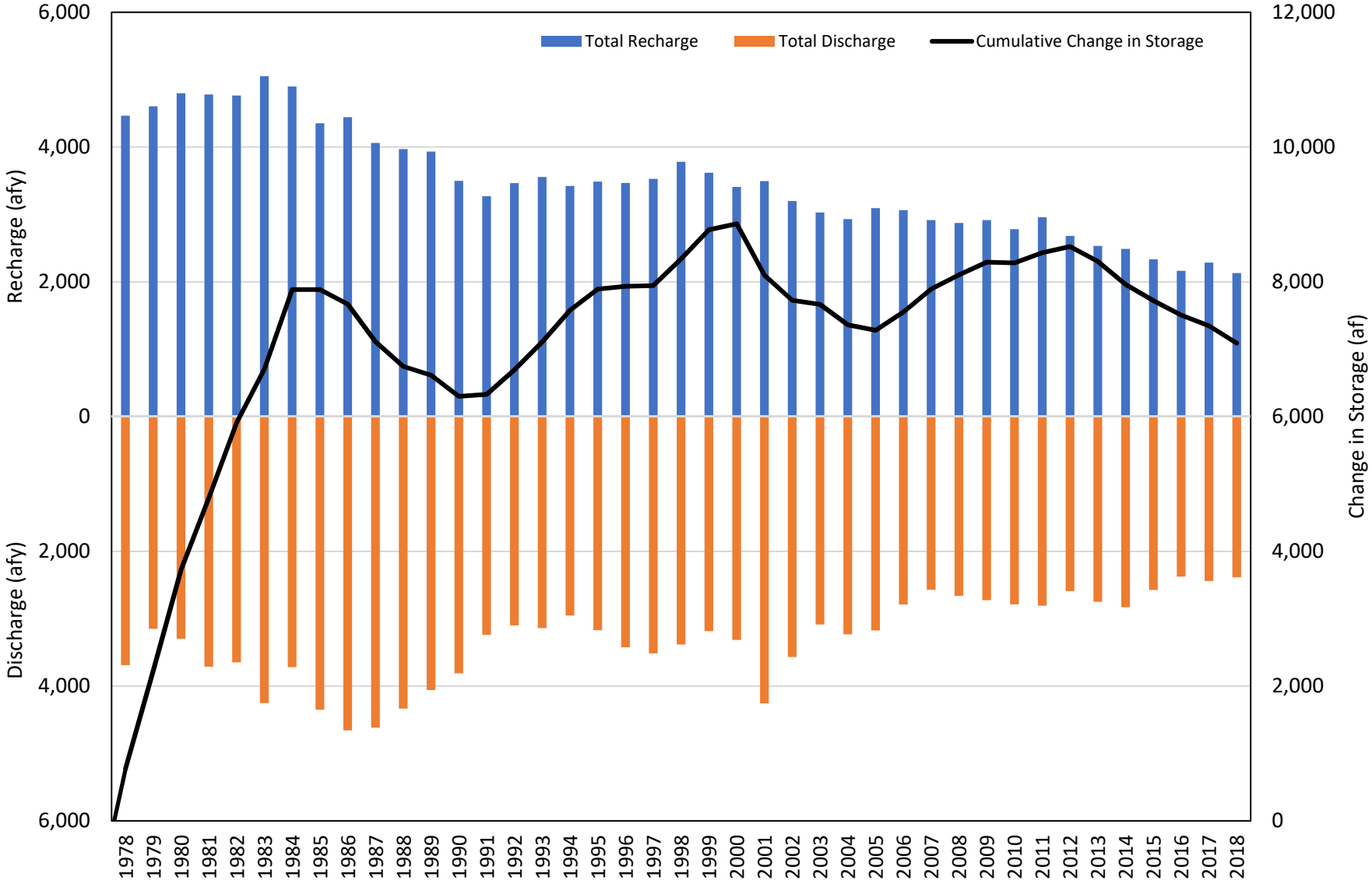


Table_2-2_Figure_2-1_Water Budget.xlsx--Figure 4-6 Water Budget
Created on 05/07/2020

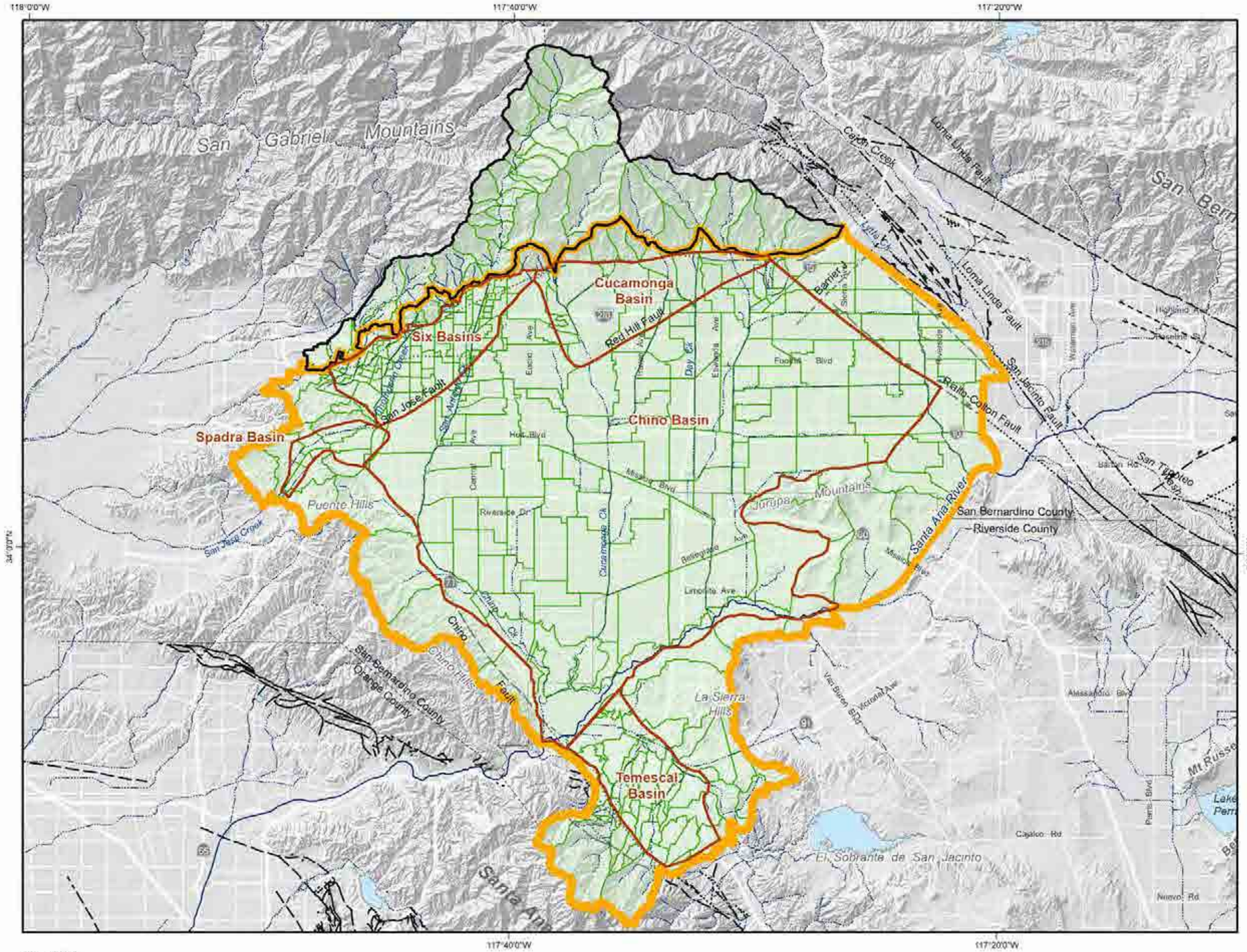
Table 3-1
Initial Parameter-Zone Coefficients and Aquifer Property Estimates

Zone	Horizontal Hydraulic Conductivity				Vertical Hydraulic Conductivity				Specific Yield			
	Zone Coeff.	(ft/day)			Zone Coeff.	(ft/day)			Zone Coeff.	(-)		
		Min	Max	Avg		Min	Max	Avg		Min	Max	Avg
Lithologic model estimates												
41		7.18	222	70.1		0.718	22.2	7.01		0.0504	0.157	0.0907
35		7.57	99.3	63.9		0.757	9.93	6.39		0.0501	0.119	0.0881
42		22.4	118	79.0		2.24	11.8	7.90		0.0687	0.120	0.0913
5		68.2	108	92.9		6.82	10.8	9.29		0.0874	0.126	0.0956
Initial pre-calibration estimates												
41	0.718	5.16	159	50.4	0.146	0.105	3.24	1.02	0.463	0.0233	0.0730	0.0421
35	0.239	1.81	23.8	15.3	0.146	0.110	1.45	0.933	0.547	0.0274	0.0654	0.0482
42	0.005	0.112	0.589	0.395	0.146	0.327	1.7	1.15	0.595	0.0409	0.0716	0.0543
5	0.887	60.5	95.9	82.3	0.0182	0.124	0.2	0.169	0.727	0.0635	0.0918	0.0695

Table 3-2
Boundary Conditions for Model Calibration in the Spadra Basin

Boundary	Condition	Estimation Method	MODFLOW Package Applied for Condition
Mountain front from Puente and San Jose Hills	Variable Flux	R4	FHB[1]
Boundary with Chino Basin	Variable Head	MODFLOW	FHB[2]
Boundary with Puente Basin	Variable Head	MODFLOW and measured water-levels	FHB[2]
Areal Recharge	Variable Flux	R4	RCH[3]
Wells	Variable Flux	Recorded Data	WEL[4]

1. FHB - Flow Head Boundary Package -variable flux
2. FHB - Flow Head Boundary Package - variable head
3. RCH - Recharge Package
4. WEL - Well Package



HSPF Model Domain

R4 Model Domain

Hydrologic Sub Area

Groundwater Model Domains

Streams & Flood Control Channels

Flood Control & Conservation Basins

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Author: CS
Date: 5/15/2020
File: Figure 3-1 Surface and ground domain.mxd

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

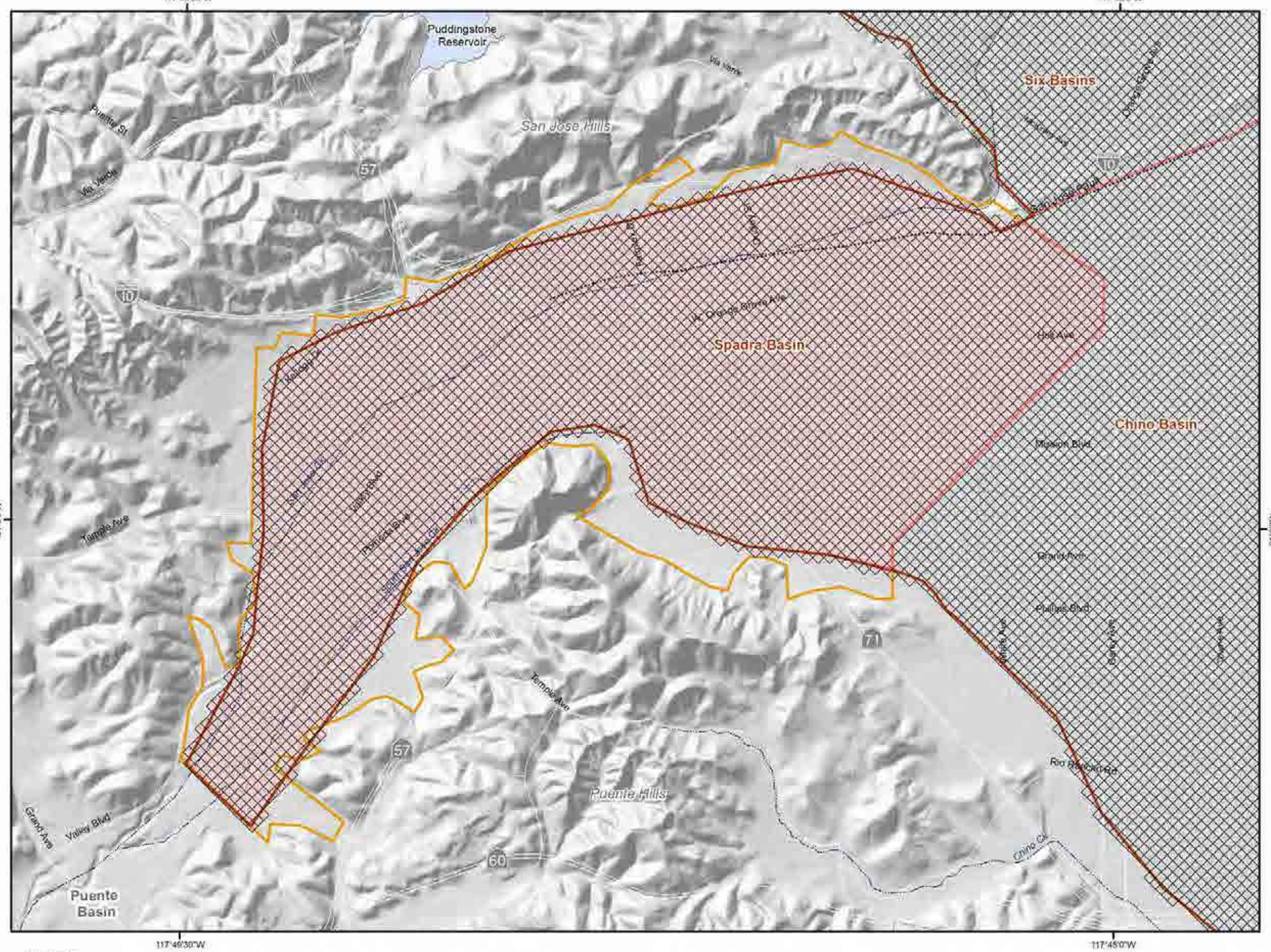
Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN

Surface Water Models and Groundwater Model Domains

Figure 3-1



Active Model Domain

Internal Basin Boundaries

Model Grid (Active Cells)
Spadra Model Active Cell

Spadra Basin GSP Boundary

Streams & Flood Control Channels

Faults

Location Certain
Location Approximate
Approximate Location of Groundwater Barrier
Location Concealed
Location Uncertain

Prepared by:
WEI
Wildermuth Environmental, Inc.

Author: CS
Date: 3/12/2020
File: Figure 3-2 model_domain_grid_v.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

SPADRA BASIN

Spadra Basin Model Domain and Model Grid

Figure 3-2

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
San Jose Hills
Puente Hills
Six Basins
Spadra Basin
Chino Basin
Puente Basin
Via Verde
Puente St
Fairgrove Dr
Duckley St
W. Orange Grove Ave
Orange Grove Ave
McKinley Ave
San Jose Fault
Holt Ave
Kellogg Dr
San Jose Ck
Valley Blvd
Pomona Blvd
South San Jose Ck
Temple Ave
Mission Blvd
Grand Ave
Phillips Blvd
White Ave
Garey Ave
Towne Ave
Rio Rancho Rd
Chino Ck
10
57
60
71

Parameter Zones in the Spadra Basin
- Zone 41
- Zone 35
- Zone 42
- Zone 5

- Active Model Domain
- Internal Basin Boundaries
- Spadra Basin GSP Boundary

- Streams & Flood Control Channels

Faults
- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

Prepared by
WEI
WILDERMUTH ENVIRONMENTAL, INC

Author: CS
Date: 5/11/2020
File: Figure 3-3 model_zones.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

Model Zonation

Figure 3-3

Table 4-1
Model Parameter Sensitivity

Zone[1]	Hydraulic Parameter[2]	Parameter Name	Relative Sensitivity	Sensitive Ranking[3]
35	XHK	HK1Z35	0.824	2
41	XHK	HK1Z41	1.873	1
42	XHK	HK1Z42	0.638	3
35	XSY	SY1Z35	0.630	4
41	XSY	SY1Z41	0.169	5
42	XSY	SY1Z42	0.114	8

1 -- Zone 5 was evaluated during the Chino Basin model calibration, and not evaluated during the Spadra model calibration. Thus, relative sensitivity and sensitivity ranking of the Zone 5 parameters is not available.

2 -- XHK = Horizontal Hydraulic Conductivity; Xsy = Specific Yield.

3 -- From most to least sensitive (i.e. a ranking of 1 represents the most senstivite parameter)

Table 4-2
Spadra Basin Calibration Wells

Well ID	Owner	Well Name	Screen Interval (ft-bgs)	Latitude	Longitude	Well Type
1002811	Unknown	1002811	Unknown	34.0608	-117.7873	Undetermined
1002815	City of Pomona	P-28	132-245	34.0567	-117.8046	Production
1203259	City of Pomona	P-31	140-196	34.0598	-117.7858	Production
1237127	California State Polytechnic University, Pomona	CPP-1	Unknown	34.0621	-117.7967	Production

Table 4-3
Calibrated Parameter-Zone Coefficients and Aquifer Property Estimates

Zone	Horizontal Hydraulic Conductivity				Vertical Hydraulic Conductivity				Specific Yield			
	Zone Coeff.	(ft/day)			Zone Coeff.	(ft/day)			Zone Coeff.	(-)		
		Min	Max	Avg		Min	Max	Avg		Min	Max	Avg
Lithologic model estimates												
41		7.18	222	70.1		0.718	22.2	7.01		0.0504	0.157	0.0907
35		7.57	99.3	63.9		0.757	9.93	6.39		0.0501	0.119	0.0881
42		22.4	118	79.0		2.24	11.8	7.90		0.0687	0.120	0.0913
5		68.2	108	92.9		6.82	10.8	9.29		0.0874	0.126	0.0956
Initial pre-calibration estimates												
41	0.718	5.16	159	50.4	0.146	0.105	3.24	1.02	0.463	0.0233	0.0730	0.0421
35	0.239	1.81	23.8	15.3	0.146	0.110	1.45	0.933	0.547	0.0274	0.0654	0.0482
42	0.005	0.112	0.589	0.395	0.146	0.327	1.7	1.15	0.595	0.0409	0.0716	0.0543
5	0.887	60.5	95.9	82.3	0.0182	0.124	0.2	0.169	0.727	0.0635	0.0918	0.0695
Final calibrated estimates												
41	1.95	43.6	230	154	0.0182	0.041	0.21	0.14	0.128	0.0088	0.0154	0.0117
35	0.602	4.55	59.7	38.4	0.0182	0.014	0.18	0.116	1.27	0.0635	0.151	0.112
42	0.004	0.297	0.470	0.404	0.0182	0.124	0.2	0.17	0.415	0.0362	0.0524	0.0396
5	0.778	5.6	172.8	54.6	0.0339	0.024	0.8	0.237	1.13	0.0567	0.177	0.102

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
San Jose Hills
Six Basins
Spadra Basin
Chino Basin
Puente Basin
Puente Hills

CPP-1
1002811
P-31
P-28

Via Verde
Puente St
Via Verde
Orange Grove Ave
McKinley Ave
San Jose Fault
Fairplex Dr
Dudley St
W. Orange Grove Ave
Holt Ave
Kellogg Dr
San Jose Ck
Valley Blvd
Pomona Blvd
South San Jose Ck
Mission Blvd
Temple Ave
Grand Ave
Phillips Blvd
White Ave
Garey Ave
Towne Ave
Rio Rancho Rd
Chino Ck
Grand Ave
Valley Blvd

10
57
71
60

Calibration Wells Symbolized by Owner
- City of Pomona
- California State Polytechnic University, Pomona
- Unknown

- Active Model Domain
- Internal Basin Boundaries
- Spadra Basin GSP Boundary
- Streams & Flood Control Channels

Faults
- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

Prepared by:
WEI
WILDERMUTH ENVIRONMENTAL, INC.

Author: CS
Date: 5/7/2020
File: Figure 4-1 Calibration Wells_v2.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Calibration Wells

Figure 4-1

Figure 4-2
Comparison of Simulated vs. Measured Wate-Level Elevation at Calibration Wells

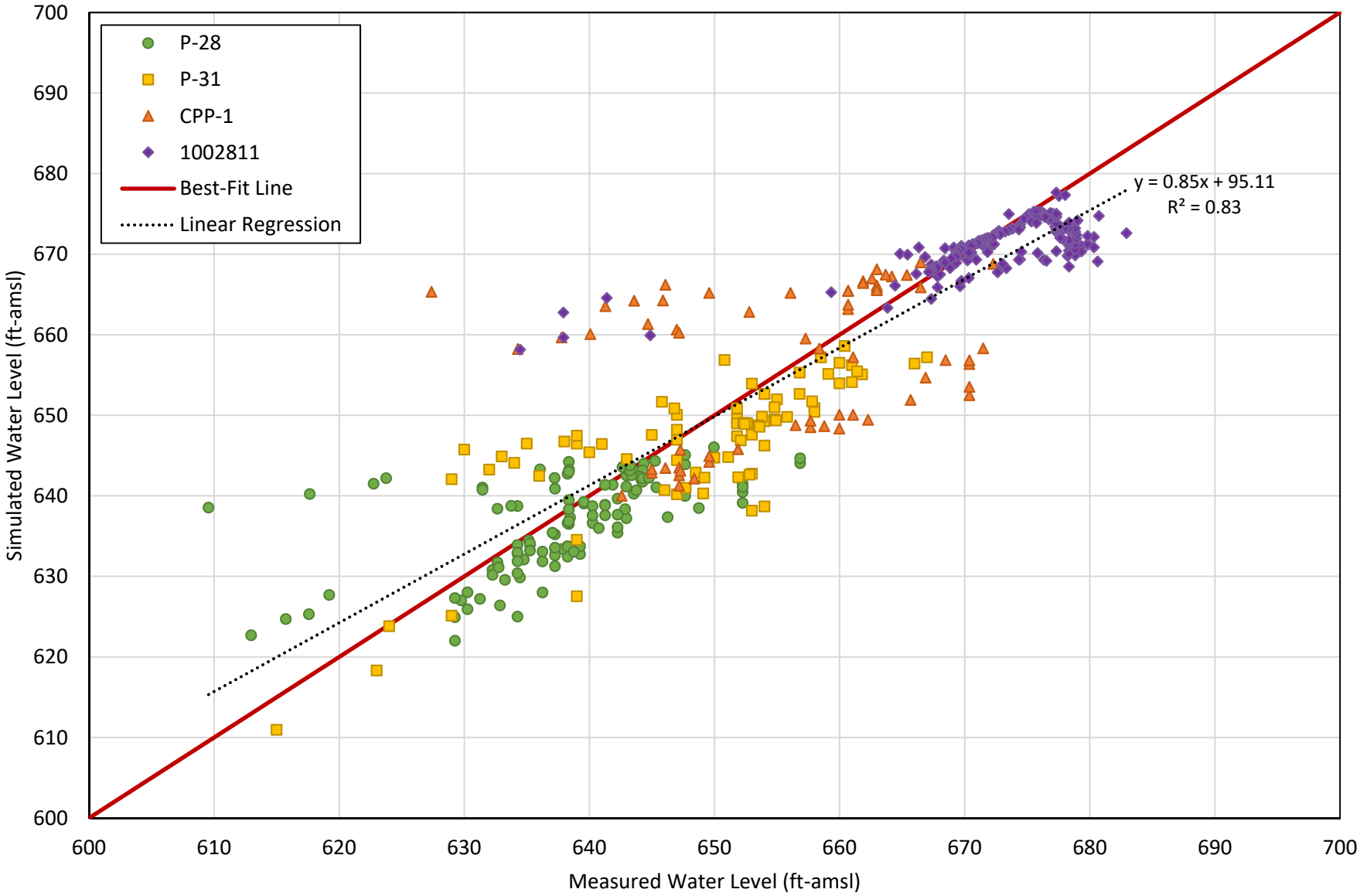


Figure_4-2-to-4-4_GWE_Stats.xlsm--F 4-2 Scatter Plot (by well)
Created on 4/23/2020

Figure 4-3a
Measured vs. Simulated Groundwater Elevations at Well P-28 in Model Calibration

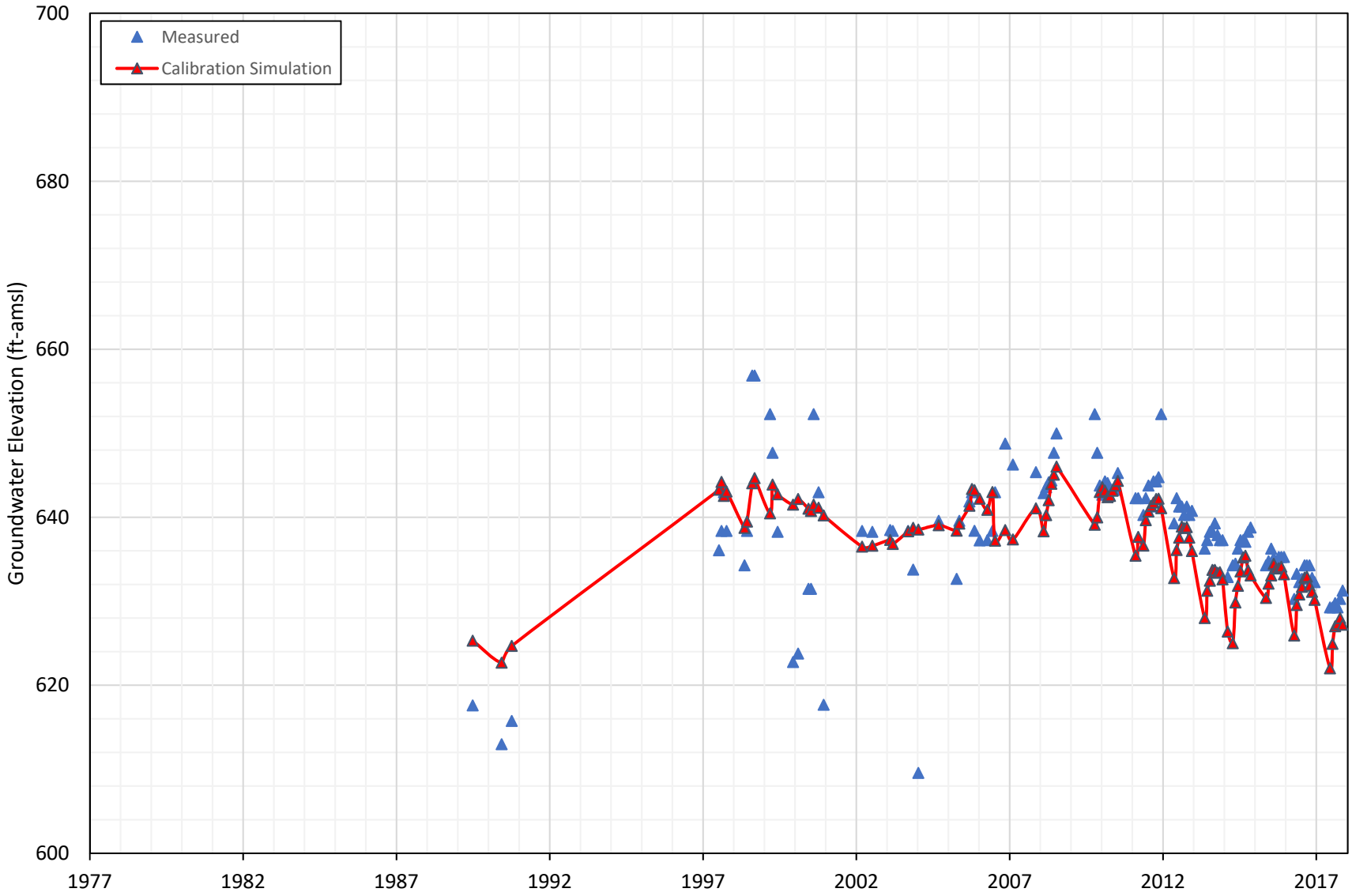


Figure_4-2-to-4-4_GWE_Stats.xlsm--P-28_hydrograph
Created on 4/23/2020

Figure 4-3b
Measured vs. Simulated Groundwater Elevations at Well P-31 in Model Calibration

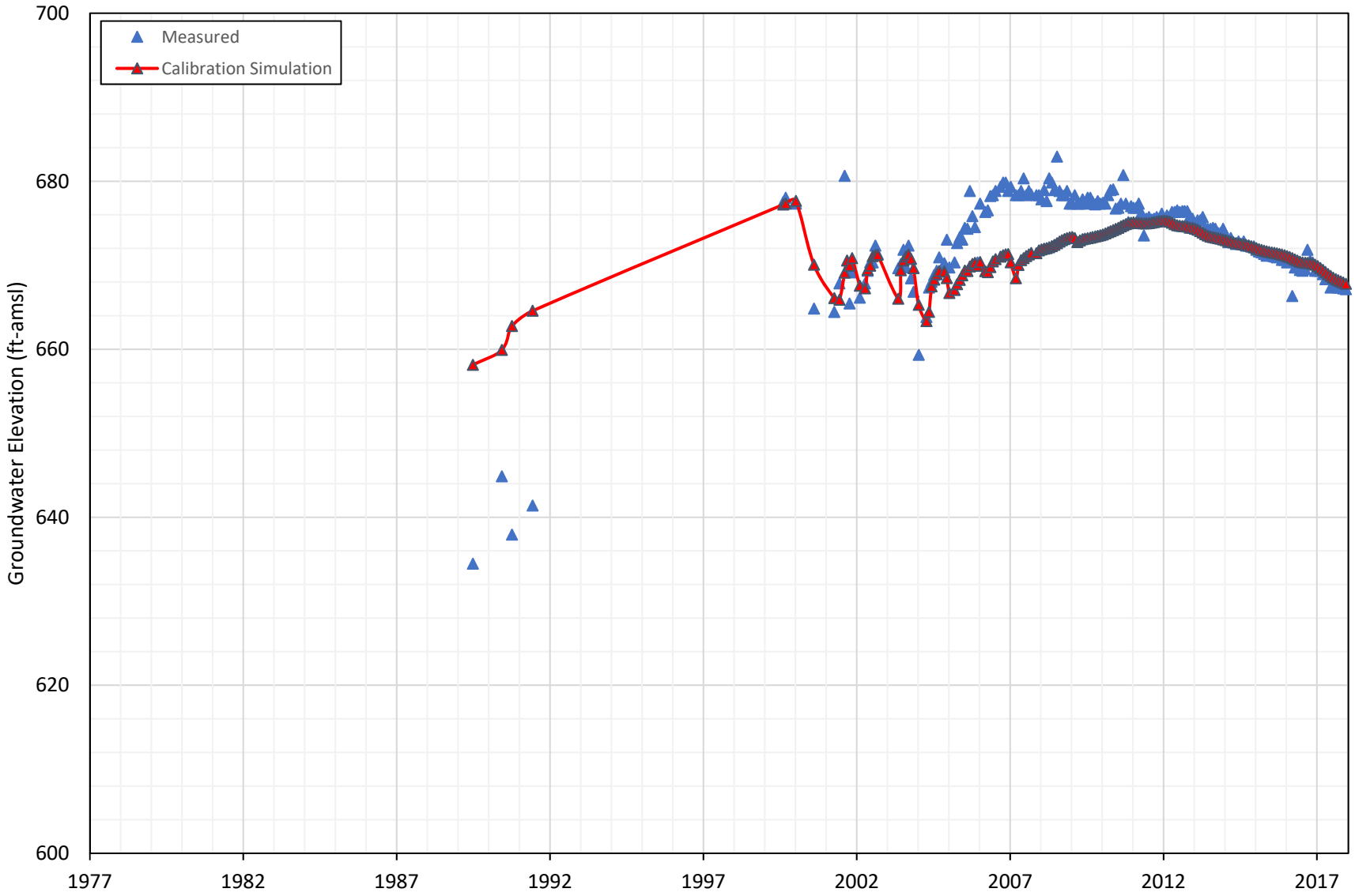


Figure_4-2-to-4-4_GWE_Stats.xlsm--P-31_hydrograph
Created on 4/23/2020

Figure 4-3c
Measured vs. Simulated Groundwater Elevations at CPP-1 in Model Calibration

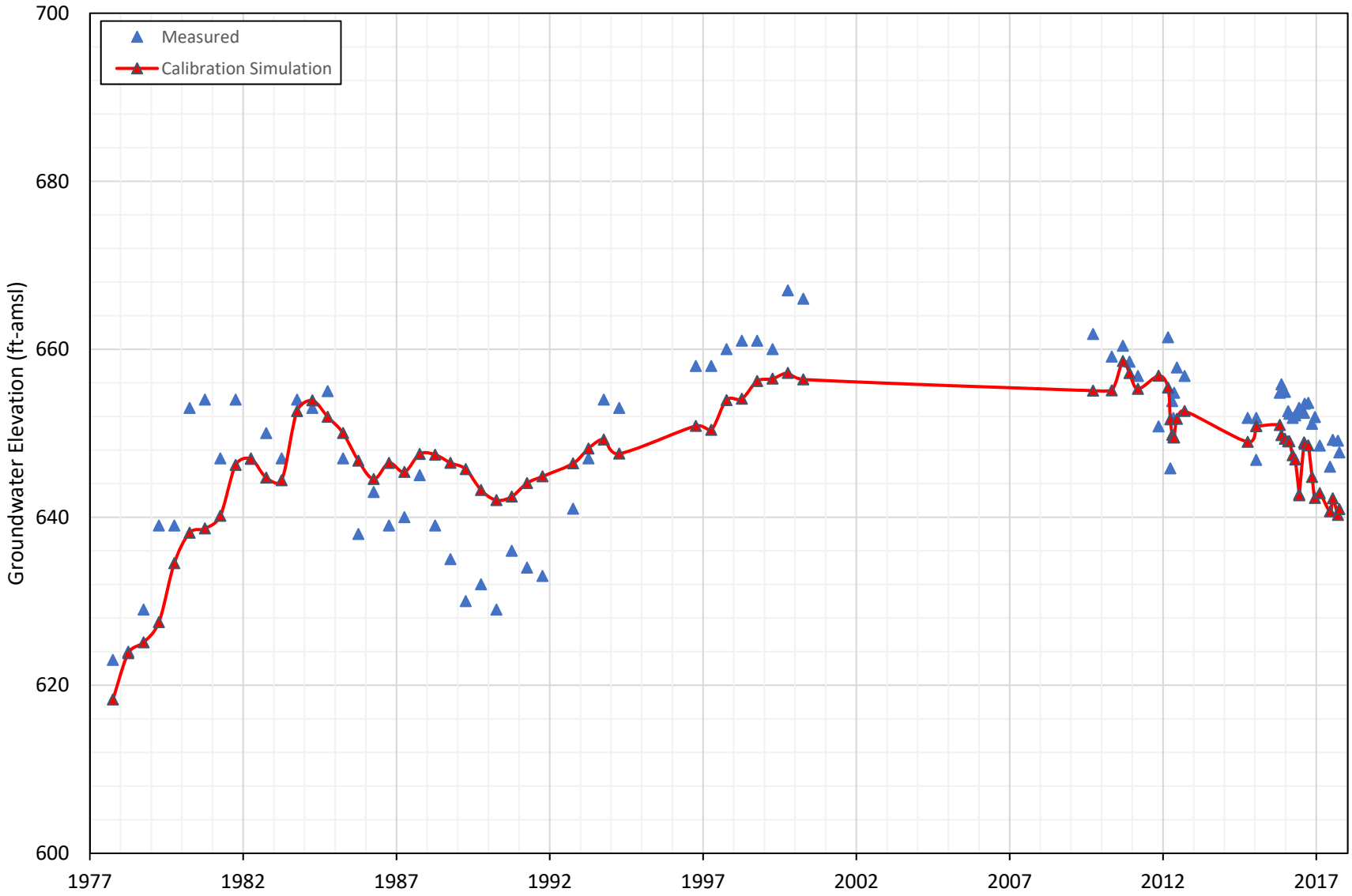


Figure_4-2-to-4-4_GWE_Stats.xlsm--CalPoly-1_hydrograph
Created on 4/23/2020

Figure 4-3d
Measured vs. Simulated Groundwater Elevations at Well 1002811 in Model Calibration

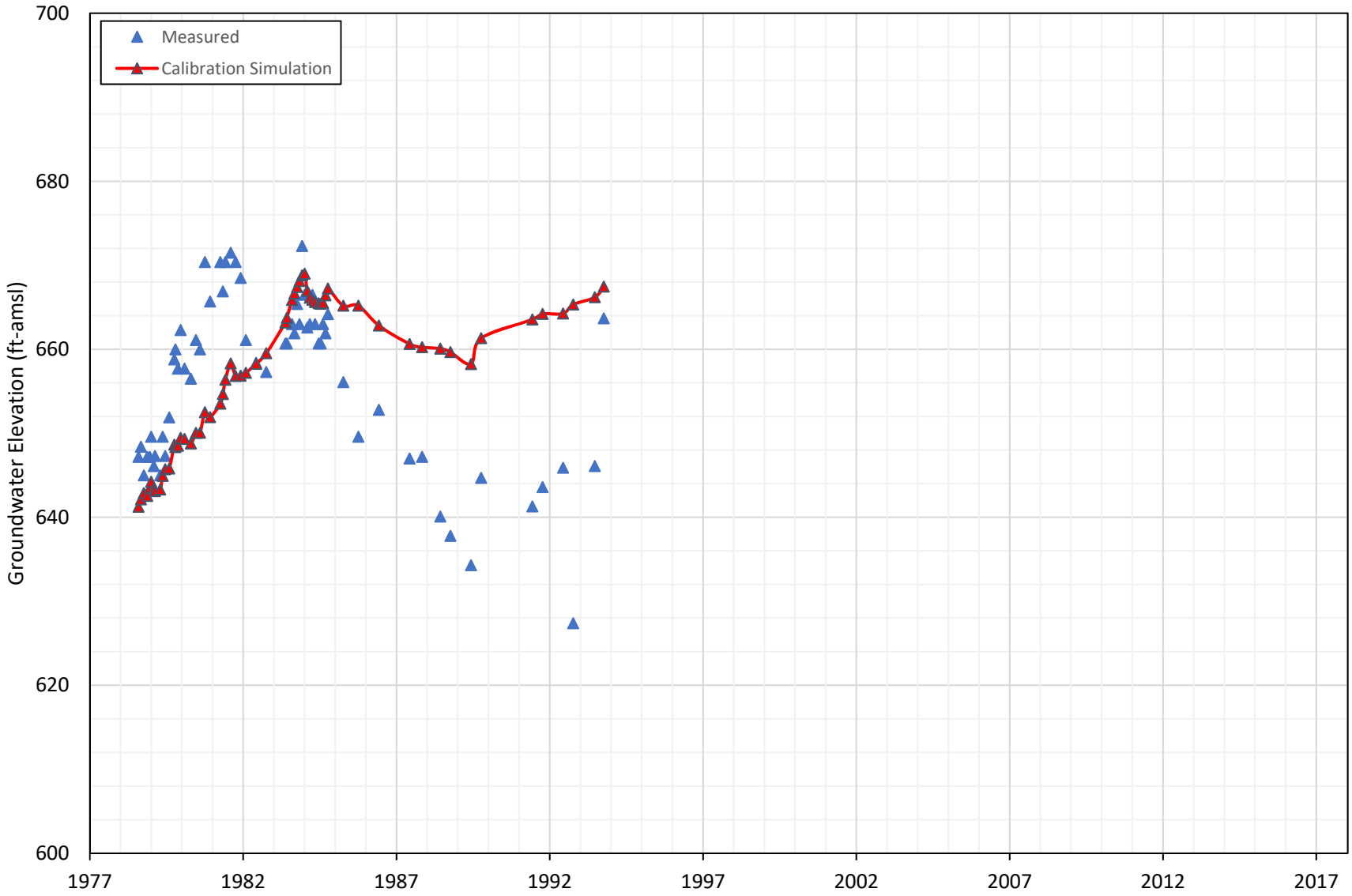


Figure_4-2-to-4-4_GWE_Stats.xlsm--1002811_hydrograph
Created on 4/23/2020

Figure 4-4
Residual Relative Frequency Histogram for Spadra Basin Model Calibration

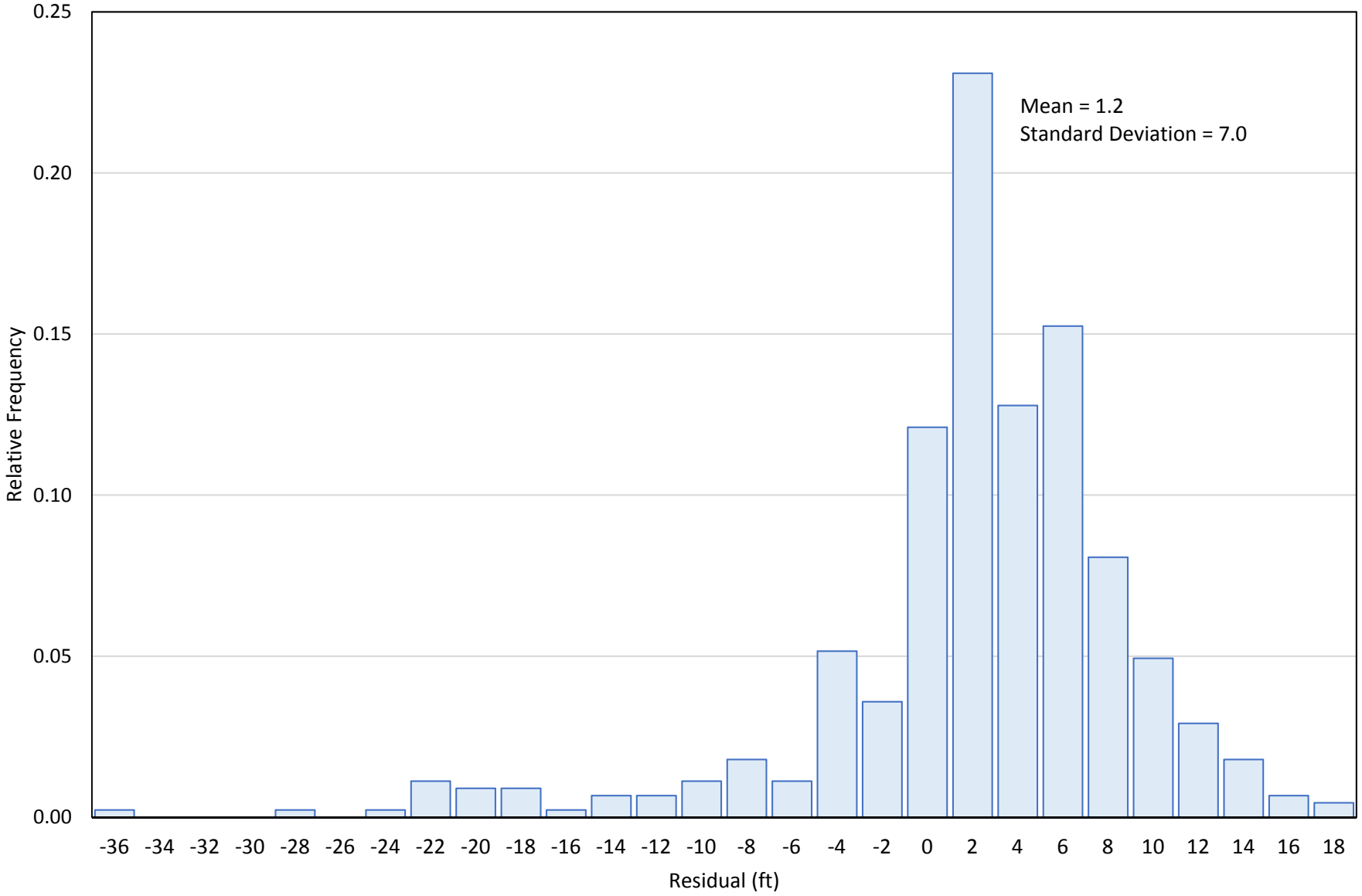
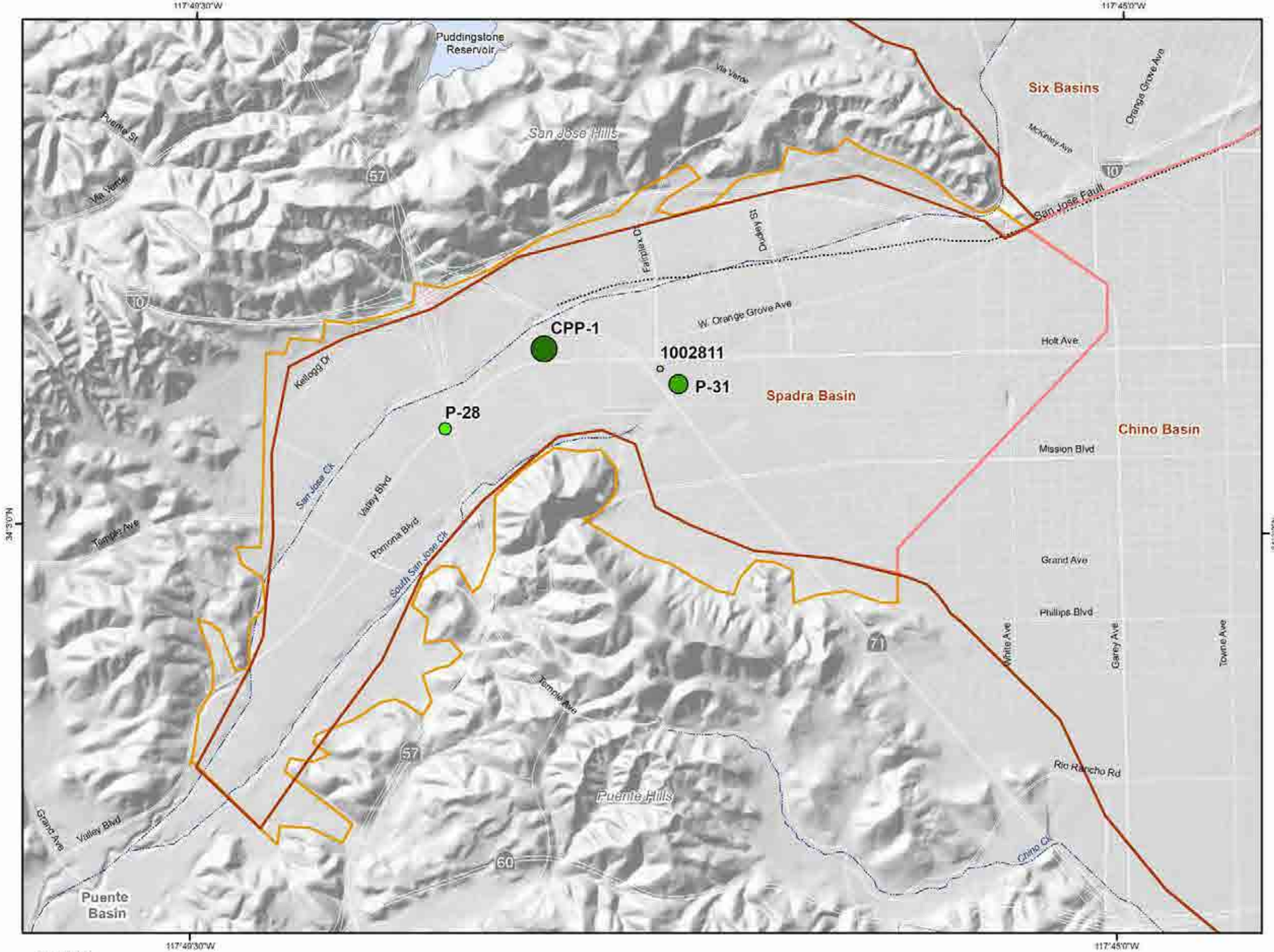


Figure_4-2-to-4-4_GWE_Stats--F 4-4_Histogram
Created on 4/23/2020



Calibration Wells Symbolized by Mean Residual Error (ft)

- -1.1
- 1.3
- 1.5
- 2.3

Active Model Domain

Internal Basin Boundaries

Spadra Basin GSP Boundary

Streams & Flood Control Channels

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Author: CS
Date: 5/7/2020
File: Figure 4-5_MeanResidual.mxd

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

Mean Residual Error of Calibration Wells

Figure 4-5

117°49'30"W
117°45'0"W
34°3'0"N

Puddingstone Reservoir
Via Verde
San Jose Hills
Six Basins
Orange Grove Ave
Makridge Ave
San Jose Fault
Pomona Fwy
Puente St
Via Verde
Temple Ave
Glendora Ave
Fairplex Dr
W. Orange Grove Ave
Spadra Basin
Kellogg Dr
San Jose Ck
Valley Blvd
Pomona Blvd
South Spadra Ck
Hot Ave
Chino Basin
Mission Blvd
Grand Ave
Phillips Blvd
Ghery Ave
Temple Ave
Rio Rancho Rd
Puente Hills
Chino Ck
Grand Ave
Valley Blvd
Puente Basin

883
650
627
678
667
674
664
605
592

660
650
640
630
620
610
600
670
650
600
670

10
57
71
60

Prepared by:
WEI
WILDERMUTH ENVIRONMENTAL, INC.

Author: CS
Date: 5/15/2020
File: Figure_4-6_Model_GWE_2018.mxd

0 0.5 1 1.5 Miles
0 0.5 1 1.5 2 Kilometers

Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan
SPADRA BASIN

--600-- Model-Estimated Groundwater-Elevation Contours (ft-amsl)

883 Wells with 2018 Groundwater Elevation Data (labeled by static groundwater elevation in ft-amsl)

Model-Estimated Groundwater-Flow Directions

Parameter Zones in the Spadra Basin
- Zone 41
- Zone 35
- Zone 42
- Zone 5

- Active Model Domain
- Internal Basin Boundaries
- Spadra Basin GSP Boundary

Streams & Flood Control Channels

Faults
- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

Groundwater Elevations and Flow Directions
End of Calibration Period - July 2018

Figure 4-6

Appendix A – Comments and Responses on the May 18, 2020 Draft Technical Memorandum 2 (TM2): Construction and Calibration of the Spadra Basin Groundwater Model

Comments by Tim Kellett, Chief Water Resources Officer, Three Valleys Municipal Water District

Comment. *My question is on Figures 4-3(a-d). All of the Measured vs Simulated models show a large difference from about 1987 – 1992. Is there any explanation that can be provided as to why all fours graphs have the same pattern? Is the something that the calibrated model is missing during that period (e.g. precipitation data, production data, etc.)? Can you determine the effect that this period of data is affecting the overall calibration of the model?*

Response. There are several things to understand and consider related to this comment—some of which were discussed in *Section 4.7 Model Limitations and Recommendations* of TM2:

- *"All of the Measured vs Simulated models show a large difference from about 1987 – 1992."* It is true that the model over-predicts groundwater elevations at these four calibration points during the mid-1980s to the mid-1990s. However, we do not consider these differences between measured and simulated groundwater elevations (~5-20 ft) as relatively "large" differences. There are other instances during the calibration period where the model under-predicts or over-predicts the measured groundwater elevations by similar magnitudes.
- *"Is there any explanation that can be provided as to why all fours graphs have the same pattern? Is the something that the calibrated model is missing during that period (e.g. precipitation data, production data, etc.)?"* A groundwater-flow model is a simplified mathematical representation of a complex natural system, and hence, will never perfectly simulate the natural system. Model errors can stem from the inaccuracies in the conceptual model, inaccuracies in recharge and discharge terms (e.g. precipitation, applied water, pumping); errors in calibration data (e.g. measurement errors for groundwater-elevation data); too little calibration data both spatially and temporally; practical limitations of grid spacing and time discretization; and the effects of processes not simulated by the model. In this case, a possible explanation for the model over-predictions of groundwater elevations during the mid-1980s to the mid-1990s is missing or inaccurate groundwater pumping data for this time period, but at this point, we simply do not know if this is the case. In Section 4.6 of TM 2 text now reads "This suggests that there may be a data gap in pumping records for this early period, but at this point, we simply do not know if this is the case."

- *"Can you determine the effect that this period of data is affecting the overall calibration of the model?"* You could compute the calibration statistics with and without the period and compare the statistics. However, we do not see the usefulness in performing this evaluation. First, we are not certain there is missing or inaccurate data during the time period. Second, the calibration results indicate that the model does a "very good" job of simulating the groundwater system during the calibration period with a small residual mean error, especially for a "first-generation" model (see Section 4.6 of TM2).
- The calibration results indicate that the model is a useful tool for informing sustainable groundwater management in the Spadra Basin. We suggest the best path forward for the Spadra Basin GSA is to develop and implement its monitoring program to enhance understanding of hydrogeologic conditions in the basin and add high-quality hydrologic data to the database (e.g. pumping and groundwater-level data). Model error and uncertainty can be reduced in the future by using the new hydrogeologic understanding and calibration data to refine the model.

Comments by Jim Ciampa, legal counsel for the Spadra Basin Groundwater Sustainability Agency

Comments. *Mr. Ciampa suggested v*arious editorial changes and grammatical fixes*.*

Response. All suggested changes and fixes have been incorporated into the final TM2.

Appendix J

Standard Operating Procedures for Groundwater-Level Monitoring

STANDARAD OPERATING PROCEDURE FOR MANUAL WATER-LEVEL MEASUREMENTS

The purpose of this Standard Operating Procedure (SOP) is to set guidelines for the determination of the depth to water in an open borehole, cased borehole, production well, monitoring well, or piezometer using manual methods with a water-level measurement device. Groundwater elevation data is a key component of a data monitoring and collection program for a groundwater basin

METHOD SUMMARY

A reference point (RP) must be identified and marked on the casing or sounding tube for use as a reference point for measurement. Often the lip of the riser pipe or sounding tube is not flat so the exact location of measurement must be marked. Another measuring reference should be located on the grout apron or ground surface. This reference is referred to as the site point (SP). Both the RP and the SP should be documented on the Water Level Field Sheet and the well sketch and by photograph.

Data should be collected from the least to the most contaminated wells (if necessary). Working with decontaminated equipment, lower the water level measurement device into the well until the water surface or bottom of casing is encountered. Measure the distance from the RP on the well casing to the groundwater and record in the appropriate form. Repeat the measurement at least twice, 5 minutes apart to ensure the quality of the measurement. Remove all downhole equipment and replace well casing cap. Decontaminate as directed in the project workplan or in the Decontamination section of these SOPs between each well and at the end of the day.

EQUIPMENT LIST

1. Water level measurement device and backup
2. Digital camera
3. Tools and keys to access well site
4. Metal tape measure
5. Black electrical tape
   Chalk (if using steel tape)
6. Paper towels
7. Nitrile gloves
8. Field reference notebook
9. Groundwater level field forms
10. Decontamination solution and equipment
    Wristwatch or something with a clock on it

PREPARATION

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2. Prepare scheduling and coordinate with staff, well owners, clients, and regulatory agency, if appropriate.
3. Decontaminate and pre-clean equipment and ensure that it is in working order according to the work plan or the decontamination section of these SOP documents.

4. Research water level trends in the area to become familiar with the range of water levels in the project region, pay special attention to the water levels from the current season.
5. Print a field form for each well to be measured, plus some extra.

PROCEDURE

1. Wear clean nitrile gloves at all times when collecting a water level measurement.
2. Perform a general site survey prior to site entry in accordance with the health and safety plan.
3. If possible and where applicable, start at those wells that are least contaminated and proceed to those wells that are most contaminated.
4. Make sure water level measuring equipment is decontaminated and in good operating condition.
5. Clean all the equipment entering the well by the following decontamination procedure or as specified in the site plan between each well and at the end of the day:
    a. Wash equipment with a solution of bleach and water.
    b. Wash equipment with an Liquinox® solution (or similar phosphate-free detergent)
    c. Rinse with deionized water
    d. Rinse with an approved solvent (e.g., methanol, isopropyl alcohol, acetone), if organic contamination is suspected.
    e. Place equipment on clean surface such as a Teflon or polyethylene sheet.
6. If required by site-specific condition, monitor headspace of well with PID or FID to determine presence of volatile organic compounds and record in site field form.
7. Identify and mark all measurement locations and record any changes in on the field data sheet and on the site sketch and by photograph.
8. Water levels in newly constructed wells should be allowed to stabilize for a minimum of 24 hours after well construction and development, prior to measurement. In low yield situations, recovery may take longer.
9. Remove well cap.
10. Note well name, well ID, address, date, observer name, and method used in the water-level data form.
11. Lower electric water level measuring device or equivalent (i.e. metal tape, or airline) into the well until water surface is encountered. In most cases an electric sounder is used. If using an electric sounder If the electric sounder is not getting a reading, you may need to use a different sounder, the metal tape method, or airline method, depending on the circumstance.
12. Measure the distance from the water surface to the reference point on the well casing. If using an electric sounder, verify the distance several times by lifting the device a few inches

above the water level and slowly lowering it back down until it sounds. If necessary, to get a clear tone, adjust the sensitivity of the meter. Remove the meter from the well, test the sounder in a bucket of water, adjust the meter sensitivity accordingly, and reinstall the meter in the well. Record all the measurements in the water-level data sheet and note the time of each measurement.

13. Note the activity of the well during measurement (i.e. static, dynamic, unknown, or recovering) on the field data sheet. A well is considered recovering for 24 hours after the well has turned off.
14. Record the designated reference point used (i.e. top of sounding tube, top of casing, plug hole) on the water-level field sheet.
15. Measure the distance of the ground surface to the reference point "GS to RP", and note on the field form. If the reference point is above ground this is a positive number, if below the ground surface the GS to RP is a negative number.
16. Check that the photos are current and well sketch is updated with the correct reference points and measured "GS to RP". If measuring a well for the first time provide a well sketch using the field sketch form. Always make sure that "GS to RP" in the sketch and on the water level field from are the same and that the RP is clearly marked on the well.
17. Wait 5 – 10 minutes to get a second measurement regardless if the activity has changed or not. If the well activity changes, wait at least two minutes to get a measurement after the well turns on/off. If the well changes activity more quickly than two minutes than modify this method accordingly.
18. Fill out water level field sheets completely. Provide comments on anything of significance that is not directly implied by the data recorded on the sheet, such as well condition, well property characteristics, well pumping cycles, problems at the well, oil in the well, etc.
19. Remove all down-hole equipment, replace well casing cap and secure, as necessary.
20. Decontaminate the first ten feet of equipment after each water level measurement. If contamination is observed along any other length of the equipment, decontaminate the affected sections. At the end of the day decontaminate and clean the entire length of the equipment as outlined in Step 6. Dry the line before placing it back on the reel.

INTERFERENCES AND POTENTIAL PROBLEMS

- The chalk used on steel tape may contaminate the well. Check the chalk type against the well water quality requirements before using this method.
- Cascading water may obscure the water mark or cause it to be inaccurate.
- Some types of electric sounders use metal indicators at 5-foot intervals around a conducting wire. These intervals should be checked with a surveyor's tape periodically to ensure accuracy.
- If there is oil present on the water, it can insulate the contacts of the probe on an electric sounder or give false readings due to thickness of the oil. Determining the thickness and density of the oil layer is warranted, in order to determine the correct water level. Measure

the top of the water surface, below the oil, using a steel tape with oil indicating paste or equivalent method. Record this level and note the presence of oil in the well. Record the level of the top of the oil. The true water level can be estimated by adding three- quarters of the thickness of the oil layer to the oil-water interface elevation (U.S. Geological Survey, 2006).

- Turbulence in the well and/or cascading water can make water level determination difficult with either an electric sounder or steel tape.
- Water levels in newly constructed wells should be allowed to stabilize for a minimum of 24 hours after well construction and development, prior to measurement. In low yield situations, recovery may take longer.
- The designated RP should be used at all times to ensure consistency. If the designated RP is not available or was modified or destroyed, a new RP must be designated and documented.
- The chalk used on steel tape may contaminate the well.
- An airline measures drawdown during pumping. It is only accurate to 0.5 foot unless it is calibrated for various "drawdowns".
- Water levels should be checked at least twice, 5 minutes apart for consistency and repeatability and to ensure that the water level is not being affected by nearby pumping, cessation of pumping, or recharge.

QUALITY ASSURACE/QUALITY CONTROL

The following general quality assurance procedures apply:

- All data must be documented on standard field data sheets or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.
- The water level within each well should be measured at least twice in order to compare results and ensure reliability. If water levels change my more than 0.02 feet for inactive wells, and 0.2 feet for active wells, measure the water level a third time. Record all measurements on the field data sheet.

STANDARAD OPERATING PROCEDURE FOR TRANSDUCER INSTALLATION AND DOWNLOAD

The purpose of this Standard Operating Procedure (SOP) is to set guidelines for canvassing wells for transducers, installing transducers, and gathering data from transducers. Groundwater elevation data is a key component of a data monitoring and collection program for a groundwater basin. Transducers are used to obtain high-frequency water level data to gain an accurate understanding of changes in the groundwater surface due to climatic variations and effects of the stresses of pumping and recharge in a basin.

METHOD SUMMARY

Working with decontaminated equipment, canvass selected wells for installation suitability. Once wells are selected, install transducers with the appropriate range and length to be installed at the appropriate depth.

Transducer type, range, and brand should be chosen carefully. Type should be determined by the accuracy required by the project. Range should be determined by the variability of groundwater elevation in the wells (i.e. if a well is known to drawdown by 50 feet when pumping, the transducer range will need to be at least 50 feet). Pumping wells tend to require transducers with a higher range. Transducer brand can be determined by a multitude of factors including but not limited to equipment cost and accuracy required. The installation depth of the transducer should be determined using historical water level data of the well, if available. The transducer should be placed below the estimated lowest water level depth of the well.

A reference point (RP) must be identified and marked on the casing or sounding tube for use as a reference point for measurement. Often the lip of the riser pipe or sounding tube is not flat so the exact location of measurement must be marked. Another measuring reference should be located on the grout apron or ground surface. This reference is referred to as the site point (SP). Both the RP and the SP should be documented on the Transducer Field Sheet, a well sketch, and by photograph.

Install transducers with the appropriate range at the appropriate depth. Return to the wells two weeks after installation to ensure that quality data is being recorded with and to adjust installation depth if needed. Data should be collected from the least to the most contaminated wells (if necessary).

EQUIPMENT LIST

1. Transducers
2. Direct read cables or stainless-steel cable with installation accessories
3. Optical readers and/or direct read cable connectors.
4. Laptop computer or tablet
5. Electrician's reel
6. Dummy transducers and test line with measurement marks, extra line
7. Extra dummies for each size of transducer
8. Copper wire and pliers
9. Digital camera
10. Keys and tools to access well sites and well access ports
11. Water level measurement device (electronic water level indicator, metal tape measure, steel tape, chalk)
12. O-rings (for replacement as needed)
13. Ruler
14. Project notebook, pens
15. Maps and directions
16. Decontamination solution and equipment
17. Water Level and Field Inspection forms
18. Well owner contact information for target wells
19. Shop towels
20. Tag line (for measuring total depth of wells if unknown)
21. Water level history graphs for target wells

PREPARATION

1. Determine good candidate wells for inspection based on proximity to other pumping and non-pumping wells (using maps and water level time- histories) and other information pertaining to the project goals.
2. Obtain well logs, historical water level data, and any other available information from target and nearby wells to determine transducer and cable length.
3. Prepare scheduling and coordinate with staff, well owners, clients, and regulatory agency, if appropriate.
4. Research water level trends in the area to become familiar with the range of water levels in the project region, pay special attention to the water levels from the current season.
5. Print a field form for each well to be canvassed, installed, or downloaded, plus some extra.
6. Purchase transducers and cables after canvassing target wells and selecting good candidates.
7. Regularly update the clock on the device used to download the transducers.

PROCEDURE

Canvassing Wells for Transducers

1. Perform a general site survey prior to site entry in accordance with the health and safety plan. Wear clean nitrile gloves when canvassing wells.
2. If required by site-specific condition, monitor headspace of well with PID or FID to determine presence of volatile organic compounds and record in site field form.
3. Decontaminate all equipment as outlined in these SOP documents before using it on each well.
4. Take pictures and draw a sketch of the well, well site, RP, SP, any possible sampling points, and anyother applicable locations.
5. Talk to well owners about amount of use, age of well, type of chlorination if applicable. Record this data on the field sheets.
6. Determine the reference point that will be used for transducer deployment. Obtain a manual water level using this reference point. Mark the reference point if the well owner allows it.
7. Carefully lower a dummy transducer into the well to the depth of transducer deployment to ensure the casing is suited for transducer deployment. Choose a dummy transducer close in size to the transducer planned for install.

Installing Transducers

1. Perform a general site survey prior to site entry in accordance with the health and safety plan. Wear clean nitrile gloves when installing transducers.
2. Decontaminate all equipment as outlined in these SOP documents before using it on each well. If possible and where applicable, start at those wells that are least contaminated and proceed to those wells that are most contaminated.
3. Completely fill out well field sheets. Write down the serial number, brand, and range of the transducer to be deployed and the length of the cable.
4. If the transducer will be installed on a direct read cable, connect the cable to the direct read cable connector and connect the cable connector to the tablet or laptop computer. If the transducer will be installed on a stainless-steel wire, connect the transducer to the appropriate optical reader and connect the optical reader to the tablet or laptop computer. Open the appropriate software for the transducer model.
5. Check and record the battery level of the transducer. The battery should be 100% when the transducer is installed.
6. Ensure the transducer is set to record at the correct frequency with the correct units for level and temperature. A frequency of 15 minutes is usually acceptable for long-term monitoring.
7. Synchronize the transduce clock to the laptop or tablet time.
8. Start a new transducer log. Ensure there is enough time to replace the transducer in the well before the log starts. Record the future start time on the transducer sheet.
9. Remove the well cap. If installing the transducer on a direct-read cable, attach the transducer to the direct-read cable and carefully lower it into the well. If the transducer

will be on a stainless-steel hanging wire attach transducer to the hanging wire and carefully lower it into the well. Securely attach the top of the cable to the well casing or well cap. Replace the well cap.

10. Obtain two water levels at least a few minutes apart following standard procedure. Record the manuals and their respective times (specify the time zone used) on the transducer field sheet. Record the well activity (static, dynamic, or recovering) and note if there are any issues such as cascading. Record the type of equipment used to obtain the water levels; electrical sounders with 0.01' precision are recommended for transducer calibration.

Downloading Transducers

1. Perform a general site survey prior to site entry in accordance with the health and safety plan. Wear clean nitrile gloves when obtaining manual water levels and downloading transducers.

2. Decontaminate all equipment as outlined in these SOP documents before using it on each well. If possible and where applicable, start at those wells that are least contaminated and proceed to those wells that are most contaminated.

3. Completely fill out transducer field sheets

4. Obtain a manual water level and record it and the time (specify the time zone used) on the transducer field sheet. Record the well activity (static, dynamic, or recovering) and note if there are any issues such as cascading. Record the type of equipment used to obtain the water levels; electrical sounders with 0.01' precision are recommended for transducer calibration.

5. Check that the water level is in the range of the transducer's measurement capabilities.

6. If the transducer is on a direct read cable, connect the cable to the direct read cable connector and connect the cable connector to the tablet or laptop computer. If the transducer is on a stainless-steel wire, secure the end of the wire to an electrical reel and carefully pull the transducer out of the well and dry with a shop towel (or similar) before connecting to the appropriate optical reader.

7. Record the battery and memory level of the transducer.

8. Download the data. Check the data graphically for possible errors.

9. Stop or pause the transducer log and update the transducer time. Note if there is a significant (more than one minute) time difference between the transducer and computer time.

10. Start a new transducer log. Ensure there is enough time to replace the transducer in the well before the log starts. Record the future start time on the transducer sheet.

11. Carefully replace the direct read cable and/or transducer in the well.

12. Obtain a second manual water level and record it on the transducer field sheet.

INTERFERENCES AND POTENTIAL PROBLEMS

- Turbulence in the well and/or cascading water can make water level determination difficult with either an electric sounder or steel tape.
- Wells that or static or recovering during the transducer download should be measured as close to the transducer start time as possible.
- Water can affect the connectivity of transducer equipment. If having connectivity issues, completely dry all equipment and connector cable interfaces. Replace O-rings where applicable.
- The designated reference point (RP) should be used at all times to ensure consistency. If the designated RP is not available or was modified or destroyed, a new RP must be designated and documented.
- Transducers should be downloaded two weeks after installation to ensure the equipment is working and was deployed correctly.
- Transducers are prone to drift as they age. Replace transducers that are consistently drifting more than a third of a foot from manual water levels collected during download.
- Ensure that the start date and time are correct when starting a new transducer log.
- If a transducer is out of range adjust either the depth of the transducer, or install a new transducer with a larger range.

QUALITY ASSURACE/QUALITY CONTROL

The following general quality assurance procedures apply:

- All data must be documented on standard field data sheets or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.
- The water level within each well should be measured at least twice in order to compare results and ensure reliability. If water levels change my more than 0.02 feet for inactive wells, and 0.2 feet for active wells, measure the water level a third time. Record all measurements on the field data sheet.

Appendix K

Cost Model for the Baseline Scenario

Table K-1a. Baseline Scenario Water Supply Plan -- City of Pomona

		Water Supply Plan										
		Potable								Non-Potable		
		Groundwater				Surface Water		Other				
Year	Total Water Demands	Chino Basin	Six Basins	Spadra Basin	Total	San Antonio Creek Water	Imported Water	Purchase from Others	Total	Spadra Basin	Recycled Water	Total	Total Supplies
2019	19,708	10,348	1,984	0	12,332	2,614	3,331	0	18,277	0	1,431	1,431	19,708
2020	23,492	11,509	3,300	0	14,809	1,950	4,390	0	21,149	0	2,343	2,343	23,492
2021	23,569	11,416	3,300	0	14,716	1,950	4,390	0	21,056	200	2,313	2,513	23,569
2022	23,646	11,323	3,300	0	14,623	1,950	4,390	0	20,963	400	2,283	2,683	23,646
2023	23,724	11,231	3,300	0	14,531	1,950	4,390	0	20,871	600	2,253	2,853	23,724
2024	23,801	11,138	3,300	0	14,438	1,950	4,390	0	20,778	800	2,223	3,023	23,801
2025	23,878	11,045	3,300	0	14,345	1,950	4,390	0	20,685	1,000	2,193	3,193	23,878
2026	23,833	11,062	3,300	0	14,362	1,950	4,390	0	20,702	969	2,162	3,131	23,833
2027	23,788	11,079	3,300	0	14,379	1,950	4,390	0	20,719	938	2,131	3,069	23,788
2028	23,744	11,097	3,300	0	14,397	1,950	4,390	0	20,737	907	2,100	3,007	23,744
2029	23,699	11,114	3,300	0	14,414	1,950	4,390	0	20,754	876	2,069	2,945	23,699
2030	23,654	11,131	3,300	0	14,431	1,950	4,390	0	20,771	845	2,038	2,883	23,654
2031	23,671	11,148	3,300	0	14,448	1,950	4,390	0	20,788	845	2,038	2,883	23,671
2032	23,689	11,166	3,300	0	14,466	1,950	4,390	0	20,806	845	2,038	2,883	23,689
2033	23,706	11,183	3,300	0	14,483	1,950	4,390	0	20,823	845	2,038	2,883	23,706
2034	23,724	11,201	3,300	0	14,501	1,950	4,390	0	20,841	845	2,038	2,883	23,724
2035	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2036	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2037	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2038	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2039	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2040	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2041	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2042	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2043	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2044	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2045	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2046	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2047	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2048	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2049	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2050	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2051	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2052	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2053	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2054	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2055	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2056	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2057	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2058	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2059	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2060	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2061	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2062	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2063	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2064	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2065	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2066	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2067	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2068	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2069	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2070	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2071	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741
2072	23,741	11,218	3,300	0	14,518	1,950	4,390	0	20,858	845	2,038	2,883	23,741

Table K-1b. Baseline Scenario Water Supply Plan -- Walnut Valley Water District

		Water Supply Plan											
		Potable								Non-Potable			
		Groundwater						Surface Water					
Year	Total Water Demands	Puente Basin	Six Basins	Spadra Basin	Main San Gabriel	Central Basin	Total	Imported Water	Total	Spadra Basin	Recycled Water	Total	Total Supplies
2019	17,595	662	0	0	0	0	662	15,795	16,457	53	1,085	1,138	17,595
2020	21,191	1,359	0	0	0	0	1,359	17,518	18,877	110	2,204	2,314	21,191
2021	21,154	1,345	0	0	0	0	1,345	17,518	18,863	109	2,182	2,291	21,154
2022	21,117	1,332	625	0	0	0	1,957	16,893	18,850	108	2,160	2,268	21,117
2023	21,081	1,318	625	0	0	0	1,943	16,893	18,836	107	2,137	2,244	21,081
2024	21,044	1,305	625	0	0	0	1,930	16,893	18,823	106	2,115	2,221	21,044
2025	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2026	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2027	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2028	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2029	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2030	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2031	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2032	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2033	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2034	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2035	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2036	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2037	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2038	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2039	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2040	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2041	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2042	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2043	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2044	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2045	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2046	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2047	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2048	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2049	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2050	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2051	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2052	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2053	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2054	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2055	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2056	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2057	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2058	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2059	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2060	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2061	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2062	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2063	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2064	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2065	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2066	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2067	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2068	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2069	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2070	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2071	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007
2072	21,007	1,291	625	0	2,500	2,000	6,416	12,393	18,809	105	2,093	2,198	21,007

Table K-1c. Baseline Scenario Water Supply Plan -- Cal Poly Pomona

		Water Supply Plan						
		Potable			Non-Potable			
		Groundwater	Surface Water					
Year	Total Water Demands	Spadra Basin	Imported Water	Total	Spadra Basin	Recycled Water	Total	Total Supplies
2019	1,824	312	105	417	0	984	984	1,401
2020	1,621	235	118	354	0	911	911	1,265
2021	1,669	312	103	415	324	929	1,253	1,669
2022	1,716	312	88	400	370	947	1,316	1,716
2023	1,764	312	73	385	415	964	1,379	1,764
2024	1,812	355	58	413	417	982	1,399	1,812
2025	1,860	389	43	432	428	1,000	1,428	1,860
2026	1,861	389	36	425	436	1,000	1,436	1,861
2027	1,862	389	29	418	443	1,000	1,443	1,862
2028	1,863	389	23	412	451	1,000	1,451	1,863
2029	1,864	410	16	426	438	1,000	1,438	1,864
2030	1,865	426	9	435	430	1,000	1,430	1,865
2031	1,865	426	9	435	430	1,000	1,430	1,865
2032	1,865	426	9	435	430	1,000	1,430	1,865
2033	1,865	426	9	435	430	1,000	1,430	1,865
2034	1,865	426	9	435	430	1,000	1,430	1,865
2035	1,865	426	9	435	430	1,000	1,430	1,865
2036	1,865	426	9	435	430	1,000	1,430	1,865
2037	1,865	426	9	435	430	1,000	1,430	1,865
2038	1,865	426	9	435	430	1,000	1,430	1,865
2039	1,865	426	9	435	430	1,000	1,430	1,865
2040	1,865	426	9	435	430	1,000	1,430	1,865
2041	1,865	426	9	435	430	1,000	1,430	1,865
2042	1,865	426	9	435	430	1,000	1,430	1,865
2043	1,865	426	9	435	430	1,000	1,430	1,865
2044	1,865	426	9	435	430	1,000	1,430	1,865
2045	1,865	426	9	435	430	1,000	1,430	1,865
2046	1,865	426	9	435	430	1,000	1,430	1,865
2047	1,865	426	9	435	430	1,000	1,430	1,865
2048	1,865	426	9	435	430	1,000	1,430	1,865
2049	1,865	426	9	435	430	1,000	1,430	1,865
2050	1,865	426	9	435	430	1,000	1,430	1,865
2051	1,865	426	9	435	430	1,000	1,430	1,865
2052	1,865	426	9	435	430	1,000	1,430	1,865
2053	1,865	426	9	435	430	1,000	1,430	1,865
2054	1,865	426	9	435	430	1,000	1,430	1,865
2055	1,865	426	9	435	430	1,000	1,430	1,865
2056	1,865	426	9	435	430	1,000	1,430	1,865
2057	1,865	426	9	435	430	1,000	1,430	1,865
2058	1,865	426	9	435	430	1,000	1,430	1,865
2059	1,865	426	9	435	430	1,000	1,430	1,865
2060	1,865	426	9	435	430	1,000	1,430	1,865
2061	1,865	426	9	435	430	1,000	1,430	1,865
2062	1,865	426	9	435	430	1,000	1,430	1,865
2063	1,865	426	9	435	430	1,000	1,430	1,865
2064	1,865	426	9	435	430	1,000	1,430	1,865
2065	1,865	426	9	435	430	1,000	1,430	1,865
2066	1,865	426	9	435	430	1,000	1,430	1,865
2067	1,865	426	9	435	430	1,000	1,430	1,865
2068	1,865	426	9	435	430	1,000	1,430	1,865
2069	1,865	426	9	435	430	1,000	1,430	1,865
2070	1,865	426	9	435	430	1,000	1,430	1,865
2071	1,865	426	9	435	430	1,000	1,430	1,865
2072	1,865	426	9	435	430	1,000	1,430	1,865

Table K-2a. Unit and Melded Costs for Water Supplies -- City of Pomona

	Groundwater												Surface Water						Recycled Water		Total Annual Cost						Unit Cost						
	Chino Basin				Six Basins				Spadra Basin				San Antonio Canyon Water				Imported Water																
Year	Assessment	Production	Treatment	O&M	Assessment	Production	Treatment	O&M	Assessment	Production	Treatment	O&M	Assessment	Production	Treatment	O&M	Tier 1	Other	Commodity	Production	Chino Basin	Six Basins	Spadra Basin	SAC Water	Imported Water	Recycled Water	Chino Basin	Six Basins	Spadra Basin	SAC Water	Imported Water	Recycled Water	Melded Total
2021	$129	$86	$120	$164	$24	$86	$21	$164	$0	$105	$78	$103	$494	$86	$7	$164	$1,104	$7	$134	$38	$5,693,601	$973,038	$57,070	$1,464,587	$4,878,607	$397,743	$499	$295	$285	$751	$1,111	$172	$571
2022	$132	$88	$123	$169	$25	$88	$21	$169	$0	$107	$80	$106	$506	$88	$7	$169	$1,143	$7	$137	$39	$5,788,502	$997,364	$116,993	$1,501,201	$5,050,618	$402,399	$511	$302	$292	$770	$1,150	$176	$586
2023	$135	$90	$126	$173	$25	$90	$22	$173	$0	$110	$82	$108	$519	$90	$7	$173	$1,200	$8	$140	$40	$5,884,590	$1,022,298	$179,877	$1,538,731	$5,301,669	$407,039	$524	$310	$300	$789	$1,208	$181	$604
2024	$139	$92	$129	$177	$26	$92	$22	$177	$0	$113	$84	$111	$532	$92	$7	$177	$1,260	$8	$144	$41	$5,981,864	$1,047,855	$245,833	$1,577,199	$5,565,911	$411,660	$537	$318	$307	$809	$1,268	$185	$623
2025	$142	$95	$132	$182	$26	$95	$23	$182	$0	$116	$86	$114	$545	$95	$8	$181	$1,311	$8	$148	$42	$6,080,323	$1,074,052	$314,973	$1,616,629	$5,790,664	$416,257	$551	$325	$315	$829	$1,319	$190	$640
2026	$146	$97	$135	$186	$27	$97	$23	$186	$0	$119	$88	$116	$559	$97	$8	$186	$1,336	$8	$151	$43	$6,242,037	$1,100,903	$312,839	$1,657,045	$5,901,298	$420,632	$564	$334	$323	$850	$1,344	$195	$656
2027	$149	$100	$139	$191	$28	$100	$24	$191	$0	$122	$90	$119	$573	$100	$8	$191	$1,370	$8	$155	$44	$6,408,036	$1,128,426	$310,402	$1,698,471	$6,051,465	$424,966	$578	$342	$331	$871	$1,378	$199	$674
2028	$153	$102	$142	$195	$29	$102	$24	$195	$0	$125	$92	$122	$587	$102	$8	$195	$1,403	$9	$159	$46	$6,578,433	$1,156,636	$307,647	$1,740,933	$6,197,264	$429,253	$593	$350	$339	$893	$1,412	$204	$691
2029	$157	$105	$146	$200	$29	$105	$25	$200	$0	$128	$95	$125	$602	$105	$8	$200	$1,442	$9	$163	$47	$6,753,346	$1,185,552	$304,560	$1,784,456	$6,369,426	$433,490	$608	$359	$348	$915	$1,451	$210	$710
2030	$161	$107	$149	$205	$30	$107	$26	$205	$0	$131	$97	$129	$617	$107	$9	$205	$1,486	$9	$167	$48	$6,932,892	$1,215,191	$301,127	$1,829,068	$6,563,562	$437,670	$623	$368	$356	$938	$1,495	$215	$731
2031	$165	$110	$153	$210	$31	$110	$26	$210	$0	$134	$99	$132	$632	$110	$9	$210	$1,545	$9	$171	$49	$7,117,323	$1,245,571	$308,655	$1,874,795	$6,825,504	$448,611	$638	$377	$365	$961	$1,555	$220	$753
2032	$169	$113	$157	$216	$31	$113	$27	$216	$0	$137	$102	$135	$648	$113	$9	$216	$1,607	$10	$175	$50	$7,306,642	$1,276,710	$316,371	$1,921,664	$7,097,909	$459,827	$654	$387	$374	$985	$1,617	$226	$776
2033	$173	$115	$161	$221	$32	$115	$28	$221	$0	$141	$104	$138	$664	$115	$9	$221	$1,672	$10	$180	$51	$7,500,979	$1,308,628	$324,281	$1,969,706	$7,381,195	$471,322	$671	$397	$384	$1,010	$1,681	$231	$800
2034	$178	$118	$165	$227	$33	$118	$28	$227	$0	$144	$107	$142	$681	$118	$10	$227	$1,738	$10	$184	$53	$7,700,466	$1,341,344	$332,388	$2,018,949	$7,675,796	$483,105	$688	$406	$393	$1,035	$1,748	$237	$824
2035	$182	$121	$169	$232	$34	$121	$29	$232	$0	$148	$110	$145	$698	$121	$10	$232	$1,808	$10	$189	$54	$7,905,240	$1,374,877	$340,697	$2,069,422	$7,982,165	$495,183	$705	$417	$403	$1,061	$1,818	$243	$849
2036	$187	$124	$173	$238	$35	$124	$30	$238	$0	$152	$112	$149	$715	$124	$10	$238	$1,880	$11	$194	$55	$8,102,871	$1,409,249	$349,215	$2,121,158	$8,300,773	$507,563	$722	$427	$413	$1,088	$1,891	$249	$876
2037	$191	$127	$178	$244	$36	$127	$31	$244	$0	$156	$115	$153	$733	$127	$10	$244	$1,955	$11	$198	$57	$8,305,442	$1,444,480	$357,945	$2,174,187	$8,632,108	$520,252	$740	$438	$424	$1,115	$1,966	$255	$903
2038	$196	$131	$182	$250	$37	$131	$31	$250	$0	$159	$118	$157	$752	$131	$11	$250	$2,034	$11	$203	$58	$8,513,079	$1,480,592	$366,894	$2,228,542	$8,976,678	$533,258	$759	$449	$434	$1,143	$2,045	$262	$931
2039	$201	$134	$187	$256	$37	$134	$32	$256	$0	$163	$121	$161	$770	$134	$11	$256	$2,115	$11	$208	$60	$8,725,906	$1,517,607	$376,066	$2,284,255	$9,335,014	$546,589	$778	$460	$445	$1,171	$2,126	$268	$960
2040	$206	$137	$191	$263	$38	$137	$33	$263	$0	$168	$124	$165	$790	$137	$11	$263	$2,200	$12	$214	$61	$8,944,053	$1,555,547	$385,468	$2,341,361	$9,707,665	$560,254	$797	$471	$456	$1,201	$2,211	$275	$990
2041	$211	$141	$196	$269	$39	$141	$34	$269	$0	$172	$127	$169	$809	$141	$11	$269	$2,288	$12	$219	$63	$9,167,654	$1,594,436	$395,104	$2,399,896	$10,095,203	$574,260	$817	$483	$468	$1,231	$2,300	$282	$1,020
2042	$216	$144	$201	$276	$40	$144	$35	$276	$0	$176	$130	$173	$830	$144	$12	$276	$2,379	$12	$225	$64	$9,396,846	$1,634,297	$404,982	$2,459,893	$10,498,223	$588,617	$838	$495	$479	$1,261	$2,391	$289	$1,052
2043	$222	$148	$206	$283	$41	$148	$35	$283	$0	$180	$134	$177	$850	$148	$12	$283	$2,474	$13	$230	$66	$9,631,767	$1,675,154	$415,107	$2,521,390	$10,917,345	$603,332	$859	$508	$491	$1,293	$2,487	$296	$1,085
2044	$227	$151	$211	$290	$42	$151	$36	$290	$0	$185	$137	$182	$872	$151	$12	$290	$2,573	$13	$236	$68	$9,872,561	$1,717,033	$425,484	$2,584,425	$11,353,211	$618,416	$880	$520	$504	$1,325	$2,586	$303	$1,119
2045	$233	$155	$216	$297	$43	$155	$37	$297	$0	$190	$140	$186	$893	$155	$12	$297	$2,676	$13	$242	$69	$10,119,375	$1,759,959	$436,121	$2,649,036	$11,806,491	$633,876	$902	$533	$516	$1,358	$2,689	$311	$1,154
2046	$239	$159	$222	$305	$44	$159	$38	$305	$0	$194	$144	$191	$916	$159	$13	$305	$2,783	$14	$248	$71	$10,372,360	$1,803,958	$447,024	$2,715,261	$12,277,881	$649,723	$925	$547	$529	$1,392	$2,797	$319	$1,191
2047	$245	$163	$227	$312	$46	$163	$39	$312	$0	$199	$147	$196	$939	$163	$13	$312	$2,895	$14	$254	$73	$10,631,669	$1,849,057	$458,200	$2,783,143	$12,768,105	$665,966	$948	$560	$542	$1,427	$2,908	$327	$1,228
2048	$251	$167	$233	$320	$47	$167	$40	$320	$0	$204	$151	$201	$962	$167	$13	$320	$3,010	$14	$260	$75	$10,897,460	$1,895,283	$469,655	$2,852,722	$13,277,916	$682,615	$971	$574	$556	$1,463	$3,025	$335	$1,267
2049	$257	$171	$239	$328	$48	$171	$41	$328	$0	$209	$155	$206	$986	$171	$14	$328	$3,131	$15	$267	$76	$11,169,897	$1,942,666	$481,396	$2,924,040	$13,808,097	$699,681	$996	$589	$570	$1,500	$3,145	$343	$1,307
2050	$264	$176	$245	$337	$49	$176	$42	$337	$0	$214	$159	$211	$1,011	$176	$14	$336	$3,256	$15	$274	$78	$11,449,144	$1,991,232	$493,431	$2,997,141	$14,359,461	$717,173	$1,021	$603	$584	$1,537	$3,271	$352	$1,348
2051	$270	$180	$251	$345	$50	$180	$43	$345	$0	$220	$163	$216	$1,036	$180	$14	$345	$3,386	$15	$280	$80	$11,735,373	$2,041,013	$505,767	$3,072,069	$14,932,855	$735,102	$1,046	$618	$599	$1,575	$3,402	$361	$1,391
2052	$277	$185	$257	$354	$52	$185	$44	$354	$0	$225	$167	$221	$1,062	$185	$15	$353	$3,522	$16	$287	$82	$12,028,757	$2,092,038	$518,411	$3,148,871	$15,529,161	$753,480	$1,072	$634	$614	$1,615	$3,537	$370	$1,435
2053	$284	$189	$264	$362	$53	$189	$45	$362	$0	$231	$171	$227	$1,089	$189	$15	$362	$3,663	$16	$295	$84	$12,329,476	$2,144,339	$531,371	$3,227,593	$16,149,294	$772,316	$1,099	$650	$629	$1,655	$3,679	$379	$1,481
2054	$291	$194	$270	$371	$54	$194	$46	$371	$0	$237	$175	$233	$1,116	$194	$16	$371	$3,809	$16	$302	$86	$12,637,713	$2,197,948	$544,656	$3,308,282	$16,794,207	$791,624	$1,127	$666	$645	$1,697	$3,826	$388	$1,528
2055	$298	$199	$277	$381	$56	$199	$48	$381	$0	$243	$180	$238	$1,144	$199	$16	$381	$3,961	$17	$310	$89	$12,953,656	$2,252,896	$558,272	$3,390,990	$17,464,889	$811,415	$1,155	$683	$661	$1,739	$3,978	$398	$1,577
2056	$306	$204	$284	$390	$57	$204	$49	$390	$0	$249	$184	$244	$1,172	$204	$16	$390	$4,120	$17	$317	$91	$13,277,497	$2,309,219	$572,229	$3,475,764	$18,162,372	$831,700	$1,184	$700	$677	$1,782	$4,137	$408	$1,627
2057	$313	$209	$291	$400	$58	$209	$50	$400	$0	$255	$189	$250	$1,202	$209	$17	$400	$4,285	$18	$325	$93	$13,609,435	$2,366,949	$586,535	$3,562,658	$18,887,726	$852,493	$1,213	$717	$694	$1,827	$4,302	$418	$1,679
2058	$321	$214	$298	$410	$60	$214	$51	$410	$0	$261	$193	$257	$1,232	$214	$17	$410	$4,456	$18	$333	$95	$13,949,670	$2,426,123	$601,198	$3,651,725	$19,642,065	$873,805	$1,244	$735	$711	$1,873	$4,474	$429	$1,733
2059	$329	$219	$306	$420	$61	$219	$53	$420	$0	$268	$198	$263	$1,262	$219	$18	$420	$4,634	$19	$342	$98	$14,298,412	$2,486,776	$616,228	$3,743,018	$20,426,549	$895,650	$1,275	$754	$729	$1,919	$4,653	$439	$1,789
2060	$337	$225	$313	$431	$63	$225	$54	$431	$0	$274	$203	$270	$1,294	$225	$18	$431	$4,820	$19	$350	$100	$14,655,873	$2,548,946	$631,634	$3,836,593	$21,242,383	$918,042	$1,306	$772	$747	$1,967	$4,839	$450	$1,846
2061	$346	$230	$321	$442	$64	$230	$55	$442	$0	$281	$208	$276	$1,326	$230	$19	$441	$5,012	$20	$359	$103	$15,022,269	$2,612,669	$647,425	$3,932,508	$22,090,819	$940,993	$1,339	$792	$766	$2,017	$5,032	$462	$1,906
2062	$355	$236	$329	$453	$66	$236	$57	$453	$0	$288	$214	$283	$1,359	$236	$19	$452	$5,213	$20	$368	$105	$15,397,826	$2,677,986	$663,610	$4,030,821	$22,973,161	$964,517	$1,373	$812	$785	$2,067	$5,233	$473	$1,967
2063	$363	$242	$338	$464	$68	$242	$58	$464	$0	$296	$219	$290	$1,393	$242	$19	$464	$5,421	$21	$377	$108	$15,782,772	$2,744,936	$680,200	$4,131,591	$23,890,764	$988,630	$1,407	$832	$805	$2,119	$5,442	$485	$2,031
2064	$372	$248	$346	$475	$69	$248	$60	$475	$0	$303	$224	$298	$1,428	$248	$20	$475	$5,638	$21	$387	$111	$16,177,341	$2,813,559	$697,205	$4,234,881	$24,845,039	$1,013,346	$1,442	$853	$825	$2,172	$5,659	$497	$2,097
2065	$382	$254	$355	$487	$71	$254	$61	$487	$0	$311	$230	$305	$1,464	$254	$20	$487	$5,864	$22	$396	$113	$16,581,775	$2,883,898	$714,636	$4,340,753	$25,837,451	$1,038,680	$1,478	$874	$846	$2,226	$5,886	$510	$2,165
2066	$391	$261	$363	$500	$73	$261	$63	$500	$0	$318	$236	$313	$1,501	$261	$21	$499	$6,098	$22	$406	$116	$16,996,319	$2,955,995	$732,501	$4,449,272	$26,869,524	$1,064,647	$1,515	$896	$867	$2,282	$6,121	$522	$2,235
2067	$401	$267	$373	$512	$75	$267	$64	$512	$0	$326	$242	$321	$1,538	$267	$22	$512	$6,342	$23	$416	$119	$17,421,227	$3,029,895	$750,814	$4,560,504	$27,942,844	$1,091,263	$1,553	$918	$889	$2,339	$6,365	$535	$2,308
2068	$411	$274	$382	$525	$77	$274	$66	$525	$0	$334	$248	$329	$1,577	$274	$22	$525	$6,596	$23	$427	$122	$17,856,758	$3,105,643	$769,584	$4,674,517	$29,059,061	$1,118,545	$1,592	$941	$911	$2,397	$6,619	$549	$2,383
2069	$421	$281	$391	$538	$79	$281	$67	$538	$0	$343	$254	$337	$1,616	$281	$23	$538	$6,860	$24	$437	$125	$18,303,176	$3,183,284	$788,824	$4,791,379	$30,219,890	$1,146,508	$1,632	$965	$934	$2,457	$6,884	$563	$2,461
2070	$432	$288	$401	$551	$80	$288	$69	$551	$0	$351	$260	$345	$1,656	$288	$23	$551	$7,134	$24	$448	$128	$18,760,756	$3,262,866	$808,544	$4,911,164	$31,427,113	$1,175,171	$1,672	$989	$957	$2,519	$7,159	$577	$2,542
2071	$443	$295	$411	$565	$82	$295	$71	$565	$0	$360	$267	$354	$1,698	$295	$24	$565	$7,420	$25	$459	$132	$19,229,775	$3,344,437	$828,758	$5,033,943	$32,682,585	$1,204,550	$1,714	$1,013	$981	$2,582	$7,445	$591	$2,625
2072	$454	$302	$421	$579	$85	$302	$73	$579	$0	$369	$273	$363	$1,740	$302	$24	$579	$7,716	$26	$471	$135	$19,710,519	$3,428,048	$849,477	$5,159,792	$33,988,236	$1,234,664	$1,757	$1,039	$1,005	$2,646	$7,742	$606	$2,711

Table K-2b. Unit and Melded Costs for Water Supplies -- Walnut Valley Water District

	Groundwater																					Surface Water			Recycled Water			
	Puente Basin				Six Basins				Spadra Basin				Main San Gabriel Basin					Central Basin					Imported Water						
Year	Assessment	Production	Treatment	O&M	Assessment	Production	Treatment	O&M	Assessment	Production	Treatment	O&M	Assessment	Production	Treatment	O&M	Untreated Tier 1 Water	Assessment	Production	Treatment	O&M	Other	Tier 1	O&M	Surcharge	Assessment	Production	Treatment	O&M
2021	$0	$65	$0	$0	$772	$100	$0	$30	$0	$65	$0	$0	$200	$89	$391	$45	$594	$532	$230	$15	$34	$228	$1,104	$9	($6)	$150	$68	$0	$0
2022	$0	$67	$0	$0	$796	$103	$0	$31	$0	$67	$0	$0	$205	$91	$401	$46	$618	$545	$236	$15	$35	$234	$1,143	$9	($6)	$154	$70	$0	$0
2023	$0	$68	$0	$0	$822	$105	$0	$32	$0	$68	$0	$0	$210	$94	$411	$47	$642	$559	$242	$16	$36	$240	$1,200	$9	($6)	$158	$71	$0	$0
2024	$0	$70	$0	$0	$849	$108	$0	$32	$0	$70	$0	$0	$215	$96	$421	$48	$668	$573	$248	$16	$37	$246	$1,260	$10	($6)	$162	$73	$0	$0
2025	$0	$72	$0	$0	$872	$110	$0	$33	$0	$72	$0	$0	$221	$98	$432	$50	$695	$587	$254	$17	$38	$252	$1,311	$10	($7)	$166	$75	$0	$0
2026	$0	$74	$0	$0	$883	$113	$0	$34	$0	$74	$0	$0	$226	$101	$442	$51	$723	$602	$260	$17	$38	$258	$1,336	$10	($7)	$170	$77	$0	$0
2027	$0	$75	$0	$0	$898	$116	$0	$35	$0	$75	$0	$0	$232	$103	$453	$52	$752	$617	$267	$17	$39	$264	$1,370	$10	($7)	$174	$79	$0	$0
2028	$0	$77	$0	$0	$913	$119	$0	$36	$0	$77	$0	$0	$238	$106	$465	$53	$782	$632	$273	$18	$40	$271	$1,403	$11	($7)	$178	$81	$0	$0
2029	$0	$79	$0	$0	$931	$122	$0	$37	$0	$79	$0	$0	$244	$108	$476	$55	$813	$648	$280	$18	$41	$278	$1,442	$11	($7)	$183	$83	$0	$0
2030	$0	$81	$0	$0	$951	$125	$0	$37	$0	$81	$0	$0	$250	$111	$488	$56	$845	$664	$287	$19	$42	$285	$1,486	$11	($7)	$187	$85	$0	$0
2031	$0	$83	$0	$0	$977	$128	$0	$38	$0	$83	$0	$0	$256	$114	$501	$58	$879	$681	$294	$19	$44	$292	$1,545	$12	($8)	$192	$87	$0	$0
2032	$0	$85	$0	$0	$1,005	$131	$0	$39	$0	$85	$0	$0	$262	$117	$513	$59	$914	$698	$302	$20	$45	$299	$1,607	$12	($8)	$197	$89	$0	$0
2033	$0	$87	$0	$0	$1,034	$134	$0	$40	$0	$87	$0	$0	$269	$120	$526	$61	$951	$715	$309	$20	$46	$307	$1,672	$12	($8)	$202	$91	$0	$0
2034	$0	$90	$0	$0	$1,064	$138	$0	$41	$0	$90	$0	$0	$276	$123	$539	$62	$989	$733	$317	$21	$47	$314	$1,738	$12	($8)	$207	$94	$0	$0
2035	$0	$92	$0	$0	$1,095	$141	$0	$42	$0	$92	$0	$0	$283	$126	$552	$64	$1,029	$752	$325	$21	$48	$322	$1,808	$13	($8)	$212	$96	$0	$0
2036	$0	$94	$0	$0	$1,128	$145	$0	$43	$0	$94	$0	$0	$290	$129	$566	$65	$1,070	$770	$333	$22	$49	$330	$1,880	$13	($9)	$217	$98	$0	$0
2037	$0	$96	$0	$0	$1,162	$148	$0	$45	$0	$96	$0	$0	$297	$132	$580	$67	$1,113	$790	$341	$22	$50	$338	$1,955	$13	($9)	$223	$101	$0	$0
2038	$0	$99	$0	$0	$1,197	$152	$0	$46	$0	$99	$0	$0	$304	$135	$595	$68	$1,157	$810	$350	$23	$52	$347	$2,034	$14	($9)	$228	$103	$0	$0
2039	$0	$101	$0	$0	$1,234	$156	$0	$47	$0	$101	$0	$0	$312	$139	$610	$70	$1,203	$830	$359	$23	$53	$356	$2,115	$14	($9)	$234	$106	$0	$0
2040	$0	$104	$0	$0	$1,272	$160	$0	$48	$0	$104	$0	$0	$320	$142	$625	$72	$1,251	$850	$368	$24	$54	$364	$2,200	$14	($10)	$240	$109	$0	$0
2041	$0	$107	$0	$0	$1,311	$164	$0	$49	$0	$107	$0	$0	$328	$146	$641	$74	$1,302	$872	$377	$25	$56	$374	$2,288	$15	($10)	$246	$111	$0	$0
2042	$0	$109	$0	$0	$1,352	$168	$0	$50	$0	$109	$0	$0	$336	$149	$657	$76	$1,354	$894	$386	$25	$57	$383	$2,379	$15	($10)	$252	$114	$0	$0
2043	$0	$112	$0	$0	$1,395	$172	$0	$52	$0	$112	$0	$0	$344	$153	$673	$77	$1,408	$916	$396	$26	$59	$393	$2,474	$15	($10)	$258	$117	$0	$0
2044	$0	$115	$0	$0	$1,440	$176	$0	$53	$0	$115	$0	$0	$353	$157	$690	$79	$1,464	$939	$406	$26	$60	$402	$2,573	$16	($11)	$265	$120	$0	$0
2045	$0	$118	$0	$0	$1,486	$181	$0	$54	$0	$118	$0	$0	$362	$161	$707	$81	$1,523	$962	$416	$27	$61	$412	$2,676	$16	($11)	$271	$123	$0	$0
2046	$0	$121	$0	$0	$1,534	$185	$0	$56	$0	$121	$0	$0	$371	$165	$725	$83	$1,584	$986	$426	$28	$63	$423	$2,783	$17	($11)	$278	$126	$0	$0
2047	$0	$124	$0	$0	$1,584	$190	$0	$57	$0	$124	$0	$0	$380	$169	$743	$86	$1,647	$1,011	$437	$29	$65	$433	$2,895	$17	($11)	$285	$129	$0	$0
2048	$0	$127	$0	$0	$1,637	$195	$0	$58	$0	$127	$0	$0	$390	$173	$762	$88	$1,713	$1,036	$448	$29	$66	$444	$3,010	$18	($12)	$292	$132	$0	$0
2049	$0	$130	$0	$0	$1,691	$200	$0	$60	$0	$130	$0	$0	$399	$178	$781	$90	$1,781	$1,062	$459	$30	$68	$455	$3,131	$18	($12)	$299	$136	$0	$0
2050	$0	$133	$0	$0	$1,747	$205	$0	$61	$0	$133	$0	$0	$409	$182	$800	$92	$1,852	$1,089	$471	$31	$70	$467	$3,256	$18	($12)	$307	$139	$0	$0
2051	$0	$136	$0	$0	$1,806	$210	$0	$63	$0	$136	$0	$0	$420	$187	$820	$94	$1,927	$1,116	$482	$31	$71	$478	$3,386	$19	($13)	$315	$143	$0	$0
2052	$0	$140	$0	$0	$1,867	$215	$0	$65	$0	$140	$0	$0	$430	$191	$841	$97	$2,004	$1,144	$495	$32	$73	$490	$3,522	$19	($13)	$323	$146	$0	$0
2053	$0	$143	$0	$0	$1,930	$220	$0	$66	$0	$143	$0	$0	$441	$196	$862	$99	$2,084	$1,172	$507	$33	$75	$502	$3,663	$20	($13)	$331	$150	$0	$0
2054	$0	$147	$0	$0	$1,996	$226	$0	$68	$0	$147	$0	$0	$452	$201	$883	$102	$2,167	$1,202	$520	$34	$77	$515	$3,809	$20	($14)	$339	$154	$0	$0
2055	$0	$150	$0	$0	$2,065	$232	$0	$69	$0	$150	$0	$0	$463	$206	$905	$104	$2,254	$1,232	$533	$35	$79	$528	$3,961	$21	($14)	$347	$157	$0	$0
2056	$0	$154	$0	$0	$2,136	$237	$0	$71	$0	$154	$0	$0	$475	$211	$928	$107	$2,344	$1,263	$546	$36	$81	$541	$4,120	$21	($14)	$356	$161	$0	$0
2057	$0	$158	$0	$0	$2,210	$243	$0	$73	$0	$158	$0	$0	$487	$216	$951	$109	$2,438	$1,294	$559	$36	$83	$555	$4,285	$22	($15)	$365	$165	$0	$0
2058	$0	$162	$0	$0	$2,287	$249	$0	$75	$0	$162	$0	$0	$499	$222	$975	$112	$2,535	$1,326	$573	$37	$85	$568	$4,456	$22	($15)	$374	$170	$0	$0
2059	$0	$166	$0	$0	$2,367	$256	$0	$77	$0	$166	$0	$0	$511	$227	$999	$115	$2,637	$1,360	$588	$38	$87	$583	$4,634	$23	($15)	$383	$174	$0	$0
2060	$0	$170	$0	$0	$2,451	$262	$0	$79	$0	$170	$0	$0	$524	$233	$1,024	$118	$2,742	$1,394	$603	$39	$89	$597	$4,820	$24	($16)	$393	$178	$0	$0
2061	$0	$175	$0	$0	$2,537	$269	$0	$81	$0	$175	$0	$0	$537	$239	$1,050	$121	$2,852	$1,428	$618	$40	$91	$612	$5,012	$24	($16)	$403	$183	$0	$0
2062	$0	$179	$0	$0	$2,628	$275	$0	$83	$0	$179	$0	$0	$550	$245	$1,076	$124	$2,966	$1,464	$633	$41	$94	$627	$5,213	$25	($17)	$413	$187	$0	$0
2063	$0	$183	$0	$0	$2,722	$282	$0	$85	$0	$183	$0	$0	$564	$251	$1,103	$127	$3,085	$1,501	$649	$42	$96	$643	$5,421	$25	($17)	$423	$192	$0	$0
2064	$0	$188	$0	$0	$2,819	$289	$0	$87	$0	$188	$0	$0	$578	$257	$1,131	$130	$3,208	$1,538	$665	$43	$98	$659	$5,638	$26	($17)	$434	$197	$0	$0
2065	$0	$193	$0	$0	$2,921	$296	$0	$89	$0	$193	$0	$0	$593	$264	$1,159	$133	$3,336	$1,577	$682	$44	$101	$676	$5,864	$27	($18)	$445	$202	$0	$0
2066	$0	$197	$0	$0	$3,026	$304	$0	$91	$0	$197	$0	$0	$608	$270	$1,188	$137	$3,470	$1,616	$699	$46	$103	$693	$6,098	$27	($18)	$456	$207	$0	$0
2067	$0	$202	$0	$0	$3,136	$311	$0	$93	$0	$202	$0	$0	$623	$277	$1,218	$140	$3,608	$1,657	$716	$47	$106	$710	$6,342	$28	($19)	$467	$212	$0	$0
2068	$0	$207	$0	$0	$3,250	$319	$0	$96	$0	$207	$0	$0	$638	$284	$1,248	$144	$3,753	$1,698	$734	$48	$109	$728	$6,596	$29	($19)	$479	$217	$0	$0
2069	$0	$213	$0	$0	$3,369	$327	$0	$98	$0	$213	$0	$0	$654	$291	$1,279	$147	$3,903	$1,740	$752	$49	$111	$746	$6,860	$29	($20)	$491	$222	$0	$0
2070	$0	$218	$0	$0	$3,492	$335	$0	$101	$0	$218	$0	$0	$671	$298	$1,311	$151	$4,059	$1,784	$771	$50	$114	$765	$7,134	$30	($20)	$503	$228	$0	$0
2071	$0	$223	$0	$0	$3,621	$344	$0	$103	$0	$223	$0	$0	$687	$306	$1,344	$155	$4,221	$1,829	$791	$52	$117	$784	$7,420	$31	($21)	$516	$234	$0	$0
2072	$0	$229	$0	$0	$3,754	$352	$0	$106	$0	$229	$0	$0	$705	$314	$1,378	$159	$4,390	$1,874	$810	$53	$120	$803	$7,716	$32	($21)	$528	$240	$0	$0

Table K-2b. Unit and Melded Costs for Water Supplies -- Walnut Valley Water District

Total Annual Cost					Unit Cost							
Spadra Basin	Main San Gabriel Basin	Central Basin	Imported Water	Recycled Water	Puente Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	Imported Water	Recycled Water	Melded Total
$7,085	$0	$0	$19,392,426	$475,632	$65		$65			$1,107	$218	$1,141
$7,196	$0	$0	$19,360,645	$482,563	$67	$1,099	$67			$1,146	$223	$973
$7,307	$0	$0	$20,324,845	$489,542	$68	$1,128	$68			$1,203	$229	$1,022
$7,420	$0	$0	$21,339,756	$496,569	$70	$1,159	$70			$1,263	$235	$1,073
$7,534	$2,000,661	$2,293,723	$16,288,262	$503,641	$72	$1,185	$72	$800	$1,147	$1,314	$241	$1,040
$7,722	$2,050,677	$2,351,066	$16,599,113	$516,232	$74	$1,200	$74	$820	$1,176	$1,339	$247	$1,063
$7,915	$2,101,944	$2,409,843	$17,021,526	$529,138	$75	$1,219	$75	$841	$1,205	$1,373	$253	$1,092
$8,113	$2,154,493	$2,470,089	$17,431,573	$542,366	$77	$1,238	$77	$862	$1,235	$1,407	$259	$1,118
$8,316	$2,208,355	$2,531,841	$17,916,005	$555,926	$79	$1,259	$79	$883	$1,266	$1,446	$266	$1,148
$8,523	$2,263,564	$2,595,137	$18,462,429	$569,824	$81	$1,283	$81	$905	$1,298	$1,490	$272	$1,181
$8,737	$2,320,153	$2,660,016	$19,200,230	$584,069	$83	$1,313	$83	$928	$1,330	$1,549	$279	$1,223
$8,955	$2,378,157	$2,726,516	$19,967,526	$598,671	$85	$1,345	$85	$951	$1,363	$1,611	$286	$1,268
$9,179	$2,437,611	$2,794,679	$20,765,495	$613,638	$87	$1,379	$87	$975	$1,397	$1,676	$293	$1,314
$9,408	$2,498,551	$2,864,546	$21,595,365	$628,979	$90	$1,413	$90	$999	$1,432	$1,743	$301	$1,361
$9,644	$2,561,015	$2,936,160	$22,458,410	$644,703	$92	$1,449	$92	$1,024	$1,468	$1,812	$308	$1,411
$9,885	$2,625,040	$3,009,564	$23,355,959	$660,821	$94	$1,486	$94	$1,050	$1,505	$1,885	$316	$1,462
$10,132	$2,690,666	$3,084,803	$24,289,389	$677,341	$96	$1,525	$96	$1,076	$1,542	$1,960	$324	$1,515
$10,385	$2,757,933	$3,161,923	$25,260,137	$694,275	$99	$1,565	$99	$1,103	$1,581	$2,038	$332	$1,570
$10,645	$2,826,881	$3,240,971	$26,269,694	$711,632	$101	$1,606	$101	$1,131	$1,620	$2,120	$340	$1,628
$10,911	$2,897,553	$3,321,995	$27,319,612	$729,423	$104	$1,649	$104	$1,159	$1,661	$2,204	$349	$1,687
$11,184	$2,969,992	$3,405,045	$28,411,505	$747,658	$107	$1,694	$107	$1,188	$1,703	$2,293	$357	$1,749
$11,463	$3,044,242	$3,490,171	$29,547,051	$766,350	$109	$1,741	$109	$1,218	$1,745	$2,384	$366	$1,813
$11,750	$3,120,348	$3,577,425	$30,727,997	$785,508	$112	$1,789	$112	$1,248	$1,789	$2,479	$375	$1,880
$12,043	$3,198,357	$3,666,861	$31,956,156	$805,146	$115	$1,839	$115	$1,279	$1,833	$2,579	$385	$1,949
$12,345	$3,278,316	$3,758,533	$33,233,419	$825,275	$118	$1,891	$118	$1,311	$1,879	$2,682	$394	$2,020
$12,653	$3,360,274	$3,852,496	$34,561,747	$845,906	$121	$1,945	$121	$1,344	$1,926	$2,789	$404	$2,095
$12,969	$3,444,281	$3,948,808	$35,943,183	$867,054	$124	$2,001	$124	$1,378	$1,974	$2,900	$414	$2,172
$13,294	$3,530,388	$4,047,528	$37,379,850	$888,731	$127	$2,060	$127	$1,412	$2,024	$3,016	$425	$2,252
$13,626	$3,618,647	$4,148,717	$38,873,958	$910,949	$130	$2,120	$130	$1,447	$2,074	$3,137	$435	$2,335
$13,967	$3,709,113	$4,252,435	$40,427,803	$933,722	$133	$2,183	$133	$1,484	$2,126	$3,262	$446	$2,422
$14,316	$3,801,841	$4,358,745	$42,043,774	$957,066	$136	$2,248	$136	$1,521	$2,179	$3,393	$457	$2,511
$14,674	$3,896,887	$4,467,714	$43,724,355	$980,992	$140	$2,316	$140	$1,559	$2,234	$3,528	$469	$2,604
$15,041	$3,994,309	$4,579,407	$45,472,130	$1,005,517	$143	$2,386	$143	$1,598	$2,290	$3,669	$480	$2,701
$15,417	$4,094,167	$4,693,892	$47,289,786	$1,030,655	$147	$2,459	$147	$1,638	$2,347	$3,816	$492	$2,801
$15,802	$4,196,521	$4,811,239	$49,180,118	$1,056,421	$150	$2,535	$150	$1,679	$2,406	$3,968	$505	$2,906
$16,197	$4,301,434	$4,931,520	$51,146,031	$1,082,832	$154	$2,614	$154	$1,721	$2,466	$4,127	$517	$3,014
$16,602	$4,408,970	$5,054,808	$53,190,549	$1,109,903	$158	$2,696	$158	$1,764	$2,527	$4,292	$530	$3,126
$17,017	$4,519,195	$5,181,179	$55,316,815	$1,137,650	$162	$2,781	$162	$1,808	$2,591	$4,464	$544	$3,243
$17,443	$4,632,174	$5,310,708	$57,528,097	$1,166,091	$166	$2,869	$166	$1,853	$2,655	$4,642	$557	$3,364
$17,879	$4,747,979	$5,443,476	$59,827,795	$1,195,244	$170	$2,961	$170	$1,899	$2,722	$4,828	$571	$3,489
$18,326	$4,866,678	$5,579,563	$62,219,446	$1,225,125	$175	$3,056	$175	$1,947	$2,790	$5,021	$585	$3,620
$18,784	$4,988,345	$5,719,052	$64,706,727	$1,255,753	$179	$3,155	$179	$1,995	$2,860	$5,221	$600	$3,755
$19,253	$5,113,054	$5,862,028	$67,293,461	$1,287,147	$183	$3,258	$183	$2,045	$2,931	$5,430	$615	$3,896
$19,735	$5,240,880	$6,008,579	$69,983,626	$1,319,325	$188	$3,365	$188	$2,096	$3,004	$5,647	$630	$4,042
$20,228	$5,371,902	$6,158,793	$72,781,358	$1,352,309	$193	$3,476	$193	$2,149	$3,079	$5,873	$646	$4,194
$20,734	$5,506,200	$6,312,763	$75,690,960	$1,386,116	$197	$3,591	$197	$2,202	$3,156	$6,108	$662	$4,352
$21,252	$5,643,855	$6,470,582	$78,716,904	$1,420,769	$202	$3,711	$202	$2,258	$3,235	$6,352	$679	$4,515
$21,783	$5,784,951	$6,632,347	$81,863,844	$1,456,288	$207	$3,835	$207	$2,314	$3,316	$6,606	$696	$4,685
$22,328	$5,929,575	$6,798,155	$85,136,618	$1,492,696	$213	$3,964	$213	$2,372	$3,399	$6,870	$713	$4,862
$22,886	$6,077,814	$6,968,109	$88,540,258	$1,530,013	$218	$4,098	$218	$2,431	$3,484	$7,144	$731	$5,045
$23,458	$6,229,760	$7,142,312	$92,079,998	$1,568,263	$223	$4,237	$223	$2,492	$3,571	$7,430	$749	$5,235
$24,045	$6,385,504	$7,320,870	$95,761,281	$1,607,470	$229	$4,382	$229	$2,554	$3,660	$7,727	$768	$5,433

Table L-2c. Engineering Cost Estimates -- Basin Optimization Scenario 3				
Description	Quantity	Unit	Unit Cost	Total Cost
Construction Work				
Site Work				
Site Preparation- Temporary Construction Fencing, Tree Protection, and Traffic Control	4.20	acre	$ 17,188	$ 72,188
Trenching, Shoring, and Bracing	4.20	acre	$ 12,500	$ 52,500
Earthwork- Rough Grading, Fine Grading, Imported Soil	4.20	acre	$ 103,750	$ 435,750
Selective Demolition, Clearing and Grubbing, Tree Removal and Trimming	4.20	acre	$ 20,500	$ 86,100
Loam and Seed/Baseball Field	182952	SF	$ 10	$ 1,829,520
Miscellaneous Signage and Striping	4.20	acre	$ 15,188	$ 63,788
Pipelines and Facilities				
Underground Recharge Gallery	1	LS	$21,000,000	$ 21,000,000
Underground Recharge Gallery to RW Pipelines	1,300	LF	$ 167	$ 217,100
Recycled Water Connections	15	EA	$ 7,500	$ 112,500
Injection Wells	7	EA	$ 2,000,000	$ 14,000,000
Injection Wells Piping - 8"	9,500	LF	$ 182	$ 1,729,000
Production Wells	5	EA	$ 2,000,000	$ 10,000,000
Production Wells Piping - 6"	24,000	LF	$ 167	$ 4,008,000
RO Plant and Wasteline	3.8	MGD	$ 10,212,403	$ 38,938,901
Pipelines from RO Plant	6,000	LF	$ 167	$ 1,002,000
Subtotal				**$ 93,547,346**
Contingencies, Other Project Costs, and Total				
Estimating Contigency		30%		$ 28,064,204
Subtotal 2				**$ 121,611,550**
Construction Contigency		10%		$ 12,161,155
Subtotal 3				**$ 133,772,705**
Other Project Costs				
Engineering and Admin		10%		$ 13,377,271
Construction Management		10%		$ 13,377,271
Total				**$ 160,527,246**
Operations and Maintenance (Annual)				
Pipelines - general	40,800	LF	$ 1.07	$ 43,829
Misc. well maintenance	12	year/well	$ 35,292	$ 423,507
Underground Recharge Gallery Cleaning	1	$/year	$ 2,500	$ 2,500
RO Plant	1	LS	$ 2,143	$ 2,143
Total				**$ 471,979**
Annualized Costs				
Annualized Capital Cost (30 years at 5.0 percent)				$ 10,442,528
Operations and Maintenance				$ 471,979
Total (Capital + O&M)				**$ 10,914,506**

Table K-3. Total Water Supplies -- Aggregate of All Water Purveyors for the Baseline Scenario										
	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Total
2021	1,345	11,416	3,300	945	0	0	1,950	22,011	5,424	46,392
2022	1,332	11,323	3,925	1,190	0	0	1,950	21,371	5,389	46,480
2023	1,318	11,231	3,925	1,434	0	0	1,950	21,356	5,355	46,568
2024	1,305	11,138	3,925	1,678	0	0	1,950	21,341	5,320	46,657
2025	1,291	11,045	3,925	1,922	2,500	2,000	1,950	16,826	5,286	46,745
2026	1,291	11,062	3,925	1,899	2,500	2,000	1,950	16,819	5,255	46,701
2027	1,291	11,079	3,925	1,875	2,500	2,000	1,950	16,812	5,224	46,657
2028	1,291	11,097	3,925	1,852	2,500	2,000	1,950	16,806	5,193	46,613
2029	1,291	11,114	3,925	1,829	2,500	2,000	1,950	16,799	5,162	46,570
2030	1,291	11,131	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,526
2031	1,291	11,148	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,543
2032	1,291	11,166	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,561
2033	1,291	11,183	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,578
2034	1,291	11,201	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,596
2035	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2036	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2037	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2038	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2039	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2040	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2041	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2042	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2043	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2044	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2045	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2046	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2047	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2048	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2049	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2050	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2051	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2052	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2053	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2054	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2055	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2056	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2057	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2058	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2059	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2060	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2061	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2062	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2063	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2064	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2065	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2066	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2067	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2068	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2069	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2070	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2071	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2072	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613

Table K-4. Melded Unit Cost -- Aggregate of All Water Purveyors for the Baseline Scenario

	Total Annual Cost									Unit Cost									
Year	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Melded Total
2021	$87,451	$5,693,601	$1,079,140	$647,388	$0	$0	$1,464,587	$24,390,117	$1,481,785	$65	$499	$327	$685			$751	$1,108	$273	$751
2022	$88,731	$5,788,502	$1,684,388	$724,477	$0	$0	$1,501,201	$24,516,515	$1,520,531	$67	$511	$429	$609			$770	$1,147	$282	$771
2023	$90,021	$5,884,590	$1,727,435	$805,015	$0	$0	$1,538,731	$25,718,039	$1,560,288	$68	$524	$440	$562			$789	$1,204	$291	$801
2024	$91,319	$5,981,864	$1,772,002	$970,666	$0	$0	$1,577,199	$26,981,886	$1,601,083	$70	$537	$451	$579			$809	$1,264	$301	$835
2025	$92,626	$6,080,323	$1,814,729	$1,126,535	$2,000,661	$2,293,723	$1,616,629	$22,137,604	$1,642,943	$72	$551	$462	$586	$800	$1,147	$829	$1,316	$311	$830
2026	$94,942	$6,242,037	$1,850,854	$1,145,165	$2,050,677	$2,351,066	$1,657,045	$22,550,763	$1,677,985	$74	$564	$472	$603	$820	$1,176	$850	$1,341	$319	$848
2027	$97,316	$6,408,036	$1,890,237	$1,164,023	$2,101,944	$2,409,843	$1,698,471	$23,114,925	$1,713,752	$75	$578	$482	$621	$841	$1,205	$871	$1,375	$328	$870
2028	$99,749	$6,578,433	$1,930,085	$1,183,108	$2,154,493	$2,470,089	$1,740,933	$23,661,850	$1,750,260	$77	$593	$492	$639	$862	$1,235	$893	$1,408	$337	$892
2029	$102,242	$6,753,346	$1,972,384	$1,246,809	$2,208,355	$2,531,841	$1,784,456	$24,309,150	$1,787,521	$79	$608	$503	$682	$883	$1,266	$915	$1,447	$346	$917
2030	$104,798	$6,932,892	$2,016,873	$1,303,285	$2,263,564	$2,595,137	$1,829,068	$25,039,912	$1,825,552	$81	$623	$514	$722	$905	$1,298	$938	$1,491	$356	$944
2031	$107,418	$7,117,323	$2,066,507	$1,335,867	$2,320,153	$2,660,016	$1,874,795	$26,040,203	$1,871,190	$83	$638	$526	$740	$928	$1,330	$961	$1,551	$365	$975
2032	$110,104	$7,306,642	$2,117,632	$1,369,263	$2,378,157	$2,726,516	$1,921,664	$27,080,474	$1,917,970	$85	$654	$540	$758	$951	$1,363	$985	$1,613	$374	$1,008
2033	$112,856	$7,500,979	$2,170,297	$1,403,495	$2,437,611	$2,794,679	$1,969,706	$28,162,322	$1,965,920	$87	$671	$553	$777	$975	$1,397	$1,010	$1,677	$383	$1,042
2034	$115,678	$7,700,466	$2,224,549	$1,438,582	$2,498,551	$2,864,546	$2,018,949	$29,287,409	$2,015,068	$90	$688	$567	$797	$999	$1,432	$1,035	$1,744	$393	$1,077
2035	$118,570	$7,905,240	$2,280,440	$1,474,547	$2,561,015	$2,936,160	$2,069,422	$30,457,465	$2,065,444	$92	$705	$581	$817	$1,024	$1,468	$1,061	$1,814	$403	$1,113
2036	$121,534	$8,102,871	$2,338,022	$1,511,411	$2,625,040	$3,009,564	$2,121,158	$31,674,287	$2,117,080	$94	$722	$596	$837	$1,050	$1,505	$1,088	$1,886	$413	$1,150
2037	$124,572	$8,305,442	$2,397,348	$1,549,196	$2,690,666	$3,084,803	$2,174,187	$32,939,745	$2,170,007	$96	$740	$611	$858	$1,076	$1,542	$1,115	$1,962	$423	$1,189
2038	$127,687	$8,513,079	$2,458,474	$1,587,926	$2,757,933	$3,161,923	$2,228,542	$34,255,784	$2,224,257	$99	$759	$626	$879	$1,103	$1,581	$1,143	$2,040	$433	$1,230
2039	$130,879	$8,725,906	$2,521,459	$1,627,624	$2,826,881	$3,240,971	$2,284,255	$35,624,425	$2,279,864	$101	$778	$642	$901	$1,131	$1,620	$1,171	$2,122	$444	$1,271
2040	$134,151	$8,944,053	$2,586,361	$1,668,315	$2,897,553	$3,321,995	$2,341,361	$37,047,772	$2,336,861	$104	$797	$659	$924	$1,159	$1,661	$1,201	$2,206	$455	$1,315
2041	$137,504	$9,167,654	$2,653,243	$1,710,022	$2,969,992	$3,405,045	$2,399,896	$38,528,013	$2,395,282	$107	$817	$676	$947	$1,188	$1,703	$1,231	$2,294	$467	$1,359
2042	$140,942	$9,396,846	$2,722,168	$1,752,773	$3,044,242	$3,490,171	$2,459,893	$40,067,421	$2,455,164	$109	$838	$694	$971	$1,218	$1,745	$1,261	$2,386	$478	$1,406
2043	$144,466	$9,631,767	$2,793,203	$1,796,592	$3,120,348	$3,577,425	$2,521,390	$41,668,363	$2,516,543	$112	$859	$712	$995	$1,248	$1,789	$1,293	$2,481	$490	$1,454
2044	$148,077	$9,872,561	$2,866,414	$1,841,507	$3,198,357	$3,666,861	$2,584,425	$43,333,298	$2,579,457	$115	$880	$730	$1,020	$1,279	$1,833	$1,325	$2,581	$503	$1,504
2045	$151,779	$10,119,375	$2,941,874	$1,887,545	$3,278,316	$3,758,533	$2,649,036	$45,064,786	$2,643,943	$118	$902	$750	$1,045	$1,311	$1,879	$1,358	$2,684	$515	$1,555
2046	$155,574	$10,372,360	$3,019,654	$1,934,733	$3,360,274	$3,852,496	$2,715,261	$46,865,488	$2,710,042	$121	$925	$769	$1,071	$1,344	$1,926	$1,392	$2,791	$528	$1,609
2047	$159,463	$10,631,669	$3,099,830	$1,983,102	$3,444,281	$3,948,808	$2,783,143	$48,738,170	$2,777,793	$124	$948	$790	$1,098	$1,378	$1,974	$1,427	$2,902	$541	$1,664
2048	$163,450	$10,897,460	$3,182,481	$2,032,679	$3,530,388	$4,047,528	$2,852,722	$50,685,711	$2,847,238	$127	$971	$811	$1,126	$1,412	$2,024	$1,463	$3,018	$555	$1,721
2049	$167,536	$11,169,897	$3,267,686	$2,083,496	$3,618,647	$4,148,717	$2,924,040	$52,711,104	$2,918,419	$130	$996	$833	$1,154	$1,447	$2,074	$1,500	$3,139	$569	$1,781
2050	$171,724	$11,449,144	$3,355,529	$2,135,584	$3,709,113	$4,252,435	$2,997,141	$54,817,462	$2,991,379	$133	$1,021	$855	$1,183	$1,484	$2,126	$1,537	$3,264	$583	$1,842
2051	$176,017	$11,735,373	$3,446,097	$2,188,973	$3,801,841	$4,358,745	$3,072,069	$57,008,022	$3,066,164	$136	$1,046	$878	$1,212	$1,521	$2,179	$1,575	$3,395	$598	$1,906
2052	$180,418	$12,028,757	$3,539,478	$2,243,698	$3,896,887	$4,467,714	$3,148,871	$59,286,151	$3,142,818	$140	$1,072	$902	$1,242	$1,559	$2,234	$1,615	$3,531	$613	$1,972
2053	$184,928	$12,329,476	$3,635,765	$2,299,790	$3,994,309	$4,579,407	$3,227,593	$61,655,351	$3,221,388	$143	$1,099	$926	$1,273	$1,598	$2,290	$1,655	$3,672	$628	$2,041
2054	$189,551	$12,637,713	$3,735,054	$2,357,285	$4,094,167	$4,693,892	$3,308,282	$64,119,262	$3,301,923	$147	$1,127	$952	$1,305	$1,638	$2,347	$1,697	$3,818	$644	$2,112
2055	$194,290	$12,953,656	$3,837,443	$2,416,217	$4,196,521	$4,811,239	$3,390,990	$66,681,672	$3,384,471	$150	$1,155	$978	$1,338	$1,679	$2,406	$1,739	$3,971	$660	$2,185
2056	$199,148	$13,277,497	$3,943,035	$2,476,622	$4,301,434	$4,931,520	$3,475,764	$69,346,520	$3,469,083	$154	$1,184	$1,005	$1,371	$1,721	$2,466	$1,782	$4,130	$676	$2,262
2057	$204,126	$13,609,435	$4,051,935	$2,538,538	$4,408,970	$5,054,808	$3,562,658	$72,117,900	$3,555,810	$158	$1,213	$1,032	$1,406	$1,764	$2,527	$1,827	$4,295	$693	$2,341
2058	$209,229	$13,949,670	$4,164,252	$2,602,001	$4,519,195	$5,181,179	$3,651,725	$75,000,075	$3,644,705	$162	$1,244	$1,061	$1,441	$1,808	$2,591	$1,873	$4,466	$710	$2,423
2059	$214,460	$14,298,412	$4,280,101	$2,667,051	$4,632,174	$5,310,708	$3,743,018	$77,997,472	$3,735,822	$166	$1,275	$1,090	$1,477	$1,853	$2,655	$1,919	$4,645	$728	$2,507
2060	$219,822	$14,655,873	$4,399,597	$2,733,728	$4,747,979	$5,443,476	$3,836,593	$81,114,700	$3,829,218	$170	$1,306	$1,121	$1,514	$1,899	$2,722	$1,967	$4,831	$746	$2,595
2061	$225,317	$15,022,269	$4,522,863	$2,802,071	$4,866,678	$5,579,563	$3,932,508	$84,356,551	$3,924,949	$175	$1,339	$1,152	$1,552	$1,947	$2,790	$2,017	$5,024	$765	$2,687
2062	$230,950	$15,397,826	$4,650,025	$2,872,123	$4,988,345	$5,719,052	$4,030,821	$87,728,007	$4,023,072	$179	$1,373	$1,185	$1,590	$1,995	$2,860	$2,067	$5,224	$784	$2,781
2063	$236,724	$15,782,772	$4,781,211	$2,943,926	$5,113,054	$5,862,028	$4,131,591	$91,234,252	$4,123,649	$183	$1,407	$1,218	$1,630	$2,045	$2,931	$2,119	$5,433	$804	$2,879
2064	$242,642	$16,177,341	$4,916,556	$3,017,524	$5,240,880	$6,008,579	$4,234,881	$94,880,674	$4,226,740	$188	$1,442	$1,253	$1,671	$2,096	$3,004	$2,172	$5,650	$824	$2,981
2065	$248,708	$16,581,775	$5,056,200	$3,092,962	$5,371,902	$6,158,793	$4,340,753	$98,672,880	$4,332,409	$193	$1,478	$1,288	$1,713	$2,149	$3,079	$2,226	$5,876	$844	$3,086
2066	$254,926	$16,996,319	$5,200,286	$3,170,286	$5,506,200	$6,312,763	$4,449,272	$102,616,698	$4,440,719	$197	$1,515	$1,325	$1,756	$2,202	$3,156	$2,282	$6,111	$865	$3,195
2067	$261,299	$17,421,227	$5,348,964	$3,249,543	$5,643,855	$6,470,582	$4,560,504	$106,718,191	$4,551,737	$202	$1,553	$1,363	$1,799	$2,258	$3,235	$2,339	$6,355	$887	$3,309
2068	$267,831	$17,856,758	$5,502,388	$3,330,782	$5,784,951	$6,632,347	$4,674,517	$110,983,665	$4,665,530	$207	$1,592	$1,402	$1,844	$2,314	$3,316	$2,397	$6,609	$909	$3,426
2069	$274,527	$18,303,176	$5,660,719	$3,414,051	$5,929,575	$6,798,155	$4,791,379	$115,419,677	$4,782,169	$213	$1,632	$1,442	$1,890	$2,372	$3,399	$2,457	$6,873	$932	$3,548
2070	$281,390	$18,760,756	$5,824,120	$3,499,403	$6,077,814	$6,968,109	$4,911,164	$120,033,045	$4,901,723	$218	$1,672	$1,484	$1,938	$2,431	$3,484	$2,519	$7,148	$955	$3,674
2071	$288,425	$19,229,775	$5,992,764	$3,586,888	$6,229,760	$7,142,312	$5,033,943	$124,830,863	$5,024,266	$223	$1,714	$1,527	$1,986	$2,492	$3,571	$2,582	$7,434	$979	$3,805
2072	$295,636	$19,710,519	$6,166,828	$3,676,560	$6,385,504	$7,320,870	$5,159,792	$129,820,506	$5,149,873	$229	$1,757	$1,571	$2,036	$2,554	$3,660	$2,646	$7,731	$1,004	$3,941

Appendix L

Cost Model for Basin Optimization Scenarios 1, 2, and 3

Table L-1. Planning Criteria -- Unit Costs and Other Assumptions		
Item	**Cost/Unit**	**Unit**
Site Work		
Site Preparation- Temporary Construction Fencing, Tree Protection, and Traffic Control	$17,188	$/acre
Trenching, Shoring, and Bracing	$12,500	$/acre
Earthwork- Rough Grading, Fine Grading, Imported Soil	$103,750	$/acre
Selective Demolition, Clearing and Grubbing, Tree Removal and Trimming	$20,500	$/acre
Loam and Seed	$10	$/SF
Miscellaneous Signage and Striping	$15,188	$/acre
Equipment		
Wells	$2,000,000	$/Well
6" Pipeline	$167	$/LF
8" Pipeline	$182	$/LF
RO Treatment Plant and Wasteline	$10,212,403	MGD
Connections	$7,500	EA
Underground Recharge Vault - Scenario 2	$9,300,000	LS
Underground Recharge Vault - Scenario 3	$21,000,000	LS
Other		
Pipelines - general	$1	$/feet
Misc. well maintenance	$35,292	$/year/well
Treatment Plant	$2,143	$/af
Underground Recharge Vault	$2,500	$/year
Estimating Contingency	30%	
Construction Contingency	10%	
Engineering and Admin	10%	
Construction Management	10%	
Amortization Rate	5%	
Amortization Period	30	Years

Notes:

All costs are for 2021. An inflation rate of 2.5% was assumed to estimated unit cost for supplies for the aggregate water supply for the Spadra Basin

SF - Squared foot

LF - Linear feet

MGD - Million gallons per day

EA - Each

LS - Lump Sum

Table L-2a. Engineering Cost Estimates -- Basin Optimization Scenario 1				
Description	Quantity	Unit	Unit Cost	Total Cost
Construction Work				
Site Work				
N/A				
Pipelines and Facilities				
Recycled Water Pipelines				
CPP-2 to Existing RW Pipeline	1910	LF	$ 167	$ 318,970
CPP-3 to Existing RW Pipeline	710	LF	$ 167	$ 118,570
CPP-4 to Existing RW Pipeline	990	LF	$ 167	$ 165,330
Recycled Water Connections	3	EA	$ 7,500	$ 22,500
Subtotal 1				**$ 625,370**
Contingencies, Other Project Costs, and Total				
Estimating Contigency		30%		$ 187,611
Subtotal 2				**$ 812,981**
Construction Contigency		10%		$ 81,298
Subtotal 3				**$ 894,279**
Other Project Costs				
Engineering and Admin		10%		$ 89,428
Construction Management		10%		$ 89,428
Total				**$ 1,073,135**
Operations and Maintenance (Annual)				
Pipelines - general	3610	LF	$ 1.07	$ 3,878
Total				**$ 3,878**
Annualized Costs				
Annualized Capital Cost (30 years at 5.0 percent)				$ 69,809
Operations and Maintenance				$ 3,878
Total (Capital + O&M)				**$ 73,687**

Table L-2b. Engineering Cost Estimates -- Basin Optimization Scenario 2				
Description	Quantity	Unit	Unit Cost	Total Cost
Construction Work				
Site Work				
Site Preparation- Temporary Construction Fencing, Tree Protection, and Traffic Control	1.50	acre	$ 17,188	$ 25,781
Trenching, Shoring, and Bracing	1.50	acre	$ 12,500	$ 18,750
Earthwork- Rough Grading, Fine Grading, Imported Soil	1.50	acre	$ 103,750	$ 155,625
Selective Demolition, Clearing and Grubbing, Tree Removal and Trimming	1.50	acre	$ 20,500	$ 30,750
Loam and Seed/Baseball Field	65340	SF	$ 10	$ 653,400
Miscellaneous Signage and Striping	1.50	acre	$ 15,188	$ 22,781
Pipelines and Facilities				
Underground Recharge Gallery	1	LS	$9,300,000	$ 9,300,000
Underground Recharge Gallery to RW pipelines	4200	LF	$ 167	$ 701,400
Underground Recharge Connections	1	EA	$ 7,500	$ 7,500
Injection Well	1	EA	$ 2,000,000	$ 2,000,000
Injection Well Piping	540	LF	$ 167	$ 90,180
Subtotal 1				**$ 13,006,168**
Contingencies, Other Project Costs, and Total				
Estimating Contingency		30%		$ 3,901,850
Subtotal 2				$ 16,908,018
Construction Contingency		10%		$ 1,690,802
Subtotal 3				**$ 18,598,820**
Other Project Costs				
Engineering and Admin		10%		$ 1,859,882
Construction Management		10%		$ 1,859,882
Total				**$ 22,318,583**
Operations and Maintenance (Annual)				$ -
Pipelines - general	4740	LF	$ 1.07	$ 5,092
Misc. well maintenance	1	year/well	$ 35,292	$ 35,292
Underground Recharge Gallery Cleaning	1	$/year	$ 2,500.00	$ 2,500
Total				**$ 42,884**
Annualized Costs				
Annualized Capital Cost (30 years at 5.0 percent)				$ 1,451,856
Operations and Maintenance				$ 42,884
Total (Capital + O&M)				**$ 1,494,740**

Table L-2c. Engineering Cost Estimates -- Basin Optimization Scenario 3				
Description	Quantity	Unit	Unit Cost	Total Cost
Construction Work				
Site Work				
Site Preparation- Temporary Construction Fencing, Tree Protection, and Traffic Control	4.20	acre	$ 17,188	$ 72,188
Trenching, Shoring, and Bracing	4.20	acre	$ 12,500	$ 52,500
Earthwork- Rough Grading, Fine Grading, Imported Soil	4.20	acre	$ 103,750	$ 435,750
Selective Demolition, Clearing and Grubbing, Tree Removal and Trimming	4.20	acre	$ 20,500	$ 86,100
Loam and Seed/Baseball Field	182952	SF	$ 10	$ 1,829,520
Miscellaneous Signage and Striping	4.20	acre	$ 15,188	$ 63,788
Pipelines and Facilities				
Underground Recharge Gallery	1	LS	$21,000,000	$ 21,000,000
Underground Recharge Gallery to RW Pipelines	1,300	LF	$ 167	$ 217,100
Recycled Water Connections	15	EA	$ 7,500	$ 112,500
Injection Wells	7	EA	$ 2,000,000	$ 14,000,000
Injection Wells Piping - 8"	9,500	LF	$ 182	$ 1,729,000
Production Wells	5	EA	$ 2,000,000	$ 10,000,000
Production Wells Piping - 6"	24,000	LF	$ 167	$ 4,008,000
RO Plant and Wasteline	3.8	MGD	$ 10,212,403	$ 38,938,901
Pipelines from RO Plant	6,000	LF	$ 167	$ 1,002,000
Subtotal				**$ 93,547,346**
Contingencies, Other Project Costs, and Total				
Estimating Contigency		30%		$ 28,064,204
Subtotal 2				**$ 121,611,550**
Construction Contigency		10%		$ 12,161,155
Subtotal 3				**$ 133,772,705**
Other Project Costs				
Engineering and Admin		10%		$ 13,377,271
Construction Management		10%		$ 13,377,271
Total				**$ 160,527,246**
Operations and Maintenance (Annual)				
Pipelines - general	40,800	LF	$ 1.07	$ 43,829
Misc. well maintenance	12	year/well	$ 35,292	$ 423,507
Underground Recharge Gallery Cleaning	1	$/year	$ 2,500	$ 2,500
RO Plant	1	LS	$ 2,143	$ 2,143
Total				**$ 471,979**
Annualized Costs				
Annualized Capital Cost (30 years at 5.0 percent)				$ 10,442,528
Operations and Maintenance				$ 471,979
Total (Capital + O&M)				**$ 10,914,506**

Table L-3a. Total Water Supplies -- Aggregate of All Agencies for Basin Optimization Scenario 1

	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Total
2021	1,345	11,416	3,300	945	0	0	1,950	22,011	5,424	46,392
2022	1,332	11,323	3,925	1,190	0	0	1,950	21,371	5,389	46,480
2023	1,318	11,231	3,925	1,434	0	0	1,950	21,356	5,355	46,568
2024	1,305	11,138	3,925	1,678	0	0	1,950	21,341	5,320	46,657
2025	1,291	11,045	3,925	1,922	2,500	2,000	1,950	16,826	5,286	46,745
2026	1,291	11,062	3,925	1,899	2,500	2,000	1,950	16,819	5,255	46,701
2027	1,291	11,079	3,925	1,432	2,500	2,000	1,950	16,812	5,667	46,657
2028	1,291	11,097	3,925	1,401	2,500	2,000	1,950	16,806	5,644	46,613
2029	1,291	11,114	3,925	1,391	2,500	2,000	1,950	16,799	5,600	46,570
2030	1,291	11,131	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,526
2031	1,291	11,148	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,543
2032	1,291	11,166	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,561
2033	1,291	11,183	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,578
2034	1,291	11,201	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,596
2035	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2036	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2037	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2038	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2039	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2040	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2041	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2042	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2043	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2044	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2045	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2046	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2047	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2048	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2049	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2050	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2051	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2052	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2053	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2054	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2055	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2056	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2057	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2058	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2059	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2060	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2061	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2062	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2063	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2064	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2065	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2066	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2067	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2068	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2069	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2070	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2071	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613
2072	1,291	11,218	3,925	1,376	2,500	2,000	1,950	16,792	5,561	46,613

Table L-3b. Total Water Supplies -- Aggregate of All Agencies for Basin Optimization Scenario 2

	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Total
2021	1,345	11,416	3,300	945	0	0	1,950	22,011	5,424	46,392
2022	1,332	11,323	3,925	1,190	0	0	1,950	21,371	5,389	46,480
2023	1,318	11,231	3,925	1,434	0	0	1,950	21,356	5,355	46,568
2024	1,305	11,138	3,925	1,678	0	0	1,950	21,341	5,320	46,657
2025	1,291	11,045	3,925	1,922	2,500	2,000	1,950	16,826	5,286	46,745
2026	1,291	11,062	3,925	1,899	2,500	2,000	1,950	16,819	5,255	46,701
2027	1,291	11,079	3,925	1,875	2,500	2,000	1,950	16,812	5,224	46,657
2028	1,291	11,097	3,925	1,852	2,500	2,000	1,950	16,806	5,193	46,613
2029	1,291	11,114	3,925	1,829	2,500	2,000	1,950	16,799	5,162	46,570
2030	1,291	11,131	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,526
2031	1,291	11,148	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,543
2032	1,291	11,166	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,561
2033	1,291	11,183	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,578
2034	1,291	11,201	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,596
2035	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2036	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2037	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2038	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2039	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2040	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2041	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2042	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2043	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2044	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2045	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2046	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2047	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2048	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2049	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2050	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2051	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2052	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2053	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2054	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2055	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2056	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2057	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2058	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2059	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2060	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2061	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2062	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2063	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2064	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2065	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2066	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2067	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2068	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2069	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2070	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2071	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613
2071	1,291	11,218	3,925	1,806	2,500	2,000	1,950	16,792	5,131	46,613

Table L-3c. Total Water Supplies -- Aggregate of All Agencies for Basin Optimization Scenario 3

	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	New Spadra Supply Scenario 3	Total
2021	1,345	11,416	3,300	945	0	0	1,950	22,011	5,424	0	46,392
2022	1,332	11,323	3,925	1,190	0	0	1,950	21,371	5,389	0	46,480
2023	1,318	11,231	3,925	1,434	0	0	1,950	21,356	5,355	0	46,568
2024	1,305	11,138	3,925	1,678	0	0	1,950	21,341	5,320	0	46,657
2025	1,291	11,045	3,925	1,922	2,500	2,000	1,950	16,826	5,286	0	46,745
2026	1,291	11,062	3,925	1,899	2,500	2,000	1,950	16,819	5,255	0	46,701
2027	1,291	11,079	3,925	1,875	2,500	2,000	1,950	16,812	5,224	0	46,657
2028	1,291	11,097	3,925	1,852	2,500	2,000	1,950	16,806	5,193	0	46,613
2029	1,291	11,114	3,925	1,829	2,500	2,000	1,950	16,799	5,162	0	46,570
2030	1,291	11,131	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,526
2031	1,291	11,148	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,543
2032	1,291	11,166	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,561
2033	1,291	11,183	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,578
2034	1,291	11,201	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,596
2035	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2036	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2037	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2038	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2039	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2040	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2041	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2042	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2043	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2044	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2045	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2046	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2047	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2048	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2049	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2050	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2051	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2052	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2053	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2054	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2055	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2056	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2057	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2058	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2059	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2060	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2061	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2062	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2063	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2064	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2065	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2066	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2067	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2068	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2069	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2070	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2071	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613
2072	1,291	11,218	3,925	1,806	2,500	2,000	1,950	13,792	5,131	3,000	46,613

Table L-4a. Melded Costs for Water Supplies -- Aggregate of All Agencies for Basin Optimization Scenario 1

	Total Annual Cost									Capital Costs - Scenario 1			Unit Cost								
Year	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Construction	O&M	Total	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Melded Total
2021	$87,451	$5,693,601	$1,079,140	$647,388	$0	$0	$1,464,587	$24,390,117	$1,481,785	$0	$0	$0	$65	$499	$327	$685			$751	$1,108	$273	$751
2022	$88,731	$5,788,502	$1,684,388	$724,477	$0	$0	$1,501,201	$24,516,515	$1,520,531	$0	$0	$0	$67	$511	$429	$609			$770	$1,147	$282	$771
2023	$90,021	$5,884,590	$1,727,435	$805,015	$0	$0	$1,538,731	$25,718,039	$1,560,288	$0	$0	$0	$68	$524	$440	$562			$789	$1,204	$291	$801
2024	$91,319	$5,981,864	$1,772,002	$970,666	$0	$0	$1,577,199	$26,981,886	$1,601,083	$0	$0	$0	$70	$537	$451	$579			$809	$1,264	$301	$835
2025	$92,626	$6,080,323	$1,814,729	$1,126,535	$2,000,661	$2,293,723	$1,616,629	$22,137,604	$1,642,943	$0	$0	$0	$72	$551	$462	$586	$800	$1,147	$829	$1,316	$311	$830
2026	$94,942	$6,242,037	$1,850,854	$1,145,165	$2,050,677	$2,351,066	$1,657,045	$22,550,763	$1,677,985	$0	$0	$0	$74	$564	$472	$603	$820	$1,176	$850	$1,341	$319	$848
2027	$97,316	$6,408,036	$1,890,237	$1,136,472	$2,101,944	$2,409,843	$1,698,471	$23,114,925	$1,802,171	$80,957	$4,497	$85,454	$75	$578	$482	$794	$841	$1,205	$871	$1,375	$318	$873
2028	$99,749	$6,578,433	$1,930,085	$1,154,369	$2,154,493	$2,470,089	$1,740,933	$23,661,850	$1,842,492	$80,957	$4,610	$85,567	$77	$593	$492	$824	$862	$1,235	$893	$1,408	$326	$895
2029	$102,242	$6,753,346	$1,972,384	$1,218,191	$2,208,355	$2,531,841	$1,784,456	$24,309,150	$1,879,365	$80,957	$4,725	$85,682	$79	$608	$503	$876	$883	$1,266	$915	$1,447	$336	$920
2030	$104,798	$6,932,892	$2,016,873	$1,274,517	$2,263,564	$2,595,137	$1,829,068	$25,039,912	$1,917,875	$80,957	$4,843	$85,800	$81	$623	$514	$926	$905	$1,298	$938	$1,491	$345	$947
2031	$107,418	$7,117,323	$2,066,507	$1,306,380	$2,320,153	$2,660,016	$1,874,795	$26,040,203	$1,965,822	$80,957	$4,964	$85,921	$83	$638	$526	$949	$928	$1,330	$961	$1,551	$354	$979
2032	$110,104	$7,306,642	$2,117,632	$1,339,040	$2,378,157	$2,726,516	$1,921,664	$27,080,474	$2,014,967	$80,957	$5,088	$86,045	$85	$654	$540	$973	$951	$1,363	$985	$1,613	$362	$1,011
2033	$112,856	$7,500,979	$2,170,297	$1,372,516	$2,437,611	$2,794,679	$1,969,706	$28,162,322	$2,065,341	$80,957	$5,215	$86,172	$87	$671	$553	$997	$975	$1,397	$1,010	$1,677	$371	$1,045
2034	$115,678	$7,700,466	$2,224,549	$1,406,829	$2,498,551	$2,864,546	$2,018,949	$29,287,409	$2,116,975	$80,957	$5,346	$86,303	$90	$688	$567	$1,022	$999	$1,432	$1,035	$1,744	$381	$1,080
2035	$118,570	$7,905,240	$2,280,440	$1,441,999	$2,561,015	$2,936,160	$2,069,422	$30,457,465	$2,169,899	$80,957	$5,480	$86,437	$92	$705	$581	$1,048	$1,024	$1,468	$1,061	$1,814	$390	$1,116
2036	$121,534	$8,102,871	$2,338,022	$1,478,049	$2,625,040	$3,009,564	$2,121,158	$31,674,287	$2,224,147	$80,957	$5,616	$86,573	$94	$722	$596	$1,074	$1,050	$1,505	$1,088	$1,886	$400	$1,154
2037	$124,572	$8,305,442	$2,397,348	$1,515,001	$2,690,666	$3,084,803	$2,174,187	$32,939,745	$2,279,750	$80,957	$5,757	$86,714	$96	$740	$611	$1,101	$1,076	$1,542	$1,115	$1,962	$410	$1,193
2038	$127,687	$8,513,079	$2,458,474	$1,552,876	$2,757,933	$3,161,923	$2,228,542	$34,255,784	$2,336,744	$80,957	$5,901	$86,858	$99	$759	$626	$1,129	$1,103	$1,581	$1,143	$2,040	$420	$1,233
2039	$130,879	$8,725,906	$2,521,459	$1,591,697	$2,826,881	$3,240,971	$2,284,255	$35,624,425	$2,395,163	$80,957	$6,048	$87,005	$101	$778	$642	$1,157	$1,131	$1,620	$1,171	$2,122	$431	$1,275
2040	$134,151	$8,944,053	$2,586,361	$1,631,490	$2,897,553	$3,321,995	$2,341,361	$37,047,772	$2,455,042	$80,957	$6,200	$87,157	$104	$797	$659	$1,186	$1,159	$1,661	$1,201	$2,206	$441	$1,318
2041	$137,504	$9,167,654	$2,653,243	$1,672,277	$2,969,992	$3,405,045	$2,399,896	$38,528,013	$2,516,418	$80,957	$6,355	$87,312	$107	$817	$676	$1,215	$1,188	$1,703	$1,231	$2,294	$453	$1,363
2042	$140,942	$9,396,846	$2,722,168	$1,714,084	$3,044,242	$3,490,171	$2,459,893	$40,067,421	$2,579,328	$80,957	$6,513	$87,470	$109	$838	$694	$1,246	$1,218	$1,745	$1,261	$2,386	$464	$1,410
2043	$144,466	$9,631,767	$2,793,203	$1,756,936	$3,120,348	$3,577,425	$2,521,390	$41,668,363	$2,643,811	$80,957	$6,676	$87,633	$112	$859	$712	$1,277	$1,248	$1,789	$1,293	$2,481	$475	$1,458
2044	$148,077	$9,872,561	$2,866,414	$1,800,860	$3,198,357	$3,666,861	$2,584,425	$43,333,298	$2,709,907	$80,957	$6,843	$87,800	$115	$880	$730	$1,309	$1,279	$1,833	$1,325	$2,581	$487	$1,507
2045	$151,779	$10,119,375	$2,941,874	$1,845,881	$3,278,316	$3,758,533	$2,649,036	$45,064,786	$2,777,654	$80,957	$7,014	$87,971	$118	$902	$750	$1,341	$1,311	$1,879	$1,358	$2,684	$499	$1,559
2046	$155,574	$10,372,360	$3,019,654	$1,892,028	$3,360,274	$3,852,496	$2,715,261	$46,865,488	$2,847,096	$80,957	$7,190	$88,147	$121	$925	$769	$1,375	$1,344	$1,926	$1,392	$2,791	$512	$1,613
2047	$159,463	$10,631,669	$3,099,830	$1,939,329	$3,444,281	$3,948,808	$2,783,143	$48,738,170	$2,918,273	$80,957	$7,369	$88,326	$124	$948	$790	$1,409	$1,378	$1,974	$1,427	$2,902	$525	$1,668
2048	$163,450	$10,897,460	$3,182,481	$1,987,812	$3,530,388	$4,047,528	$2,852,722	$50,685,711	$2,991,230	$80,957	$7,554	$88,511	$127	$971	$811	$1,445	$1,412	$2,024	$1,463	$3,018	$538	$1,725
2049	$167,536	$11,169,897	$3,267,686	$2,037,507	$3,618,647	$4,148,717	$2,924,040	$52,711,104	$3,066,011	$80,957	$7,742	$88,699	$130	$996	$833	$1,481	$1,447	$2,074	$1,500	$3,139	$551	$1,785
2050	$171,724	$11,449,144	$3,355,529	$2,088,445	$3,709,113	$4,252,435	$2,997,141	$54,817,462	$3,142,661	$80,957	$7,936	$88,893	$133	$1,021	$855	$1,518	$1,484	$2,126	$1,537	$3,264	$565	$1,847
2051	$176,017	$11,735,373	$3,446,097	$2,140,656	$3,801,841	$4,358,745	$3,072,069	$57,008,022	$3,221,227	$80,957	$8,134	$89,091	$136	$1,046	$878	$1,556	$1,521	$2,179	$1,575	$3,395	$579	$1,910
2052	$180,418	$12,028,757	$3,539,478	$2,194,173	$3,896,887	$4,467,714	$3,148,871	$59,286,151	$3,301,758	$80,957	$8,338	$89,295	$140	$1,072	$902	$1,595	$1,559	$2,234	$1,615	$3,531	$594	$1,977
2053	$184,928	$12,329,476	$3,635,765	$2,249,027	$3,994,309	$4,579,407	$3,227,593	$61,655,351	$3,384,302	$80,957	$8,546	$89,503	$143	$1,099	$926	$1,634	$1,598	$2,290	$1,655	$3,672	$609	$2,045
2054	$189,551	$12,637,713	$3,735,054	$2,305,252	$4,094,167	$4,693,892	$3,308,282	$64,119,262	$3,468,910	$80,957	$8,760	$89,717	$147	$1,127	$952	$1,675	$1,638	$2,347	$1,697	$3,818	$624	$2,116
2055	$194,290	$12,953,656	$3,837,443	$2,362,884	$4,196,521	$4,811,239	$3,390,990	$66,681,672	$3,555,632	$80,957	$8,979	$89,936	$150	$1,155	$978	$1,717	$1,679	$2,406	$1,739	$3,971	$639	$2,190
2056	$199,148	$13,277,497	$3,943,035	$2,421,956	$4,301,434	$4,931,520	$3,475,764	$69,346,520	$3,644,523	$80,957	$9,203	$90,160	$154	$1,184	$1,005	$1,760	$1,721	$2,466	$1,782	$4,130	$655	$2,266
2057	$204,126	$13,609,435	$4,051,935	$2,482,505	$4,408,970	$5,054,808	$3,562,658	$72,117,900	$3,735,636	$0	$9,433	$9,433	$158	$1,213	$1,032	$1,804	$1,764	$2,527	$1,827	$4,295	$672	$2,344
2058	$209,229	$13,949,670	$4,164,252	$2,544,567	$4,519,195	$5,181,179	$3,651,725	$75,000,075	$3,829,027	$0	$9,669	$9,669	$162	$1,244	$1,061	$1,849	$1,808	$2,591	$1,873	$4,466	$689	$2,425
2059	$214,460	$14,298,412	$4,280,101	$2,608,182	$4,632,174	$5,310,708	$3,743,018	$77,997,472	$3,924,753	$0	$9,911	$9,911	$166	$1,275	$1,090	$1,895	$1,853	$2,655	$1,919	$4,645	$706	$2,510
2060	$219,822	$14,655,873	$4,399,597	$2,673,386	$4,747,979	$5,443,476	$3,836,593	$81,114,700	$4,022,872	$0	$10,159	$10,159	$170	$1,306	$1,121	$1,943	$1,899	$2,722	$1,967	$4,831	$723	$2,599
2061	$225,317	$15,022,269	$4,522,863	$2,740,221	$4,866,678	$5,579,563	$3,932,508	$84,356,551	$4,123,443	$0	$10,413	$10,413	$175	$1,339	$1,152	$1,991	$1,947	$2,790	$2,017	$5,024	$742	$2,690
2062	$230,950	$15,397,826	$4,650,025	$2,808,726	$4,988,345	$5,719,052	$4,030,821	$87,728,007	$4,226,530	$0	$10,673	$10,673	$179	$1,373	$1,185	$2,041	$1,995	$2,860	$2,067	$5,224	$760	$2,784
2063	$236,724	$15,782,772	$4,781,211	$2,878,944	$5,113,054	$5,862,028	$4,131,591	$91,234,252	$4,332,193	$0	$10,940	$10,940	$183	$1,407	$1,218	$2,092	$2,045	$2,931	$2,119	$5,433	$779	$2,883
2064	$242,642	$16,177,341	$4,916,556	$2,950,918	$5,240,880	$6,008,579	$4,234,881	$94,880,674	$4,440,498	$0	$11,213	$11,213	$188	$1,442	$1,253	$2,145	$2,096	$3,004	$2,172	$5,650	$799	$2,984
2065	$248,708	$16,581,775	$5,056,200	$3,024,691	$5,371,902	$6,158,793	$4,340,753	$98,672,880	$4,551,510	$0	$11,494	$11,494	$193	$1,478	$1,288	$2,198	$2,149	$3,079	$2,226	$5,876	$818	$3,090
2066	$254,926	$16,996,319	$5,200,286	$3,100,308	$5,506,200	$6,312,763	$4,449,272	$102,616,698	$4,665,298	$0	$11,781	$11,781	$197	$1,515	$1,325	$2,253	$2,202	$3,156	$2,282	$6,111	$839	$3,199
2067	$261,299	$17,421,227	$5,348,964	$3,177,816	$5,643,855	$6,470,582	$4,560,504	$106,718,191	$4,781,930	$0	$12,075	$12,075	$202	$1,553	$1,363	$2,309	$2,258	$3,235	$2,339	$6,355	$860	$3,312
2068	$267,831	$17,856,758	$5,502,388	$3,257,261	$5,784,951	$6,632,347	$4,674,517	$110,983,665	$4,901,479	$0	$12,377	$12,377	$207	$1,592	$1,402	$2,367	$2,314	$3,316	$2,397	$6,609	$881	$3,430
2069	$274,527	$18,303,176	$5,660,719	$3,338,693	$5,929,575	$6,798,155	$4,791,379	$115,419,677	$5,024,015	$0	$12,687	$12,687	$213	$1,632	$1,442	$2,426	$2,372	$3,399	$2,457	$6,873	$903	$3,552
2070	$281,390	$18,760,756	$5,824,120	$3,422,160	$6,077,814	$6,968,109	$4,911,164	$120,033,045	$5,149,616	$0	$13,004	$13,004	$218	$1,672	$1,484	$2,487	$2,431	$3,484	$2,519	$7,148	$926	$3,678
2071	$288,425	$19,229,775	$5,992,764	$3,507,714	$6,229,760	$7,142,312	$5,033,943	$124,830,863	$5,278,356	$0	$13,329	$13,329	$223	$1,714	$1,527	$2,549	$2,492	$3,571	$2,582	$7,434	$949	$3,809
2072	$295,636	$19,710,519	$6,166,828	$3,595,407	$6,385,504	$7,320,870	$5,159,792	$129,820,506	$5,410,315	$0	$13,662	$13,662	$229	$1,757	$1,571	$2,613	$2,554	$3,660	$2,646	$7,731	$973	$3,945

Table L-4b. Melded Costs for Water Supplies -- Aggregate of All Agencies for Basin Optimization Scenario 2

	Total Annual Cost									Capital Costs - Scenario 2				Unit Cost							
Year	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Construction	O&M	Recycled Water	Total	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Melded Total
2021	$87,451	$5,693,601	$1,079,140	$647,388	$0	$0	$1,464,587	$24,390,117	$1,481,785	$0	$0	$0	$0	$65	$499	$327	$685			$751	$1,108	$273	$751
2022	$88,731	$5,788,502	$1,684,388	$724,477	$0	$0	$1,501,201	$24,516,515	$1,520,531	$0	$0	$0	$0	$67	$511	$429	$609			$770	$1,147	$282	$771
2023	$90,021	$5,884,590	$1,727,435	$805,015	$0	$0	$1,538,731	$25,718,039	$1,560,288	$0	$0	$0	$0	$68	$524	$440	$562			$789	$1,204	$291	$801
2024	$91,319	$5,981,864	$1,772,002	$970,666	$0	$0	$1,577,199	$26,981,886	$1,601,083	$0	$0	$0	$0	$70	$537	$451	$579			$809	$1,264	$301	$835
2025	$92,626	$6,080,323	$1,814,729	$1,126,535	$2,000,661	$2,293,723	$1,616,629	$22,137,604	$1,642,943	$0	$0	$0	$0	$72	$551	$462	$586	$800	$1,147	$829	$1,316	$311	$830
2026	$94,942	$6,242,037	$1,850,854	$1,145,165	$2,050,677	$2,351,066	$1,657,045	$22,550,763	$1,677,985	$0	$0	$0	$0	$74	$564	$472	$603	$820	$1,176	$850	$1,341	$319	$848
2027	$97,316	$6,408,036	$1,890,237	$1,164,023	$2,101,944	$2,409,843	$1,698,471	$23,114,925	$1,813,463	$1,683,708	$49,732	$0	$1,733,440	$75	$578	$482	$621	$841	$1,205	$871	$1,375	$347	$909
2028	$99,749	$6,578,433	$1,930,085	$1,183,108	$2,154,493	$2,470,089	$1,740,933	$23,661,850	$1,852,463	$1,683,708	$50,976	$0	$1,734,683	$77	$593	$492	$639	$862	$1,235	$893	$1,408	$357	$931
2029	$102,242	$6,753,346	$1,972,384	$1,246,809	$2,208,355	$2,531,841	$1,784,456	$24,309,150	$1,892,279	$1,683,708	$52,250	$0	$1,735,958	$79	$608	$503	$682	$883	$1,266	$915	$1,447	$367	$956
2030	$104,798	$6,932,892	$2,016,873	$1,303,285	$2,263,564	$2,595,137	$1,829,068	$25,039,912	$1,932,929	$1,683,708	$53,556	$0	$1,737,264	$81	$623	$514	$722	$905	$1,298	$938	$1,491	$377	$983
2031	$107,418	$7,117,323	$2,066,507	$1,335,867	$2,320,153	$2,660,016	$1,874,795	$26,040,203	$1,981,252	$1,683,708	$54,895	$0	$1,738,603	$83	$638	$526	$740	$928	$1,330	$961	$1,551	$386	$1,015
2032	$110,104	$7,306,642	$2,117,632	$1,369,263	$2,378,157	$2,726,516	$1,921,664	$27,080,474	$2,030,783	$1,683,708	$56,268	$0	$1,739,975	$85	$654	$540	$758	$951	$1,363	$985	$1,613	$396	$1,048
2033	$112,856	$7,500,979	$2,170,297	$1,403,495	$2,437,611	$2,794,679	$1,969,706	$28,162,322	$2,081,553	$1,683,708	$57,674	$0	$1,741,382	$87	$671	$553	$777	$975	$1,397	$1,010	$1,677	$406	$1,082
2034	$115,678	$7,700,466	$2,224,549	$1,438,582	$2,498,551	$2,864,546	$2,018,949	$29,287,409	$2,133,592	$1,683,708	$59,116	$0	$1,742,824	$90	$688	$567	$797	$999	$1,432	$1,035	$1,744	$416	$1,117
2035	$118,570	$7,905,240	$2,280,440	$1,474,547	$2,561,015	$2,936,160	$2,069,422	$30,457,465	$2,186,932	$1,683,708	$60,594	$0	$1,744,302	$92	$705	$581	$817	$1,024	$1,468	$1,061	$1,814	$426	$1,153
2036	$121,534	$8,102,871	$2,338,022	$1,511,411	$2,625,040	$3,009,564	$2,121,158	$31,674,287	$2,241,605	$1,683,708	$62,109	$0	$1,745,817	$94	$722	$596	$837	$1,050	$1,505	$1,088	$1,886	$437	$1,190
2037	$124,572	$8,305,442	$2,397,348	$1,549,196	$2,690,666	$3,084,803	$2,174,187	$32,939,745	$2,297,645	$1,683,708	$63,662	$0	$1,747,369	$96	$740	$611	$858	$1,076	$1,542	$1,115	$1,962	$448	$1,230
2038	$127,687	$8,513,079	$2,458,474	$1,587,926	$2,757,933	$3,161,923	$2,228,542	$34,255,784	$2,355,086	$1,683,708	$65,253	$0	$1,748,961	$99	$759	$626	$879	$1,103	$1,581	$1,143	$2,040	$459	$1,270
2039	$130,879	$8,725,906	$2,521,459	$1,627,624	$2,826,881	$3,240,971	$2,284,255	$35,624,425	$2,413,963	$1,683,708	$66,885	$0	$1,750,592	$101	$778	$642	$901	$1,131	$1,620	$1,171	$2,122	$470	$1,312
2040	$134,151	$8,944,053	$2,586,361	$1,668,315	$2,897,553	$3,321,995	$2,341,361	$37,047,772	$2,474,312	$1,683,708	$68,557	$0	$1,752,264	$104	$797	$659	$924	$1,159	$1,661	$1,201	$2,206	$482	$1,355
2041	$137,504	$9,167,654	$2,653,243	$1,710,022	$2,969,992	$3,405,045	$2,399,896	$38,528,013	$2,536,170	$1,683,708	$70,271	$0	$1,753,978	$107	$817	$676	$947	$1,188	$1,703	$1,231	$2,294	$494	$1,400
2042	$140,942	$9,396,846	$2,722,168	$1,752,773	$3,044,242	$3,490,171	$2,459,893	$40,067,421	$2,599,575	$1,683,708	$72,027	$0	$1,755,735	$109	$838	$694	$971	$1,218	$1,745	$1,261	$2,386	$507	$1,447
2043	$144,466	$9,631,767	$2,793,203	$1,796,592	$3,120,348	$3,577,425	$2,521,390	$41,668,363	$2,664,564	$1,683,708	$73,828	$0	$1,757,536	$112	$859	$712	$995	$1,248	$1,789	$1,293	$2,481	$519	$1,495
2044	$148,077	$9,872,561	$2,866,414	$1,841,507	$3,198,357	$3,666,861	$2,584,425	$43,333,298	$2,731,178	$1,683,708	$75,674	$0	$1,759,382	$115	$880	$730	$1,020	$1,279	$1,833	$1,325	$2,581	$532	$1,545
2045	$151,779	$10,119,375	$2,941,874	$1,887,545	$3,278,316	$3,758,533	$2,649,036	$45,064,786	$2,799,457	$1,683,708	$77,566	$0	$1,761,273	$118	$902	$750	$1,045	$1,311	$1,879	$1,358	$2,684	$546	$1,596
2046	$155,574	$10,372,360	$3,019,654	$1,934,733	$3,360,274	$3,852,496	$2,715,261	$46,865,488	$2,869,444	$1,683,708	$79,505	$0	$1,763,213	$121	$925	$769	$1,071	$1,344	$1,926	$1,392	$2,791	$559	$1,650
2047	$159,463	$10,631,669	$3,099,830	$1,983,102	$3,444,281	$3,948,808	$2,783,143	$48,738,170	$2,941,180	$1,683,708	$81,492	$0	$1,765,200	$124	$948	$790	$1,098	$1,378	$1,974	$1,427	$2,902	$573	$1,705
2048	$163,450	$10,897,460	$3,182,481	$2,032,679	$3,530,388	$4,047,528	$2,852,722	$50,685,711	$3,014,709	$1,683,708	$83,530	$0	$1,767,237	$127	$971	$811	$1,126	$1,412	$2,024	$1,463	$3,018	$588	$1,763
2049	$167,536	$11,169,897	$3,267,686	$2,083,496	$3,618,647	$4,148,717	$2,924,040	$52,711,104	$3,090,077	$1,683,708	$85,618	$0	$1,769,326	$130	$996	$833	$1,154	$1,447	$2,074	$1,500	$3,139	$602	$1,822
2050	$171,724	$11,449,144	$3,355,529	$2,135,584	$3,709,113	$4,252,435	$2,997,141	$54,817,462	$3,167,329	$1,683,708	$87,758	$0	$1,771,466	$133	$1,021	$855	$1,183	$1,484	$2,126	$1,537	$3,264	$617	$1,884
2051	$176,017	$11,735,373	$3,446,097	$2,188,973	$3,801,841	$4,358,745	$3,072,069	$57,008,022	$3,246,512	$1,683,708	$89,952	$0	$1,773,660	$136	$1,046	$878	$1,212	$1,521	$2,179	$1,575	$3,395	$633	$1,948
2052	$180,418	$12,028,757	$3,539,478	$2,243,698	$3,896,887	$4,467,714	$3,148,871	$59,286,151	$3,327,675	$1,683,708	$92,201	$0	$1,775,909	$140	$1,072	$902	$1,242	$1,559	$2,234	$1,615	$3,531	$649	$2,014
2053	$184,928	$12,329,476	$3,635,765	$2,299,790	$3,994,309	$4,579,407	$3,227,593	$61,655,351	$3,410,867	$1,683,708	$94,506	$0	$1,778,214	$143	$1,099	$926	$1,273	$1,598	$2,290	$1,655	$3,672	$665	$2,083
2054	$189,551	$12,637,713	$3,735,054	$2,357,285	$4,094,167	$4,693,892	$3,308,282	$64,119,262	$3,496,139	$1,683,708	$96,869	$0	$1,780,577	$147	$1,127	$952	$1,305	$1,638	$2,347	$1,697	$3,818	$681	$2,154
2055	$194,290	$12,953,656	$3,837,443	$2,416,217	$4,196,521	$4,811,239	$3,390,990	$66,681,672	$3,583,542	$1,683,708	$99,291	$0	$1,782,998	$150	$1,155	$978	$1,338	$1,679	$2,406	$1,739	$3,971	$698	$2,228
2056	$199,148	$13,277,497	$3,943,035	$2,476,622	$4,301,434	$4,931,520	$3,475,764	$69,346,520	$3,673,131	$1,683,708	$101,773	$0	$1,785,481	$154	$1,184	$1,005	$1,371	$1,721	$2,466	$1,782	$4,130	$716	$2,304
2057	$204,126	$13,609,435	$4,051,935	$2,538,538	$4,408,970	$5,054,808	$3,562,658	$72,117,900	$3,764,959	$0	$104,317	$0	$104,317	$158	$1,213	$1,032	$1,406	$1,764	$2,527	$1,827	$4,295	$734	$2,347
2058	$209,229	$13,949,670	$4,164,252	$2,602,001	$4,519,195	$5,181,179	$3,651,725	$75,000,075	$3,859,083	$0	$106,925	$0	$106,925	$162	$1,244	$1,061	$1,441	$1,808	$2,591	$1,873	$4,466	$752	$2,429
2059	$214,460	$14,298,412	$4,280,101	$2,667,051	$4,632,174	$5,310,708	$3,743,018	$77,997,472	$3,955,560	$0	$109,598	$0	$109,598	$166	$1,275	$1,090	$1,477	$1,853	$2,655	$1,919	$4,645	$771	$2,515
2060	$219,822	$14,655,873	$4,399,597	$2,733,728	$4,747,979	$5,443,476	$3,836,593	$81,114,700	$4,054,449	$0	$112,338	$0	$112,338	$170	$1,306	$1,121	$1,514	$1,899	$2,722	$1,967	$4,831	$790	$2,603
2061	$225,317	$15,022,269	$4,522,863	$2,802,071	$4,866,678	$5,579,563	$3,932,508	$84,356,551	$4,155,810	$0	$115,147	$0	$115,147	$175	$1,339	$1,152	$1,552	$1,947	$2,790	$2,017	$5,024	$810	$2,694
2062	$230,950	$15,397,826	$4,650,025	$2,872,123	$4,988,345	$5,719,052	$4,030,821	$87,728,007	$4,259,706	$0	$118,025	$0	$118,025	$179	$1,373	$1,185	$1,590	$1,995	$2,860	$2,067	$5,224	$830	$2,789
2063	$236,724	$15,782,772	$4,781,211	$2,943,926	$5,113,054	$5,862,028	$4,131,591	$91,234,252	$4,366,198	$0	$120,976	$0	$120,976	$183	$1,407	$1,218	$1,630	$2,045	$2,931	$2,119	$5,433	$851	$2,887
2064	$242,642	$16,177,341	$4,916,556	$3,017,524	$5,240,880	$6,008,579	$4,234,881	$94,880,674	$4,475,353	$0	$124,000	$0	$124,000	$188	$1,442	$1,253	$1,671	$2,096	$3,004	$2,172	$5,650	$872	$2,989
2065	$248,708	$16,581,775	$5,056,200	$3,092,962	$5,371,902	$6,158,793	$4,340,753	$98,672,880	$4,587,237	$0	$127,100	$0	$127,100	$193	$1,478	$1,288	$1,713	$2,149	$3,079	$2,226	$5,876	$894	$3,094
2066	$254,926	$16,996,319	$5,200,286	$3,170,286	$5,506,200	$6,312,763	$4,449,272	$102,616,698	$4,701,918	$0	$130,278	$0	$130,278	$197	$1,515	$1,325	$1,756	$2,202	$3,156	$2,282	$6,111	$916	$3,204
2067	$261,299	$17,421,227	$5,348,964	$3,249,543	$5,643,855	$6,470,582	$4,560,504	$106,718,191	$4,819,466	$0	$133,535	$0	$133,535	$202	$1,553	$1,363	$1,799	$2,258	$3,235	$2,339	$6,355	$939	$3,317
2068	$267,831	$17,856,758	$5,502,388	$3,330,782	$5,784,951	$6,632,347	$4,674,517	$110,983,665	$4,939,953	$0	$136,873	$0	$136,873	$207	$1,592	$1,402	$1,844	$2,314	$3,316	$2,397	$6,609	$963	$3,435
2069	$274,527	$18,303,176	$5,660,719	$3,414,051	$5,929,575	$6,798,155	$4,791,379	$115,419,677	$5,063,451	$0	$140,295	$0	$140,295	$213	$1,632	$1,442	$1,890	$2,372	$3,399	$2,457	$6,873	$987	$3,557
2070	$281,390	$18,760,756	$5,824,120	$3,499,403	$6,077,814	$6,968,109	$4,911,164	$120,033,045	$5,190,038	$0	$143,802	$0	$143,802	$218	$1,672	$1,484	$1,938	$2,431	$3,484	$2,519	$7,148	$1,012	$3,683
2071	$288,425	$19,229,775	$5,992,764	$3,586,888	$6,229,760	$7,142,312	$5,033,943	$124,830,863	$5,319,789	$0	$147,397	$0	$147,397	$223	$1,714	$1,527	$1,986	$2,492	$3,571	$2,582	$7,434	$1,037	$3,814
2072	$295,636	$19,710,519	$6,166,828	$3,676,560	$6,385,504	$7,320,870	$5,159,792	$129,820,506	$5,452,783	$0	$151,082	$0	$151,082	$229	$1,757	$1,571	$2,036	$2,554	$3,660	$2,646	$7,731	$1,063	$3,950

Table L-4c. Melded Costs for Water Supplies -- Aggregate of All Agencies for Basin Optimization Scenario 3

	Total Annual Cost									Capital Costs - Scenario 3a				Unit Cost								
Year	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Construction	O&M	Recycled Water	Total	Puente Basin	Chino Basin	Six Basins	Spadra Basin	Main San Gabriel Basin	Central Basin	San Antonio Creek Water	Imported Water	Recycled Water	Melded Total
2021	$87,451	$5,693,601	$1,079,140	$647,388	$0	$0	$1,464,587	$24,390,117	$1,481,785	$0	$0		$0	$65	$499	$327	$685			$751	$1,108	$273	$751
2022	$88,731	$5,788,502	$1,684,388	$724,477	$0	$0	$1,501,201	$24,516,515	$1,520,531	$0	$0		$0	$67	$511	$429	$609			$770	$1,147	$282	$771
2023	$90,021	$5,884,590	$1,727,435	$805,015	$0	$0	$1,538,731	$25,718,039	$1,560,288	$0	$0		$0	$68	$524	$440	$562			$789	$1,204	$291	$801
2024	$91,319	$5,981,864	$1,772,002	$970,666	$0	$0	$1,577,199	$26,981,886	$1,601,083	$0	$0		$0	$70	$537	$451	$579			$809	$1,264	$301	$835
2025	$92,626	$6,080,323	$1,814,729	$1,126,535	$2,000,661	$2,293,723	$1,616,629	$22,137,604	$1,642,943	$0	$0		$0	$72	$551	$462	$586	$800	$1,147	$829	$1,316	$311	$830
2026	$94,942	$6,242,037	$1,850,854	$1,145,165	$2,050,677	$2,351,066	$1,657,045	$22,550,763	$1,677,985	$0	$0		$0	$74	$564	$472	$603	$820	$1,176	$850	$1,341	$319	$848
2027	$97,316	$6,408,036	$1,890,237	$1,164,023	$2,101,944	$2,409,843	$1,698,471	$23,114,925	$1,713,752	$0	$0		$0	$75	$578	$482	$621	$841	$1,205	$871	$1,375	$328	$870
2028	$99,749	$6,578,433	$1,930,085	$1,183,108	$2,154,493	$2,470,089	$1,740,933	$23,661,850	$1,750,260	$0	$0		$0	$77	$593	$492	$639	$862	$1,235	$893	$1,408	$337	$892
2029	$102,242	$6,753,346	$1,972,384	$1,246,809	$2,208,355	$2,531,841	$1,784,456	$24,309,150	$1,787,521	$0	$0		$0	$79	$608	$503	$682	$883	$1,266	$915	$1,447	$346	$917
2030	$104,798	$6,932,892	$2,016,873	$1,582,236	$2,263,564	$2,595,137	$1,829,068	$20,554,562	$2,577,192	$13,041,286	$589,437		$13,630,723	$81	$623	$514	$876	$905	$1,298	$938	$1,490	$502	$1,163
2031	$107,418	$7,117,323	$2,066,507	$1,621,792	$2,320,153	$2,660,016	$1,874,795	$21,375,849	$2,641,622	$13,041,286	$604,173		$13,645,459	$83	$638	$526	$898	$928	$1,330	$961	$1,550	$515	$1,191
2032	$110,104	$7,306,642	$2,117,632	$1,662,337	$2,378,157	$2,726,516	$1,921,664	$22,229,966	$2,707,663	$13,041,286	$619,277		$13,660,563	$85	$654	$540	$921	$951	$1,363	$985	$1,612	$528	$1,220
2033	$112,856	$7,500,979	$2,170,297	$1,703,895	$2,437,611	$2,794,679	$1,969,706	$23,118,225	$2,775,354	$13,041,286	$634,759		$13,676,045	$87	$671	$553	$944	$975	$1,397	$1,010	$1,676	$541	$1,251
2034	$115,678	$7,700,466	$2,224,549	$1,746,493	$2,498,551	$2,864,546	$2,018,949	$24,041,990	$2,844,738	$13,041,286	$650,628		$13,691,914	$90	$688	$567	$967	$999	$1,432	$1,035	$1,743	$554	$1,282
2035	$118,570	$7,905,240	$2,280,440	$1,790,155	$2,561,015	$2,936,160	$2,069,422	$25,002,682	$2,915,857	$13,041,286	$666,893		$13,708,180	$92	$705	$581	$991	$1,024	$1,468	$1,061	$1,813	$568	$1,315
2036	$121,534	$8,102,871	$2,338,022	$1,834,909	$2,625,040	$3,009,564	$2,121,158	$26,001,777	$2,988,753	$13,041,286	$683,566		$13,724,852	$94	$722	$596	$1,016	$1,050	$1,505	$1,088	$1,885	$582	$1,349
2037	$124,572	$8,305,442	$2,397,348	$1,880,782	$2,690,666	$3,084,803	$2,174,187	$27,040,811	$3,063,472	$13,041,286	$700,655		$13,741,941	$96	$740	$611	$1,041	$1,076	$1,542	$1,115	$1,961	$597	$1,384
2038	$127,687	$8,513,079	$2,458,474	$1,927,801	$2,757,933	$3,161,923	$2,228,542	$28,121,380	$3,140,059	$13,041,286	$718,171		$13,759,458	$99	$759	$626	$1,068	$1,103	$1,581	$1,143	$2,039	$612	$1,420
2039	$130,879	$8,725,906	$2,521,459	$1,975,996	$2,826,881	$3,240,971	$2,284,255	$29,245,145	$3,218,560	$13,041,286	$736,126		$13,777,412	$101	$778	$642	$1,094	$1,131	$1,620	$1,171	$2,120	$627	$1,458
2040	$134,151	$8,944,053	$2,586,361	$2,025,396	$2,897,553	$3,321,995	$2,341,361	$30,413,833	$3,299,024	$13,041,286	$754,529		$13,795,815	$104	$797	$659	$1,122	$1,159	$1,661	$1,201	$2,205	$643	$1,497
2041	$137,504	$9,167,654	$2,653,243	$2,076,031	$2,969,992	$3,405,045	$2,399,896	$31,629,241	$3,381,500	$13,041,286	$773,392		$13,814,678	$107	$817	$676	$1,150	$1,188	$1,703	$1,231	$2,293	$659	$1,537
2042	$140,942	$9,396,846	$2,722,168	$2,127,932	$3,044,242	$3,490,171	$2,459,893	$32,893,237	$3,466,037	$13,041,286	$792,727		$13,834,013	$109	$838	$694	$1,178	$1,218	$1,745	$1,261	$2,385	$676	$1,578
2043	$144,466	$9,631,767	$2,793,203	$2,181,130	$3,120,348	$3,577,425	$2,521,390	$34,207,763	$3,552,688	$13,041,286	$812,545		$13,853,831	$112	$859	$712	$1,208	$1,248	$1,789	$1,293	$2,480	$692	$1,622
2044	$148,077	$9,872,561	$2,866,414	$2,235,659	$3,198,357	$3,666,861	$2,584,425	$35,574,840	$3,641,505	$13,041,286	$832,859		$13,874,145	$115	$880	$730	$1,238	$1,279	$1,833	$1,325	$2,579	$710	$1,666
2045	$151,779	$10,119,375	$2,941,874	$2,291,550	$3,278,316	$3,758,533	$2,649,036	$36,996,569	$3,732,543	$13,041,286	$853,680		$13,894,966	$118	$902	$750	$1,269	$1,311	$1,879	$1,358	$2,682	$727	$1,712
2046	$155,574	$10,372,360	$3,019,654	$2,348,839	$3,360,274	$3,852,496	$2,715,261	$38,475,136	$3,825,857	$13,041,286	$875,022		$13,916,308	$121	$925	$769	$1,301	$1,344	$1,926	$1,392	$2,790	$746	$1,760
2047	$159,463	$10,631,669	$3,099,830	$2,407,560	$3,444,281	$3,948,808	$2,783,143	$40,012,813	$3,921,503	$13,041,286	$896,898		$13,938,184	$124	$948	$790	$1,333	$1,378	$1,974	$1,427	$2,901	$764	$1,810
2048	$163,450	$10,897,460	$3,182,481	$2,467,749	$3,530,388	$4,047,528	$2,852,722	$41,611,964	$4,019,541	$13,041,286	$919,320		$13,960,606	$127	$971	$811	$1,366	$1,412	$2,024	$1,463	$3,017	$783	$1,861
2049	$167,536	$11,169,897	$3,267,686	$2,529,442	$3,618,647	$4,148,717	$2,924,040	$43,275,047	$4,120,029	$13,041,286	$942,303		$13,983,589	$130	$996	$833	$1,401	$1,447	$2,074	$1,500	$3,138	$803	$1,914
2050	$171,724	$11,449,144	$3,355,529	$2,592,678	$3,709,113	$4,252,435	$2,997,141	$45,004,619	$4,223,030	$13,041,286	$965,861		$14,007,147	$133	$1,021	$855	$1,436	$1,484	$2,126	$1,537	$3,263	$823	$1,969
2051	$176,017	$11,735,373	$3,446,097	$2,657,495	$3,801,841	$4,358,745	$3,072,069	$46,803,337	$4,328,606	$13,041,286	$990,007		$14,031,293	$136	$1,046	$878	$1,472	$1,521	$2,179	$1,575	$3,394	$844	$2,025
2052	$180,418	$12,028,757	$3,539,478	$2,723,933	$3,896,887	$4,467,714	$3,148,871	$48,673,968	$4,436,821	$13,041,286	$1,014,757		$14,056,044	$140	$1,072	$902	$1,508	$1,559	$2,234	$1,615	$3,529	$865	$2,084
2053	$184,928	$12,329,476	$3,635,765	$2,792,031	$3,994,309	$4,579,407	$3,227,593	$50,619,387	$4,547,741	$13,041,286	$1,040,126		$14,081,412	$143	$1,099	$926	$1,546	$1,598	$2,290	$1,655	$3,670	$886	$2,145
2054	$189,551	$12,637,713	$3,735,054	$2,861,832	$4,094,167	$4,693,892	$3,308,282	$52,642,583	$4,661,435	$13,041,286	$1,066,129		$14,107,416	$147	$1,127	$952	$1,585	$1,638	$2,347	$1,697	$3,817	$908	$2,208
2055	$194,290	$12,953,656	$3,837,443	$2,933,378	$4,196,521	$4,811,239	$3,390,990	$54,746,668	$4,777,971	$13,041,286	$1,092,783		$14,134,069	$150	$1,155	$978	$1,624	$1,679	$2,406	$1,739	$3,969	$931	$2,274
2056	$199,148	$13,277,497	$3,943,035	$3,006,712	$4,301,434	$4,931,520	$3,475,764	$56,934,876	$4,897,420	$13,041,286	$1,120,102		$14,161,388	$154	$1,184	$1,005	$1,665	$1,721	$2,466	$1,782	$4,128	$954	$2,341
2057	$204,126	$13,609,435	$4,051,935	$3,081,880	$4,408,970	$5,054,808	$3,562,658	$59,210,571	$5,019,855	$13,041,286	$1,148,105		$14,189,391	$158	$1,213	$1,032	$1,707	$1,764	$2,527	$1,827	$4,293	$978	$2,411
2058	$209,229	$13,949,670	$4,164,252	$3,158,927	$4,519,195	$5,181,179	$3,651,725	$61,577,251	$5,145,352	$13,041,286	$1,176,807		$14,218,094	$162	$1,244	$1,061	$1,749	$1,808	$2,591	$1,873	$4,465	$1,003	$2,484
2059	$214,460	$14,298,412	$4,280,101	$3,237,900	$4,632,174	$5,310,708	$3,743,018	$64,038,555	$5,273,986	$13,041,286	$1,206,228		$14,247,514	$166	$1,275	$1,090	$1,793	$1,853	$2,655	$1,919	$4,643	$1,028	$2,559
2060	$219,822	$14,655,873	$4,399,597	$3,318,848	$4,747,979	$5,443,476	$3,836,593	$66,598,266	$5,405,835	$0	$1,236,383		$1,236,383	$170	$1,306	$1,121	$1,838	$1,899	$2,722	$1,967	$4,829	$1,054	$2,357
2061	$225,317	$15,022,269	$4,522,863	$3,401,819	$4,866,678	$5,579,563	$3,932,508	$69,260,320	$5,540,981	$0	$1,267,293		$1,267,293	$175	$1,339	$1,152	$1,884	$1,947	$2,790	$2,017	$5,022	$1,080	$2,438
2062	$230,950	$15,397,826	$4,650,025	$3,486,864	$4,988,345	$5,719,052	$4,030,821	$72,028,809	$5,679,506	$0	$1,298,975		$1,298,975	$179	$1,373	$1,185	$1,931	$1,995	$2,860	$2,067	$5,223	$1,107	$2,521
2063	$236,724	$15,782,772	$4,781,211	$3,574,036	$5,113,054	$5,862,028	$4,131,591	$74,907,989	$5,821,493	$0	$1,331,450		$1,331,450	$183	$1,407	$1,218	$1,979	$2,045	$2,931	$2,119	$5,431	$1,135	$2,607
2064	$242,642	$16,177,341	$4,916,556	$3,663,387	$5,240,880	$6,008,579	$4,234,881	$77,902,288	$5,967,031	$0	$1,364,736		$1,364,736	$188	$1,442	$1,253	$2,029	$2,096	$3,004	$2,172	$5,648	$1,163	$2,697
2065	$248,708	$16,581,775	$5,056,200	$3,754,971	$5,371,902	$6,158,793	$4,340,753	$81,016,307	$6,116,206	$0	$1,398,854		$1,398,854	$193	$1,478	$1,288	$2,079	$2,149	$3,079	$2,226	$5,874	$1,192	$2,790
2066	$254,926	$16,996,319	$5,200,286	$3,848,846	$5,506,200	$6,312,763	$4,449,272	$84,254,836	$6,269,111	$0	$1,433,826		$1,433,826	$197	$1,515	$1,325	$2,131	$2,202	$3,156	$2,282	$6,109	$1,222	$2,886
2067	$261,299	$17,421,227	$5,348,964	$3,945,067	$5,643,855	$6,470,582	$4,560,504	$87,622,853	$6,425,839	$0	$1,469,671		$1,469,671	$202	$1,553	$1,363	$2,185	$2,258	$3,235	$2,339	$6,353	$1,252	$2,986
2068	$267,831	$17,856,758	$5,502,388	$4,043,694	$5,784,951	$6,632,347	$4,674,517	$91,125,537	$6,586,485	$0	$1,506,413		$1,506,413	$207	$1,592	$1,402	$2,239	$2,314	$3,316	$2,397	$6,607	$1,284	$3,089
2069	$274,527	$18,303,176	$5,660,719	$4,144,786	$5,929,575	$6,798,155	$4,791,379	$94,768,271	$6,751,147	$0	$1,544,073		$1,544,073	$213	$1,632	$1,442	$2,295	$2,372	$3,399	$2,457	$6,871	$1,316	$3,196
2070	$281,390	$18,760,756	$5,824,120	$4,248,406	$6,077,814	$6,968,109	$4,911,164	$98,556,658	$6,919,926	$0	$1,582,675		$1,582,675	$218	$1,672	$1,484	$2,353	$2,431	$3,484	$2,519	$7,146	$1,349	$3,307
2071	$288,425	$19,229,775	$5,992,764	$4,354,616	$6,229,760	$7,142,312	$5,033,943	$102,496,522	$7,092,924	$0	$1,622,242		$1,622,242	$223	$1,714	$1,527	$2,411	$2,492	$3,571	$2,582	$7,432	$1,382	$3,421
2072	$295,636	$19,710,519	$6,166,828	$4,463,481	$6,385,504	$7,320,870	$5,159,792	$106,593,921	$7,270,247	$0	$1,662,798		$1,662,798	$229	$1,757	$1,571	$2,472	$2,554	$3,660	$2,646	$7,729	$1,417	$3,540

WE SUPPORT OUR COMMUNITIES

WE ARE WATER FOCUSED

WE TAKE PRIDE IN WHAT WE DO

WE STRIVE TO BECOME OUR BEST

WE DO WHAT'S RIGHT

WE BELIEVE IN QUALITY

WE LISTEN

WE SOLVE CHALLENGING PROBLEMS

WE SEE THE BIGGER PICTURE

WE TAKE OWNERSHIP

WE COLLABORATE

WE HAVE FUN

WE ARE WEST YOST

WEST YOST

Water. Engineered.