ATTACHMENT 5: Workplan
Hydrogeologic Characterization of the Eastern Turlock Subbasin

This Workplan mirrors the components discussed in the Project Description (Attachment 4) and supports the stated goals and objectives of the Project. The **goal of the Project** is to develop an understanding of the hydrogeology of the Project Area, to apply that understanding to predict impacts of increased groundwater use on subbasin groundwater levels and quality, and to support groundwater management activities based on Project results. To meet this goal, the following tasks are included in the Workplan:

1. Compile Hydrogeologic Data and Develop Project Databases/GIS
2. Document Current and Historical Land Use and Groundwater Use
3. Evaluate Aquifer Systems and Groundwater Conditions
4. Update Hydrogeologic Conceptual Model
5. Expand and Revise a Subbasin-wide Numerical Model
6. Evaluate Scenarios for Current and Future Land Use
7. Prepare Project Report
8. Manage Project

The stated Project objectives are repeated from the Project Description below along with the primary task numbers that support each objective:

- Development of a comprehensive, updated hydrogeologic conceptual model that provides an overall understanding of how the groundwater system works in the Project Area (shown on **Figure 5-1**) – **Tasks 1-4**
- Evaluation of changing land use and groundwater conditions that supports a better understanding of land use impacts on groundwater resources – **Tasks 1-6, especially Tasks 5-6**
- Revision and application of a regional numerical model as a tool to assist with land use planning and groundwater management decisions throughout the subbasin – **Task 5**
- Support for ongoing groundwater programs such as the California Statewide Groundwater Elevation Monitoring (CASGEM) program – **Tasks 1-8, especially Task 3**
- Support for programs associated with the Turlock Groundwater Basin Groundwater Management Plan (GWMP[1]) including recent regulatory requirements of a GWMP such as the mapping of recharge zones as required by Assembly Bill 359 (AB359, 2011) – **Tasks 1-8, especially Tasks 4-5**.

The TGBA will serve as the Project Advisory Committee (PAC) to track progress and performance of the Project and ensure that the goals and objectives are being met. As described previously, the TGBA/PAC

[1] *The GWMP Executive Summary and key excerpts, including the MOU documenting the establishment of the TGBA, are included as Supporting Documentation in Attachment 3 of this grant application*.

is composed of 13 local agencies involved in groundwater management for the Turlock Subbasin including the cities of Turlock (Applicant), Modesto, Ceres, and Hughson; Keyes and Denair Community Services Districts (CSD); Merced and Turlock irrigation districts; Hilmar County Water District (CWD); Eastside and Ballico-Cortez water districts, and Stanislaus and Merced counties. In addition, two participating agencies, Ballico CSD and Delhi CWD, will also serve on the PAC. As previously mentioned, these two agencies cooperate with the TGBA, attend meetings, and support groundwater management activities in the subbasin. **To allow the PAC to evaluate the ongoing progress and performance, a task-specific deliverable will be provided at the end of each main task (Tasks 1-6).** This deliverable will summarize the data, methods, analysis, and results associated with each task. The PAC will review and provide comments on each of the Project deliverables. To ensure progress and performance, comments provided by the PAC will be addressed. The revised deliverables will be combined at the end of the project into the Final Project Report (Task 7). Dissemination of the Project deliverables will be achieved through the PAC and their local meetings with stakeholders. In addition, the Applicant will prepare ***quarterly progress reports*** and provide them to the PAC and DWR (Task 8).

The scope for each of the tasks and subtasks, along with strategies for evaluating performance, are discussed below.

Task 1: Compile Hydrogeologic Data and Develop Project Databases/GIS

This task represents **an aggressive approach to compilation of Project Area data**, even incomplete or partial data sets, if they could contribute to the hydrogeologic understanding. The process involves reviews at county offices and local agencies and sifting through numerous paper files to identify and collect key data. Because the Project area spans two counties, both Stanislaus and Merced County agencies will be included in the review. For small community water system data, the Department of Public Health (DPH), Drinking Water Division in Sacramento will be contacted. Although the data collection process for some of these data will be impacted by recent regulations associated with the Homeland Security Act (HSA) of 2002, some of the water supply data are accessible.

Technical publications covering the Project area will also be compiled including documents from DWR, USGS, and University of California Water Resources Center Archives. Document appendices will be reviewed for data tables or other data summaries involving groundwater levels, quality, and wells. In this manner, key older data can be preserved and shared– data that previously existed only in paper form in the back of older documents that are out of circulation.

Data will be cataloged with the source and collection date of the data and verified through the project's QA/QC process. Collectively, these data will be incorporated to better understand the physical, hydrologic, climatic, soils, geologic, and subsurface hydrogeologic conditions in the Project Area. Task 1 subtasks are summarized below that identify key activities, data sets, sources, database development and QA/QC processes.

Task 1.1: Compile Physical, Geologic, and Hydrologic Data

Numerous sources will be accessed to compile and to catalog the physical, geologic, and hydrologic data in the Project area. Many of these data sets are available as GIS layers from the State of California, DWR, and ESRI (GIS software developer); some have already been compiled such as county and city boundaries, roads, cultural features, drainages, recent aerial photographs, and topography. More locally, Turlock Irrigation District (TID) has also compiled numerous GIS shapefiles that cover the Turlock Subbasin and the Project Area including soils, and some land use. As a member of TGBA, TID has made numerous GIS layers available for this project. These data will be incorporated to better understand the physical, geologic, and hydrologic setting and provide the foundation of the Project GIS. Key data types and sources are summarized below:

- Topographic maps – USGS, National Elevation Dataset (NED)
- Drainages, lakes, watershed delineation – California Watersheds
- Aerial photographs – library collections
- State and local geologic maps – California Geological Survey
- Technical publications by USGS, DWR, and others
- Climatic and stream flow data – TID, DWR, USGS, NOAA, PRISM
- Soils maps - USDA

Available data will be organized and documented for ready access using relational databases and Geographic Information System (GIS) layers. Similar processes will be employed for the compilation of hydrogeologic and land use data.

Task 1.2: Compile Hydrogeologic Data

Key hydrogeologic data sets involve aquifer delineation and properties, groundwater wells (location, dates, and construction information), water levels, hydraulic gradients, groundwater occurrence and flow, groundwater quality, and subsidence information.

In preparation for this application, TGBA has requested and received almost 1,000 drillers' logs from DWR covering the Project Area. Although some small areas immediately west of the Project Area were also included, the amount of information in the Project Area is substantial. Well locations on these logs have not been adequately linked to the quarter sections and reflect only the closest section (square mile), making it difficult to readily determine exact locations of wells. Nonetheless, a systematic examination of this data set – identifying key information to extract – will provide significant insight into the Project Area groundwater use and aquifers that support it. At a minimum, logs provide information on the number of wells drilled in the Project Area over time.

An additional source of hydrogeologic data includes recent work by USGS in the Central Valley and Turlock Subbasin. USGS has compiled significant volumes of historical data, combining them with recent data and original work, which may not have been considered in previous evaluations. For example, the USGS has developed interpretations of geologic textures in the shallow subsurface over their model area (Figure 5, Attachment 4), which extends into the Project Area. Those data may provide insight into the complex geology beneath the Project Area and can be extended to the east using drillers' logs, if

warranted. Recent modeling being conducted by USGS (Phillips, et al, 2007[2]) has also been associated with a significant data collection effort that can contribute to the Project. These data are publically available and will be compiled for the Project. The 2007 USGS study will also provide key data on surface water-groundwater interaction along the rivers that serve as the subbasin boundaries.

Historical publications and data are also important to a successful data compilation task. Numerous publications dating back almost a century provide key historical data from the Turlock subbasin; these are often not considered or repeated in modern investigations. An extensive bibliography will be developed to identify as many of these references as possible.

County agencies are judged to have significant hydrogeologic information that have yet to be compiled and reviewed. Both Stanislaus and Merced counties require well and water system permits that will provide information and data on location and numbers of wells drilled in the Project Area over time. These data will be used to supplement and cross check with the DWR driller log data set.

Since the 1960s, DWR has maintained a water level database for the subbasin. Those data along with other key monitoring data are compiled by TID into a water level database. Although recent water levels are sparse in the Project Area, water levels dating back to the 1970s are included in the water level database. Historical water levels were also compiled in connection with the development of the TID groundwater model. Although data in the Project Area represent fewer measurements that in the western subbasin, some water level data are available over time. All water level data will be compiled into the Project database and linked to drillers' logs if sufficient data exist. Static water levels are recorded in new irrigation and domestic wells as they came on line and will provide additional recent data for evaluating trends.

Groundwater quality data are expected to be sparse in the Project Area and a considerable level of effort is needed to identify possible data sources. Such sources may include older publications, USGS recent water quality sampling, available online data from the State's Geotracker program, and county files. An important groundwater quality data set is available from Merced County, where regulations require that all domestic wells are sampled for water quality. These county files will provide key data that may not be available from other sources. In some instances, irrigation wells are analyzed for constituents of agricultural concern such as boron. Water quality data will be incorporated into the Project database.

Subsidence information will also be compiled for the Project Area. Although likely less susceptible than areas to the west, subsurface hydrogeology properties will be compiled and examined for the potential of compaction and subsidence.

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[2] *The title page, abstract, and figure showing the regional model for this USGS study are provided as Supporting Documentation in Attachment 4.*

Task 1.3: Compile Land Use Data

The Land Use Planning departments for Stanislaus and Merced counties will be involved in the data compilation effort. Land use planning for the Project Area will be discussed with planners and reviewed in the county General and Specific Plans. Land use maps have already been compiled from DWR including GIS shapefiles dating back to 1984. Additional land use data have been compiled by TID for the TID groundwater model and will be incorporated into the Project. Additional agricultural and maps from the California Farm Mapping Program will also be compiled and incorporated into the analysis. Available data will be organized and documented for ready access, including development of relational databases and GIS layers.

Task 1.4: Create Project Databases and Project GIS

Data and information will be tabulated into a Data Management System for the Project involving relational databases in Excel and Access formats and linked to the Project Geographical Information System (GIS). Databases will be developed for selected hydrologic and hydrogeologic data. At a minimum, databases will include well construction data, water level records, and water quality data. The Project GIS will be populated with the available shapefiles including topography, hydrology (including drainages and watersheds), land use, aerial photographs (georeferenced if needed), rainfall isohyetal maps and geologic and soil maps.

Task 1.5: Apply QA/QC Procedures

Although QA/QC procedures will be applied to all tasks throughout the Project, specific QA/QC measures are highlighted separately in Task 1 to elevate the importance of developing reliable databases. First a Project QA/QC Officer will be assigned to the Project to direct QC procedures. Project databases will be verified to ensure accurate entry and representation of data. The database structure and source data will be reviewed by a qualified professional not involved in data entry. Data sources will be referenced to facilitate independent comparison of the original data and those in the database by the Project QA/QC officer or designee. Data will also be plotted as appropriate to identify outliers, which will be flagged in the database. Metadata will be added to Project GIS files. Project QA/QC procedures are described in more detail in Attachment 8.

Task 1.6: Prepare Technical Memorandum No. 1

A brief technical memorandum (TM) will be prepared that documents the data collection efforts and summarizes project databases and Project GIS files. The TM will be provided to the PAC for review and comment. PAC comments will be incorporated into the Project report (Task 7).

Task 1 Deliverable:

- Technical Memorandum No. 1 summarizing project databases and Project GIS; memorandum will be provided to the PAC for review and comment.

Task 2: Document Current and Historical Land Use and Groundwater Use

A simple compilation of historical data from well logs (including well date, depth, and perforated interval) can provide insights into groundwater use and its evolution over time. For example, have wells typically been drilled deeper in more recent times than in the past? Do yields improve or decline with depth? Have wells been replaced? How has land use change impacted the number of wells? Do land use changes indicate changes in groundwater use – e.g., has non-irrigated pasture been converted to irrigated agriculture? Where are key areas of riparian growth and how have they changed over time?

Task 2.1: Analyze Land Use Data Sets

An evaluation of land use in the Project Area over time will be conducted with parcel information, older aerial photographs, data from County Planning departments and DWR land use maps. DWR land use maps are available as shapefiles from 1984 through 2004. The focus will be on the changes to irrigated land over time. Some of these land use data (e.g., acres of irrigated agriculture) have been compiled for the TID groundwater model (1952 – 2006) and will be incorporated into the analysis. **Figure 5-2**[3] illustrates some of the changes in land use over time with a focus on the irrigated acreage in the Foothills Non-District Areas (included in the Project Area). This graph illustrates the increasing use of groundwater for irrigation in the Project Area and provides an example of how the land use data sets will be updated and analyzed. Groundwater pumping and water level declines have been linked to the early 1960s. Land use data that pre-dates and post-dates this change will be examined in detail. However, the focus of the analysis will be more recent data (post 2004) to determine how irrigated acreages have changed over the last few years and implications of these trends for the future.

Task 2.2: Incorporate Groundwater Use Databases

The database of wells, drilling date, and location information will be used to identify the number of wells and changes in well numbers and construction with time in the Project Area. Timing and development of community water systems, domestic well permits, and other water supply information will be incorporated into this task. An understanding of the links between land use and groundwater use will be developed along with trends in land use/groundwater use changes over time.

Task 2.3: Prepare Technical Memorandum No. 2

A brief TM will be prepared that describes land use and groundwater use over time. The land use summary will focus on changes in irrigated agriculture spatially and temporally in the Project Area. The groundwater use will document the number of wells drilled in the Project Area for various time periods and highlight trends over the last 20 years. The TM will be provided to the PAC for review and comments. PAC comments will be incorporated into the Project Report (Task 7).

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[3] *Figure 5-2 was modified for emphasis from a figure in the GWMP that illustrated the increase in irrigated acreage in the Project Area over time. Documentation of this land use change is highlighted in the GWMP on page 2 of the Executive Summary, provided in Supporting Documentation of Attachment 3.*

Task 2 Deliverable:

- Technical Memorandum No. 2 describing land use and groundwater use over time. The memorandum will be provided to the PAC for review and comments.

Task 3: Evaluate Aquifer Systems and Groundwater Conditions

Task 3.1: Evaluate Project Area Aquifers

Although data are sparse in the Project Area, the DWR well log database reveals that several hundred wells have been drilled in the Project Area. Geologic descriptions will be reviewed for systematic identification of geologic layers that can be incorporated into the overall analysis. For example, prominent blue clays, hard layers, or "broken rock" descriptions on drillers' logs may correlate to key stratigraphic units that can contribute to the overall understanding of aquifer systems. Well test information on driller's logs can be used to estimate aquifer parameters through a careful examination of static and pumping water levels, test time, and pumping rate. These data provide a time-dependent specific capacity that can be converted to transmissivity using empirical coefficients and general knowledge of the aquifer system.

In addition, regional aquifer data will be incorporated from adjacent subbasins. For example, in San Joaquin County to the north several studies have been conducted on Mehrten aquifer properties. These data will be reviewed to supplement local aquifer data. Aquifer properties in the USGS calibrated model will be compared across the region (Phillips, et al., 2007).

Task 3.2: Evaluate Groundwater Conditions

Groundwater in the Project Area likely occurs under unconfined conditions but is also likely to be more confined with depth. Duripan and other shallow restrictive layers control surface recharge rates to the west (in Eastside and Ballico-Cortez water districts) and likely limit recharge in some portions of the Project Area. Soils and restrictive layers in the Project Area will be examined for impacts to recharge, and groundwater levels, flow, and quality. This task will include mapping of significant groundwater recharge areas, based primarily on topography, soils, shallow geology and depth to groundwater.

Task 3.2.1: Describe Groundwater Occurrence and Flow

Water level data compiled from numerous sources will be analyzed in detail to document groundwater levels and flow in the Project Area. Data will be linked to well location, well construction information (if well names can be linked to drillers logs), and aquifer system. Changes in water levels will be analyzed over time to the extent allowed by the limited data set. Water levels from wells outside of the Project Area, which may have longer records, will be incorporated into the analysis. The more complete hydrographs will be compared to the sparse Project Area data to infer trends and fluctuations in the Project Area. Levels will be compared to climatic data to see if water levels can be correlated to dry and wet hydrologic cycles. Data probably are not sufficient for preparation of groundwater level maps for numerous periods in time; nonetheless, the data will be examined for regional flow patterns.

Task 3.2.2: Evaluate Groundwater Quality

Groundwater quality data in the Project Area will be evaluated for constituents of concern that may limit groundwater use for either drinking water or agricultural irrigation. Groundwater quality objectives for beneficial uses will be summarized from the Basin Plan prepared by the Regional Water Quality Control Board (RWQCB) for comparison to quality data. Online databases, such as Geotracker, will be reviewed to identify any releases of contaminants to soil or groundwater in the Project Area. Available data will be compiled and compared against other available nearby data (including areas adjacent to, but outside of, the Project Area) to assess areal patterns (if any) and differences in water quality within the aquifers.

Task 3.3: Prepare Technical Memorandum No. 3

A brief TM will be prepared that describes aquifers and groundwater levels, quality, and flow in the Project Area. Changes in groundwater conditions throughout the area will also be documented. The TM will be provided to the PAC for review and comments; PAC comments will be incorporated into the Project Report (Task 7).

Task 3 Deliverable:

- Technical Memorandum No. 3 will be prepared to describe the aquifer systems and groundwater conditions in the Project Area. The memorandum will be provided to the PAC for review and comments.

Task 4: Update the Hydrogeologic Conceptual Model

This task will pull together the data and findings of the previous tasks to provide a comprehensive and updated conceptual hydrogeologic model.

Task 4.1 Describe the Hydrogeologic Framework

This task will build on TM No. 3 and summarize the conceptual understanding of the area for the preparation of a water balance. This task will include cross sections, and maps for illustration of the hydrogeologic conditions.

Task 4.2 Update the Water Balance for the Project Area

Data and analyses will be incorporated into a water balance for the Project Area. Rainfall, runoff, evapotranspiration and other hydrologic factors will be analyzed with a focus on groundwater recharge (inflows to the water balance). Land use and groundwater wells will be used to estimate outflows from the area (including subsurface outflow). Numerous studies by the USGS and others will be used to document surface water-groundwater interaction along the Merced and Tuolumne rivers. Resultant changes in groundwater storage will be compared to the water level data for consistency.

Collectively, these data will form an updated conceptual hydrogeologic model for the Project Area. Results will be incorporated into the existing basin flow model for analysis of future land use changes and potential impacts to the groundwater basin.

Task 4.3 Prepare Technical Memorandum No. 4 and Conduct Workshop No. 1

A TM will be prepared that describes the conceptual model and water balance for the Project Area. The TM will be provided to the PAC for review and comments. PAC comments will be incorporated into the Project Report (Task 7). A follow-up workshop will be conducted with the PAC to present the hydrogeologic characterization conducted to date. The PAC will provide input on the presentation and assist in identifying objectives of the Project numerical model to be considered during the development of the model in Task 5.

Task 4 Deliverables:

- Technical Memorandum No. 4 describing the hydrogeologic conceptual model including a water balance for the Project Area. The memorandum will be provided to the PAC for review and comments.
- Workshop No. 1 to present the hydrogeologic conceptual model and identify specific objectives for the numerical model to be developed in Task 5.

Task 5: Expand and Revise a Subbasin-Wide Groundwater Flow Model

The goal for the modeling task is to develop a tool with which to evaluate changing land use and groundwater conditions in the Project Area and to evaluate future potential groundwater management activities. As described in the Project Description, there are two existing regional flow models that have been developed for all or a portion of the Turlock Subbasin; one developed by the Turlock Irrigation District (TID) that covers the entire subbasin and the second by the U.S. Geological Survey (USGS) that covers a larger region but does not extend over the eastern Project Area. The extent of the two models and the Project Area are shown on **Figure 5-3**.

TID has provided the model files for review in support of this application. Also in support of this application, USGS has provided the steady-model files for preliminary review. The USGS transient model will be publically available, but is currently in the final stages of calibration. Neither model can be readily applied to this Project without revision and/or expansion. ***The review and preliminary evaluation of these two models were used to develop a strategy for an improved, expanded, and updated tool for ongoing TGBA use.***

Our strategy for development of a new Project model takes advantage of and builds on both of the existing models, while incorporating the new data and analyses from this Project. Data sets from the TID subbasin model will be extracted for use in the more conventional platform of the USGS model, which will be extended to the east. The result will be a management model on a conventional platform, which TGBA can apply to groundwater management in the Turlock Subbasin. To provide the background and

rationale for this strategy, a brief summary of the two models is provided below. The subtasks associated with meeting the task goal and objectives follow the model summaries.

Turlock Subbasin Finite Element Model

The TID model was developed in FEMFLOW3D by Timothy J. Durbin, Inc. and is documented in his reports submitted to TID in 2005 and 2008. The FEMFLOW3D model simulates steady-state and transient groundwater flow over a 542 square mile area encompassing all of the Turlock Subbasin (**Figure 5-3**). This model comprises multiple layers and simulates groundwater flow through the key geologic formations and aquifer zones delineated in the existing hydrogeology conceptual models of the area. In general, heterogeneous distributions of aquifer thickness, hydraulic conductivity, and storage coefficients were simulated in the final calibrated FEMFLOW3D model. Recharge in the model area is represented as total recharge from several sources including net percolation of rainfall, agricultural return flow, urban return flows, and creek and river recharge.

The FEMFLOW3D model was calibrated to steady-state conditions (representing average year conditions during 1952-1956) and transient conditions over the periods 1952-1998 and 1991-2006. Calibration was performed by first matching groundwater elevations measured in monitoring and production wells representing steady-state conditions with steady-state model-simulated elevations. A second phase of calibration simulated transient recharge and outflow conditions and measured groundwater elevations were compared with model-simulated elevations. Further evaluation of the FEMFLOW3D calibration results indicates that the steady-state model accurately represented average conditions, but that transient calibration results represented a larger error, indicating that in its current form, the model may not be useful in simulating future groundwater conditions and management scenarios, especially in the Project Area.

Current and Updated MODFLOW Model

The second numerical groundwater flow model that covers a portion of the Turlock Subbasin is the USGS MODFLOW model documented in 2007 (Phillips, et al., 2007). The MODFLOW model simulates steady-state groundwater flow over an approximate 1,300 square mile area encompassing most of the subbasin. The eastern portion of the Turlock Subbasin including most of the Project Area is not included in the current MODFLOW area (**Figure 5-3**). A no-flow boundary condition was assigned to the eastern model boundary along the Project Area Foothills. The regional USGS model comprises 16 layers and like the FEMFLOW3D model, simulates groundwater flow through the key geologic formations and aquifer zones. In general, heterogeneous distributions of aquifer thickness, hydraulic conductivity, and storage coefficients were simulated in the final calibrated model. Recharge in the model area is represented as total recharge from several sources including net percolation of rainfall, agricultural return flow, urban return flows, and creek and river recharge.

The MODFLOW model was calibrated to steady-state conditions representing water year 2000. Calibration was performed by matching steady-state model-simulated elevations with measured groundwater elevations. As documented in the 2007 USGS report, the steady-state MODFLOW model accurately represented average conditions. The mean and root mean squared errors for the steady-state MODFLOW model were only 2.9 and 7.5 feet, respectively over the entire model area. The

MODFLOW model results showed good agreement between measured and simulated groundwater elevations in the TID area.

A second phase of calibration and updating of the USGS MODFLOW model is currently underway. The transient model incorporates an updated, robust streamflow routing package (SFR-2) to more accurately simulate surface water-groundwater interactions along the Tuolumne and Merced rivers. During a May 2012 conversation with a TGBA representative, Mr. Steven Phillips of the USGS stated that the scope of the current modeling analysis involves calibration simulations of transient conditions over the period of 1960-2004. Preliminary calibration results indicate that the transient model is accurately simulating dynamic groundwater flow; final calibration of the updated transient model is scheduled for completion before December 2012.

Modeling Strategy

Because a critical groundwater management challenge in the Project Area is related to changes (declines) in groundwater elevations over time, a predictive model must be able to accurately represent these changes as judged by calibration quality. As such, a well-calibrated transient model is the preferred tool for this Project. TGBA proposes to conduct additional modeling analyses of changing land and groundwater use over time for this Project by building on the previous transient modeling performed by Durbin and the USGS.

Because the USGS MODFLOW model is constructed on a more conventional platform, contains a robust integration with surface water modeling along the Merced River, and may simulate transient conditions more accurately than the FEMFLOW3D model, ***TGBA proposes expansion of the USGS MODFLOW model as a base for the Project model.*** Model data sets will be extracted from the TID finite element model to supplement the Project model input as necessary. The USGS regional model can also be parsed at the Tuolumne and Merced rivers and assigned new northern and eastern boundary conditions, if warranted for the model update.

Key subtasks to complete the modeling evaluation are listed below:

Task 5.1: Obtain USGS MODFLOW Model and Verify Model Results

As an initial step, TGBA will obtain the USGS MODFLOW model input and output and complete documentation for both the steady-state model published in 2007 and the transient model update currently underway and scheduled for completion by the USGS in 2012. A discussion with USGS confirmed that these files could be accessed for this Project (Phillips, personal communication, May 2012). Model files will be imported and the updated transient model will be run to verify calibration quality and results.

Task 5.2: Expand the Model and Modify Boundary Conditions

The USGS model will be expanded eastward to include the Project Area. The boundary condition of the current eastern model boundary will be modified to account for hydrologic conditions in the Project Area. Data requirements for the expanded model area will be developed in previous Tasks 1-4. Input

data sets will be extracted from the TID model and compared to those in the USGS model. More detailed or accurate data sets may be substituted and the model grid may also be revised if warranted. The regional model may be cut at the Tuolumne and Merced rivers to focus updating the data sets on the Turlock Subbasin. Since the USGS incorporated an updated and more robust streamflow routing package (SFR-2), the extraction of the subbasin from the model will consider surface water-groundwater interactions to determine if and where the model may be parsed.

Task 5.3: Calibrate the Revised Project Model

The revised Project model will be used to simulate transient groundwater flow and compare the calibration quality in the original and revised MODFLOW model areas. Additional calibration simulations may be conducted if necessary to ensure that the Project Model represents an accurate tool for evaluating conditions in the Project Area.

Task 5.4: Prepare Technical Memorandum No. 5 and Conduct Workshop No. 2

The revised Project Model will be documented in a TM that will include data sets, model construction details, and calibration results. The TM will be provided to the PAC for review and comments. PAC comments will be incorporated into the Project Report (Task 7). A follow-up workshop will be conducted with the PAC to present the results of the Project Model. At the workshop, the PAC will be solicited for input on the objectives and details of potential scenarios for model application in Task 6.

Task 5 Deliverables:

- Technical Memorandum No. 5 documenting the revised Project numerical model. The memorandum will be provided to the PAC for review and comments.
- Workshop No. 2 will be conducted with the PAC to present the model results and identify scenarios for analysis.

Task 6: Evaluate Scenarios for Future Changes in Land Use

The revised Project numerical model developed in Task 5 will be applied to simulate numerous scenarios of changes in groundwater and land use over the subbasin.

Task 6.1: Develop Future Land Use Scenarios for Analysis

Scenarios will be developed based on the input of the PAC in Workshop No. 2 (Task 5). Impacts of future drought will also be assessed. These predictive model runs will be used to inform future land use and groundwater management decisions for the subbasin. For costing purposes, five model scenarios are included.

Task 6.2: Analyze Future Land Use Scenarios

The Project Model will be applied to the scenarios developed above. Output will include changes to groundwater levels spatially and temporally across the Project Area and the entire subbasin.

Task 6.3: Prepare Technical Memorandum No. 6

A brief TM will be prepared that documents the details of the scenarios and results of the modeling. The TM will be provided to the PAC for review and comments. PAC comments will be incorporated into the Project Report (Task 7).

Task 6 Deliverable:

- Technical Memorandum No. 6 describing potential land use changes and modeling results. The memorandum will be provided to the PAC for review and comments.

Task 7: Prepare Project Report

Draft and final project reports will be prepared based on the technical memoranda and PAC comments prepared in subsequent tasks.

Task 7.1: Prepare Draft Project Report

A draft Project report will be prepared that documents the data collection effort, presents the project databases and GIS, describes the methods and analysis, and summarizes the results. The draft Project report will combine the information presented in the task-specific technical memoranda (No. 1 through 6) into an integrated technical report.

Task 7.2: Present Report to PAC

The details of the Project Report will be reviewed in a final presentation to the PAC (Workshop No. 3). The Workshop will adhere to notifications pursuant to the Brown Act and will invite other interested parties identified by the PAC. Figures from the report will be presented in PowerPoint format. Both verbal and written comments will be solicited from the PAC.

Task 7.3: Prepare Final Project Report

Comments provided by the PAC in Workshop No. 3 (and other written comments as available) will be incorporated into a Final Project Report. Model documentation and project databases will be provided as report appendices. The Final Project Report will be presented to DWR. We will work with DWR to ensure that confidentiality agreements such as information on the Drillers' Logs (provided by DWR) will be maintained.

Task 7 Deliverables:

- Draft and Final Project Report that compiles all of the Technical Memoranda into one synthesis document. The draft report will be provided to the PAC for review and comments. The Final Project Report will be provided to both the PAC and DWR at the end of the project.
- Workshop No. 3 will present the draft report to the PAC and interested parties.

Task 8: Project Management

In order to manage the Project efficiently, the Applicant will adhere to a Project Management plan that involves, at a minimum, the following items:

- preparation of quarterly progress reports for DWR and PAC
- tracking of progress and performance,
- adhering to schedule and budget,
- identification of milestones,
- dissemination of Project deliverables and progress to the PAC.

The Applicant will prepare quarterly progress reports in compliance with the DWR agreement. This will include detailed tracking of tasks completed, budget expended, budget remaining, and adherence to schedules. **These tasks are subdivided in the budget and schedule as: *Task 8.1: Manage Project Progress, Schedule, and Budget; Task 8.2: Prepare Quarterly Progress Reports; and Task 8.3: Provide Project Materials to the PAC.***

Task 8 Deliverables:

- Quarterly Progress Reports will be prepared that provide an update of work status, budget, and schedule. Progress reports will be provided to DWR and the PAC.

Dissemination of Information and Involvement of the Project Advisory Committee (PAC)

The TGBA and two additional participating agencies, serving as the PAC, represent all of the local agencies engaged in managing groundwater. By providing progress reports, technical memoranda, and three presentations/workshops to the PAC, the Project material will be available to the managers who need it on a real-time basis. In turn, PAC members can provide these materials to other stakeholders at separate workshops and/or board/city council meetings. Having the 15 PAC members continually updated, and allowing them to update their interested parties, provides for a wide network for project dissemination. In addition, workshops will be conducted at TGBA meetings[4] that are noticed pursuant to the Brown Act. Interested parties and the public can participate at the Project workshops. PAC members can also invite specific stakeholders to attend.

[4] *The TGBA has held numerous similar public meetings such as those conducted during the GWMP process. That process of stakeholder involvement and coordination with other agencies is documented in Section 6 of the GWMP, provided as Supporting Documentation in Attachment 3 of this grant application.*

As other projects move forward in the subbasin, the PAC will be apprised of how this Project may also serve related groundwater management activities and allow subsequent groundwater management to benefit from this Project. For more than fifteen years, the TGBA has been conducting regular meetings on groundwater issues and has a high interest in serving as the PAC for this Project to optimize the data and analysis for the benefit of the subbasin groundwater resources.

Implementation of Improved Groundwater Management

Attachment 4, Section 4.5, *Support of the Groundwater Management Plan*, summarizes how the proposed Project supports specific BMOs defined in the GWMP. The Workplan, defined with GWMP goals and objectives in mind, supports management actions defined in the GWMP Implementation Plan[5]. Specific GWMP management actions supported by this Project are:

- **Protection of Natural Recharge Areas.** The GWMP identifies the basic steps for protection of natural recharge areas. The proposed Project addresses all four of the steps. These are to identify recharge areas within the cities and counties, develop a GIS-based map of natural recharge areas, inform planning entities of the importance of these areas, and make recommendations for the protection of these areas. Tasks 1 through 3 will identify recharge areas, Task 4 will provide recharge maps, and Task 5 through 7 will assess the importance of recharge areas, inform the PAC agencies and provide recommendations for protection.
- **Feasibility Evaluation of Artificial Recharge Projects.** The GWMP identifies steps toward an artificial recharge program, including mapping of potential sites and consideration of stormwater flows. Tasks 1 through 4 of the proposed Project will support identification and evaluation of potential sites and potential water sources, including stormwater. The GWMP also envisions in-lieu recharge projects; the proposed project's land use mapping and water balance (i.e., documentation of crop water use) will provide fundamental information to assess in-lieu recharge in the future.
- **Support of Public Health Programs (well construction and abandonment standards).** The GWMP includes actions to protect groundwater quality, including installation of sanitary well seals on all new wells and abandonment of wells in accordance with standards. In Tasks 1 and 2, the proposed Project will provide a well inventory database that supports this management action specifically, while Task 3.2.2 will identify areas with water quality problems. Among the other tasks, Task 7 will increase awareness of the issues for PAC agencies with well permitting responsibilities. As stated in the GWMP: "This management action is particularly valuable in unincorporated areas not served by a water purveyor." It is noteworthy that the study area encompasses most of the unincorporated areas in the basin.
- **Water Quality Management.** The GWMP calls for detailed hydrogeologic assessments focusing on areas with poor water quality and resulting in a GIS-based map of areas with poor water quality. The GWMP indicates that the information would be used with the recharge area mapping to develop strategies for water quality management. The proposed Project fits directly into this management action. Groundwater quality in the Project area is unknown; this study will be the first to compile groundwater quality data and characterize groundwater quality in the

[5] *GWMP BMOs and the Implementation Plan are provided as Supporting Documentation in Attachment 3 of this grant application.*

eastern third of the basin. Specifically, Task 1 will compile water quality data and start a water quality database. Task 3.2.2 will characterize groundwater quality in the study area and provide GIS maps of poor water quality areas. As noted in the GWMP, these tasks are fundamental to water quality protection strategies.

- **Groundwater Monitoring Program.** The GWMP recognizes that groundwater monitoring, data analysis, and archiving of collected data are essential for any groundwater management plan. Accordingly, the GWMP implementation plan includes evaluation of groundwater level and quality monitoring programs and accompanying database management. In Tasks 1 through 4, the proposed Project will provide the hydrogeologic data and conceptual model to serve as a framework for improved monitoring. Tasks 5 and 6 respectively provide and apply the numerical model for further assessment of issues and monitoring needs. These tasks will identify potential areas for monitoring (e.g., recharge areas, surface water/groundwater interaction areas, water quality problem areas) plus areas to complement the current CASGEM monitoring network. Tasks 7 and 8 provide the reporting and dissemination of project information to the agencies who would be responsible for improved monitoring.

CEQA Compliance, Access to Private Property, Permits, and Confidential Data

This Project does not involve additional steps necessary for permits nor compliance with the California Environmental Quality Act (CEQA). The Project constitutes a study, and, as such, is exempt from CEQA documentation. Field visits to the Project Area can be accomplished without access to private property. TGBA is in the process of sending letters to prospective well owners in the eastern subbasin, including the Project Area. It is beyond the scope of this Project to visit, inspect, or seek additional well owner permission to conduct monitoring in a private well, so access agreements are not necessary. Rather, the Project will identify key areas of interest and available well data for the PAC /TGBA consideration for future monitoring. The identification of promising areas for monitoring and/or target wells can be accomplished through examination of well documentation and use of GIS layers and other maps. No physical facilities are proposed or needed for the project. No permits are required.

Some of the data compiled and analyzed for this Project are subject to confidentiality agreements such as the DWR Driller's Logs and regulations connected with the Homeland Security Act (HSA) of 2002. TGBA will remain vigilant in adhering to confidentiality agreements and current law. Nonetheless, almost all of the technical details and interpretations relatively to this Project can be incorporated into the Project database without compromise of these requirements.

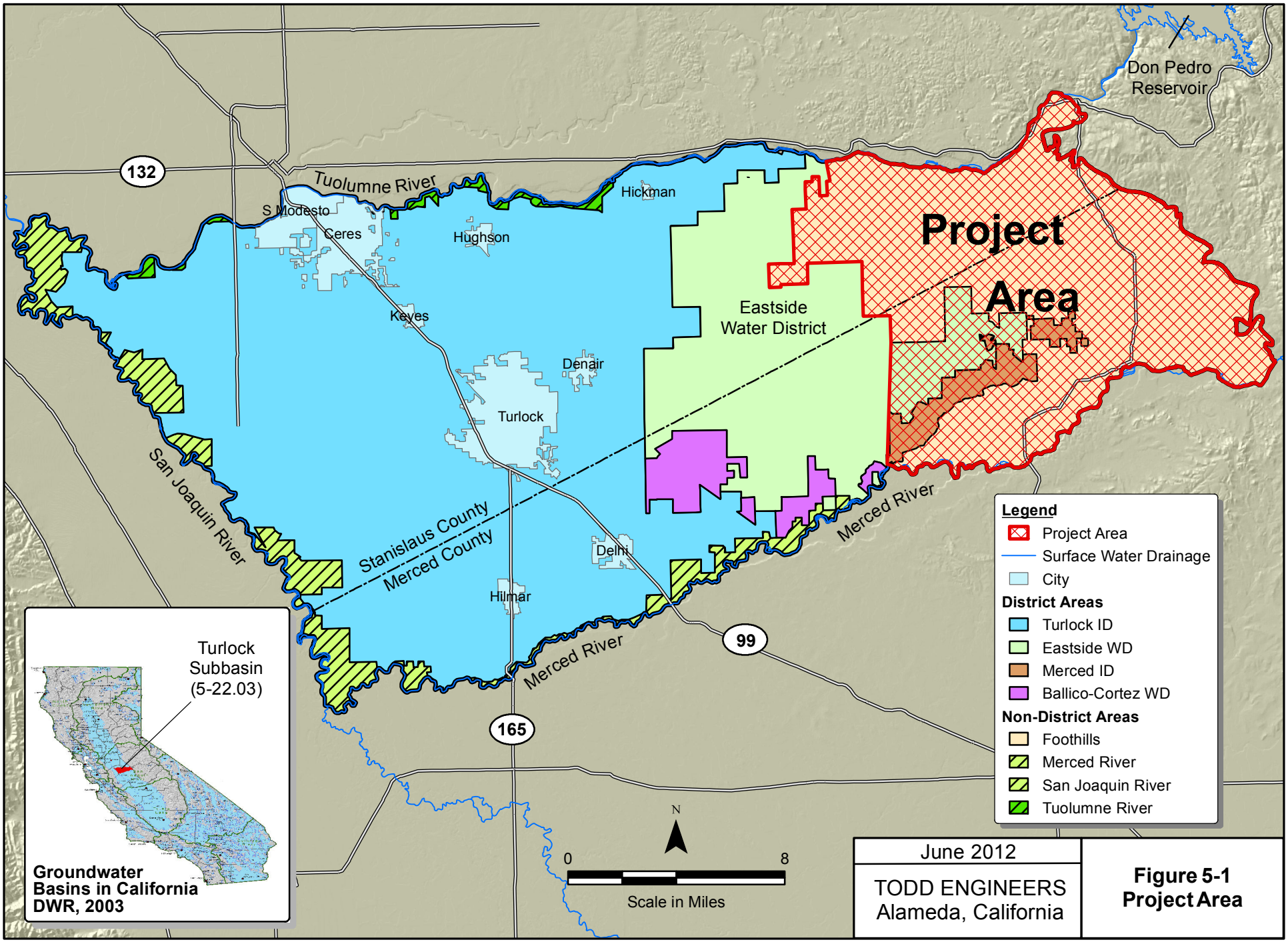
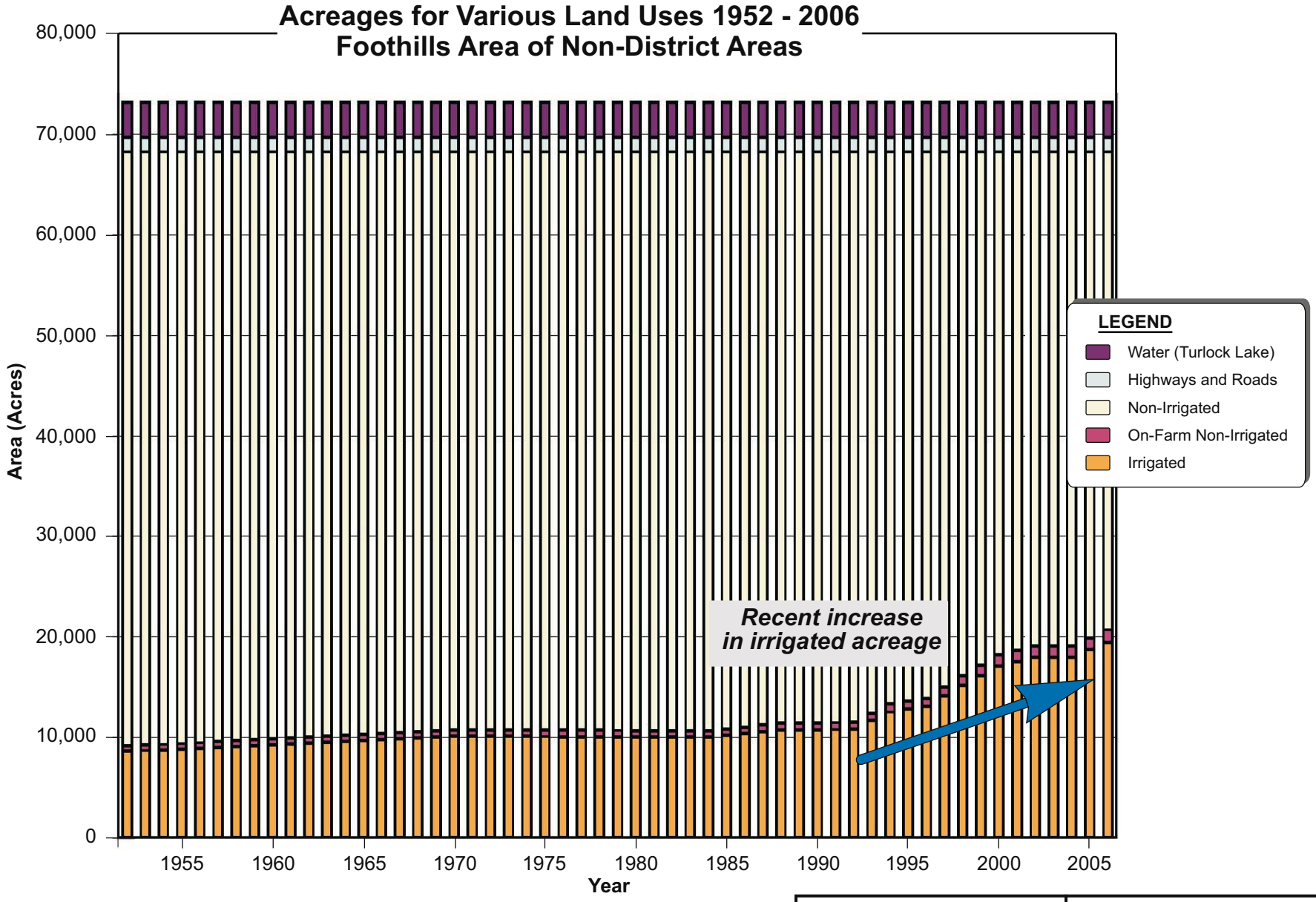


Figure 5-1
Project Area



Note: Foothills Non-District Areas shown as part of the Project Area on Figure 5-1

Source: TGBA, 2008, Figure 4d.

June 2012	Figure 5-2 Generalized Land Use for Foothills Non-District Areas in Project Area
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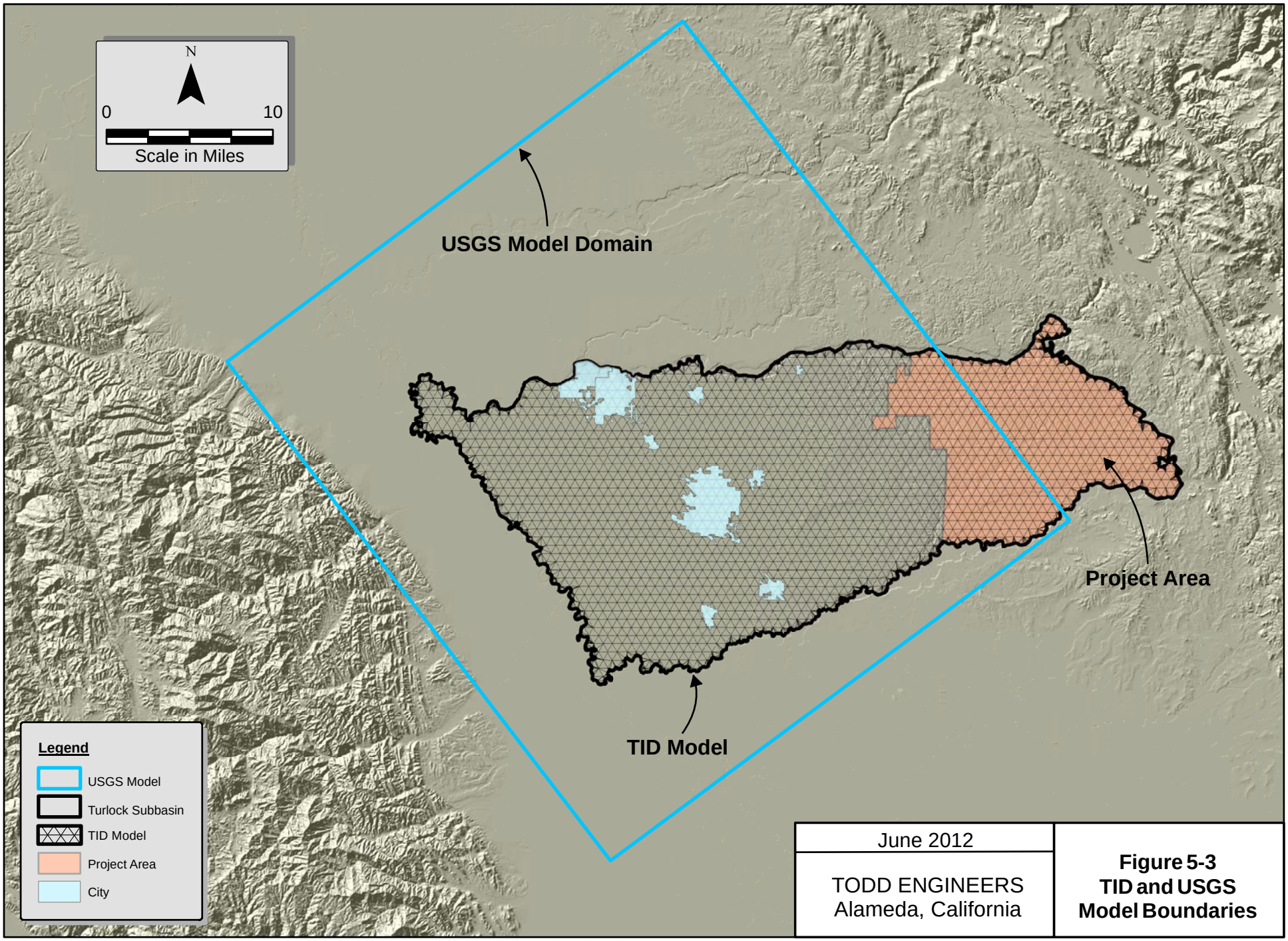

June 2012

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Figure 5-3
TID and USGS Model Boundaries