



**MONTGOMERY
& ASSOCIATES**

Water Resource Consultants

October 27, 2011

**GROUNDWATER MODELING WORK PLAN
FOR WELLHEAD PILOT TREATMENT SYSTEMS**

**ROOSEVELT IRRIGATION DISTRICT
EARLY RESPONSE ACTION
WEST VAN BUREN AREA
WATER QUALITY ASSURANCE REVOLVING FUND SITE**



Exp 12/31/2013

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1.0 INTRODUCTION

This Work Plan outlines the scope of work and tasks associated with groundwater modeling to evaluate hydrologic effects of prioritized pumping of wells to be equipped with wellhead treatment, pursuant to the RID-95 Wellhead Pilot Treatment System Proposal (RID-95 Pilot) (Synergy Environmental, 2011). The RID-95 Pilot is being undertaken to determine the effectiveness of wellhead treatment technology in meeting the objectives of an ADEQ-approved Early Response Action (ERA) in the West Van Buren Area (WVBA) Water Quality Assurance Revolving Fund (WQARF) Site. The WVBA WQARF Site is shown on **Figure 1**. The Roosevelt Irrigation District (RID) is implementing the RID-95 Pilot.

In an August 22, 2011 letter to ADEQ, RID proposed to operate pilot wellhead treatment systems at up to four wells (RID-89, RID-92, RID-95, and RID-114) to obtain information on the viability of wellhead treatment in the full ERA design and to enhance hydraulic capture, remove a substantial amount of the hazardous substances impacting RID's water supply, and control air emissions (Gallaher & Kennedy, 2011). The pilot systems would provide groundwater treatment performance data for use in developing the full-scale

ERA. In a September 2, 2011 letter, ADEQ stated that they agreed that pilot wellhead treatment operations would provide useful data for the ERA and approved implementation (ADEQ, 2011). In its letter, however, ADEQ limited operational rates of the pilot treatment wells to historic RID operational rates until modeling is completed to demonstrate that adverse hydrologic effects will not occur.

This Work Plan describes the modeling tasks necessary to evaluate the hydrologic effects associated with wellhead treatment operations. Under the RID-95 Pilot, the current seasonal pumping regimen employed by RID to meet irrigation demands will be modified for the wells having wellhead treatment. The current RID pumping regimen and the proposed prioritized and sustained pumping regimen at the four wells equipped with wellhead treatment will be simulated in the model to project the net hydrologic effect of the proposed pumping changes through 2014. An update on the modeling progress for this wellhead treatment approach, and the full ERA, was presented to ADEQ in a meeting on September 27, 2011. Submittal of this Work Plan was conceptually discussed during that meeting.

1.1 MODEL OBJECTIVES

In its ERA-approval letter dated June 24, 2010, ADEQ specified the need to evaluate the hydrologic effects of groundwater pumping changes proposed for the RID ERA in the Work Plan submitted by Montgomery & Associates (M&A) in February 2010. ADEQ specified that the groundwater model must meet two primary objectives:

- Estimate the effects on groundwater levels and capture zones in the WVBA due to the proposed ERA pumping regimen, and
- Evaluate how the groundwater withdrawals diverted from the RID wells during the ERA will affect other contaminant plumes within the WVBA and neighboring WQARF and Superfund sites.

The proposed modeling scope of work presented in this Work Plan was developed to meet these objectives for the operation of the four wells proposed to be equipped with wellhead treatment: RID-89, RID-92, RID-95, and RID-114. These wells may operate for up to three years, 2012 through 2014, before the full ERA pumping regimen begins.

1.2 PREVIOUS MODELING

A groundwater flow model was previously developed for the WVBA WQARF Site and surrounding area by ADEQ. This model is known as the “Central Phoenix Plume Model” (CPPM) and was developed during the late 1990s (Roy F. Weston, Inc. [Weston], 2000). The model code MODFLOW-SURFACT (HydroGeoLogic, 1996) was used to develop the CPPM. The CPPM model grid encompasses the WVBA WQARF Site and is bounded by 99th Avenue on the west, Camelback Road on the north, 56th Street on the east, and Dobbins Road on the south (**Figure 2**). The final CPPM developed by ADEQ was a 5-layer transient groundwater flow model that simulated seasonal pumping in the model study area during the period from 1972 through 1996. The most recent activity conducted on the groundwater model by ADEQ included validation simulations for the period from 1996 through 1998 (Weston, 2001).

The CPPM will serve as the basis for the proposed modeling associated with the RID ERA. M&A obtained the CPPM from ADEQ in 2009, updated portions of it through 2007, and conducted preliminary simulations to confirm that the updated model executes properly. The updated CPPM will be used for the ERA modeling.

2.0 GROUNDWATER MODELING SCOPE OF WORK

The proposed scope of work for the groundwater modeling includes the following tasks:

TASK 1: UPDATE MODEL

TASK 2: EVALUATE MODEL CALIBRATION

**TASK 3: PROJECT HYDROLOGIC EFFECT OF PRIORITIZED PUMPING AT
WELLS WITH WELLHEAD TREATMENT**

TASK 4: PREPARE TECHNICAL MEMORANDUM

The proposed modeling effort will simulate groundwater flow and advective migration of contaminants using particle tracking. Contaminant transport modeling will not be conducted during this phase of modeling. The model code MODFLOW-SURFACT will be used to simulate groundwater flow. The particle tracking model code MODPATH (Pollock, 1994) will be used to simulate hydraulic capture and advective contaminant migration. The Groundwater Vistas graphical user interface will be used to facilitate the modeling (Rumbaugh and Rumbaugh, 2007). Activities to be conducted for each of these tasks are described below.

2.1 TASK 1 – UPDATE MODEL

During the previous model update conducted by M&A, several potential problems with the original CPPM model were identified. These potential problems were not addressed during the previous modeling effort. These potential problems included anomalous or missing pumping data and unexpected variations in stress period length. These potential problems will be further evaluated and fixed during this modeling effort.

2.2 TASK 2 – EVALUATE MODEL CALIBRATION

Using the updated model from Task 1, simulated groundwater levels will be compared to measured groundwater levels. The model was originally calibrated to measured groundwater level data for the time period 1972 through 1996 (Weston, 2000). The model was then validated using measured groundwater level data for the time period 1996 through 1998 (Weston, 2001). The model will not be recalibrated during this phase of modeling. Model calibration will be evaluated using the following statistics:

- Residual mean – the average difference between simulated and measured groundwater level elevations
- Absolute residual mean – the average of the absolute value of difference between simulated and measured groundwater level elevations
- Residual standard deviation
- Residual standard deviation divided by the range of measured data – values should be below 10 percent for an acceptably calibrated model.

Simulated groundwater levels will also be compared to measured groundwater levels for the time period 1972 through 2007.

2.3 TASK 3 – PROJECT HYDROLOGIC EFFECT OF PRIORITIZED PUMPING AT WELLS WITH WELLHEAD TREATMENT

As required in ADEQ's approval letter for the ERA, the model will be used to:

- Estimate the effects on groundwater levels and capture zones in the WVBA WQARF Site due to the proposed pilot wellhead treatment pumping regimen at four wells, and

- Evaluate how the groundwater withdrawals associated with implementation of the pilot wellhead treatment pumping regimen will affect other contaminant plumes within the WVBA WQARF Site and neighboring WQARF and Superfund sites.

Model simulations will be conducted to project groundwater levels, capture zones, and effects on other contaminant plumes in and near the WVBA WQARF Site for both the current RID pumping regimen and the proposed pilot wellhead treatment pumping regimen through 2014. The differences in projected groundwater levels, capture zones, and contaminant plumes between these simulations will represent an estimate of the potential net effect of pumping changes associated with the pilot wellhead treatment regimen compared with the current pumping regimen. Because the current net annual volume of groundwater pumped by RID is not expected to change after startup of the pilot wellhead treatment pumping regimen, the projected future changes in groundwater levels are expected to be localized and small.

2.4 TASK 4 – PREPARE TECHNICAL MEMORANDUM

A technical memorandum will be prepared to summarize the modeling. Specifically, text, tables, and figures will be prepared to summarize:

- Activities conducted to update the model;
- Evaluation of model calibration;
- Model projections;
- Conclusions reached based on the model results; and
- Recommendations for additional evaluations.

A draft technical memorandum will be provided to ADEQ for review. Comments received from ADEQ will be addressed in the final technical memorandum provided to ADEQ.

3.0 SCHEDULE

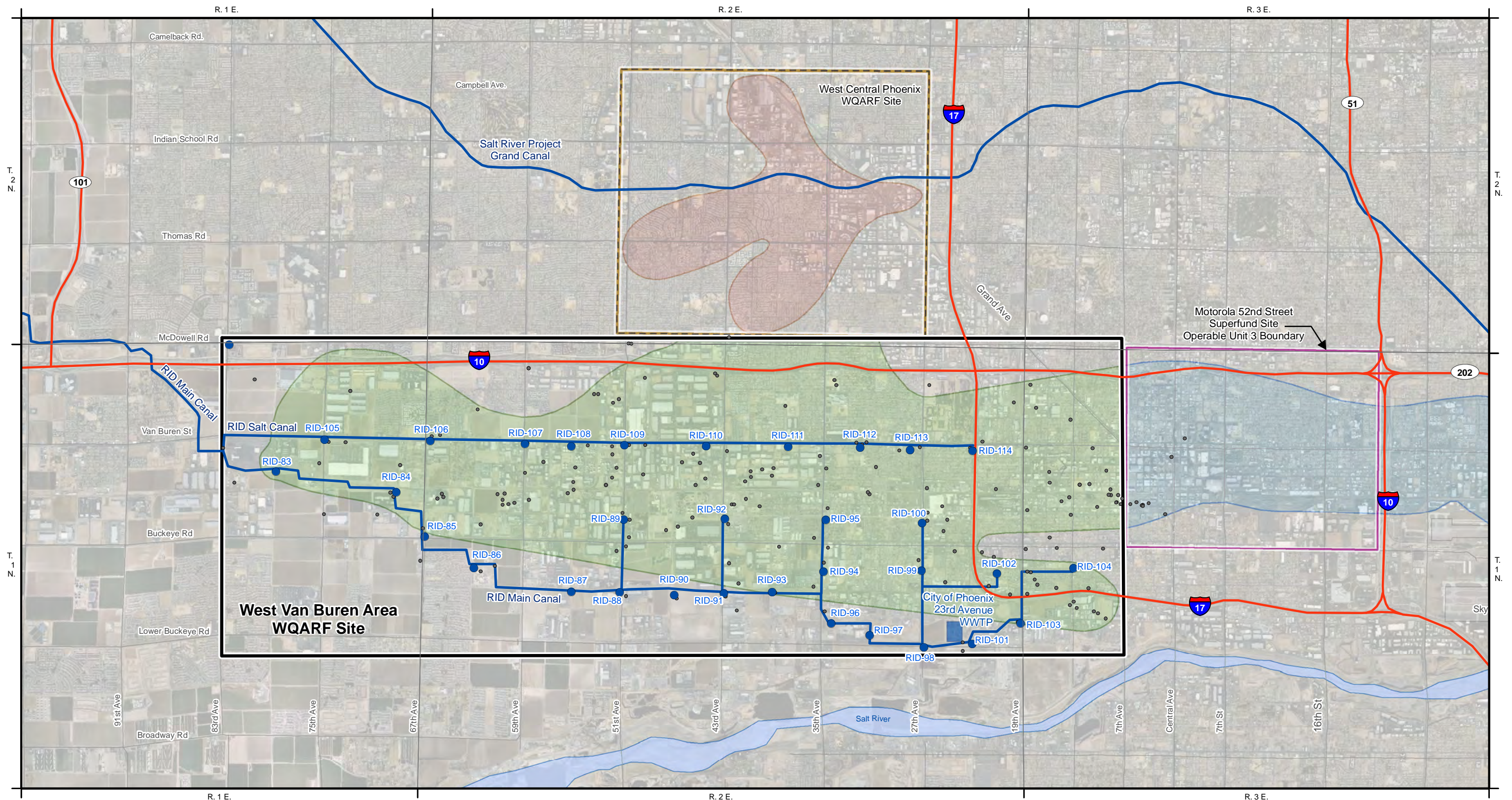
The proposed schedule for conducting the groundwater modeling is shown in the chart below. Approximately 6 weeks will be required to complete the scope of work.

SCHEDULE						GROUNDWATER MODELING (TASK 3)
(weeks)						
1	2	3	4	5	6	
						Authorization to Proceed
						TASK 1: UPDATE MODEL
						TASK 2: EVALUATE MODEL CALIBRATION
						TASK 3: PROJECT HYDROLOGIC EFFECT OF PRIORITIZED PUMPING AT WELLS WITH WELLHEAD TREATMENT
						TASK 4: PREPARE TECHNICAL MEMORANDUM

4.0 REFERENCES CITED

- Arizona Department of Environmental Quality (ADEQ), 2010, **Conditional Approval of a Water Quality Assurance Revolving Fund (WQARF) Early Response Action (ERA) Work Plan for the West Van Buren Registry Site**. June 24, 2010.
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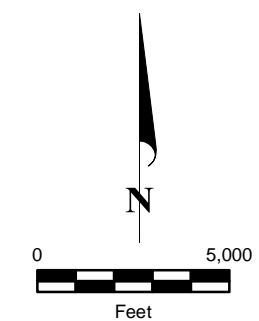
EXPLANATION

- Roosevelt Irrigation District Well
- Monitor Well
- Existing Canal or Pipeline
- Interstates
- Local Streets

- Estimated Extent of Impacted Groundwater in WVBA WQARF Site Based on 1st Quarter 2008 Data (Terranext, 2008)
- Estimated Extent of Impacted Groundwater in West Central Phoenix WQARF Site
- Estimated Extent of Impacted Groundwater in Motorola 52nd Street Superfund Site

Abbreviations

WVBA - West Van Buren Area
WQARF - Water Quality Assurance Revolving Fund
WWTP - Waste Water Treatment Plant
RID - Roosevelt Irrigation District



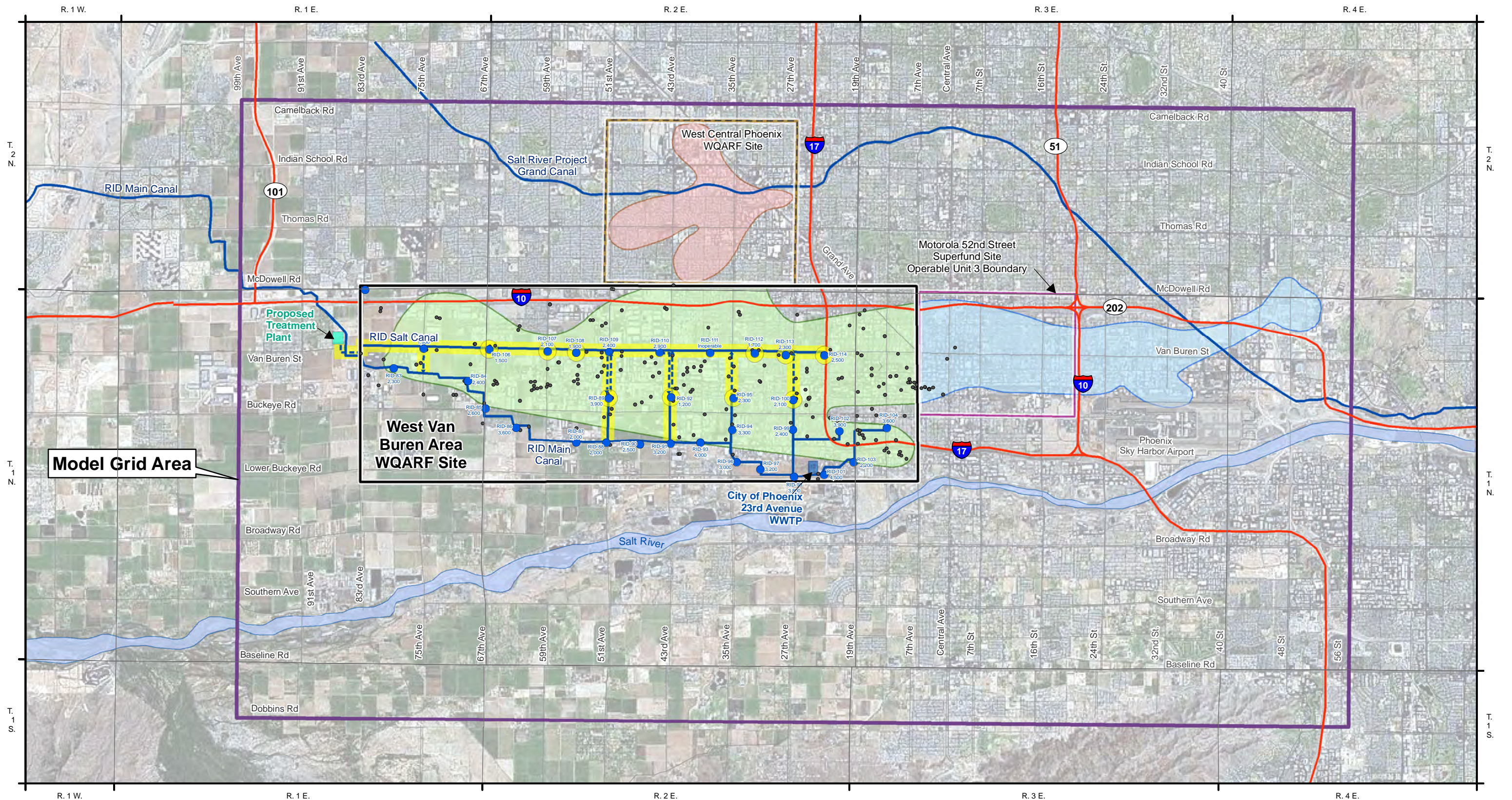
Roosevelt Irrigation District
Early Response Action
Groundwater Modeling Work Plan

STUDY AREA



2011

FIGURE 1

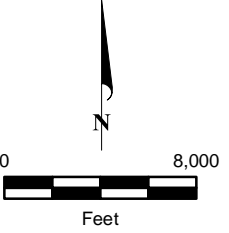


EXPLANATION

- Roosevelt Irrigation District Well
- RID-89 — Well ID
- 3,900 — Estimated Pumping Rate (gpm)
- Monitor Well
- Existing Canal or Pipeline
- - - Proposed New Below-Grade Pipeline
- Interstates
- Local Streets

- Estimated Extent of Impacted Groundwater in WVBA WQARF Site Based on 1st Quarter 2008 Data (Terranext, 2008)
- Estimated Extent of Impacted Groundwater in West Central Phoenix WQARF Site
- Estimated Extent of Impacted Groundwater in Motorola 52nd Street Superfund Site
- Early Response Action

- Abbreviations**
- WVBA - West Van Buren Area
 - WQARF - Water Quality Assurance Revolving Fund
 - WWTP - Waste Water Treatment Plant
 - RID - Roosevelt Irrigation District
 - gpm - Gallons Per Minute



Roosevelt Irrigation District
Early Response Action
Groundwater Modeling Work Plan

MODEL STUDY AREA



2011
FIGURE 2