Presentation Purpose: Provide overview of two regional enhanced recharge studies being undertaken by the Sonoma County Water Agency and many of its local partners:

• Stormwater Management/Groundwater Recharge Studies – Assessing feasibility for multi-benefit projects in three watersheds (Laguna – Mark West, Sonoma Valley and Petaluma Valley) that manage **local stormwater** in a manner that both lessen flooding and enhance groundwater recharge.

• Groundwater Banking Feasibility Study – Assessing feasibility of storing surplus **Russian River drinking water** during wet weather conditions (i.e., the winter and spring seasons) in aquifers beneath the Santa Rosa Plain and/or Sonoma Valley. The stored water would then be available for subsequent recovery and use during dry weather conditions (i.e., the summer and fall seasons) or emergency situations.

Presentation will include:

•Drivers and Benefits of Enhanced Recharge

•Overview of both studies, including objectives, methodology, results of work completed to date and next steps

The general theme common to both studies is improving the sustainability of local water resources through coordinated and integrated management of surface water and groundwater resources.

Water Resource Issues & Challenges

- Water Supply Reliability
- Operational Reliability
- Resilience Against Natural Hazards
- Adaption to Climate Change
- Balancing Surface Water & Groundwater

Water Supply Reliability - For people and the environment, Changing Regulations, Drought, Growth

Maintain Operational Reliability - Water Quality, Aging Infrastructure

Improve Resilience Against Natural Hazards - Seismic, Extreme Events

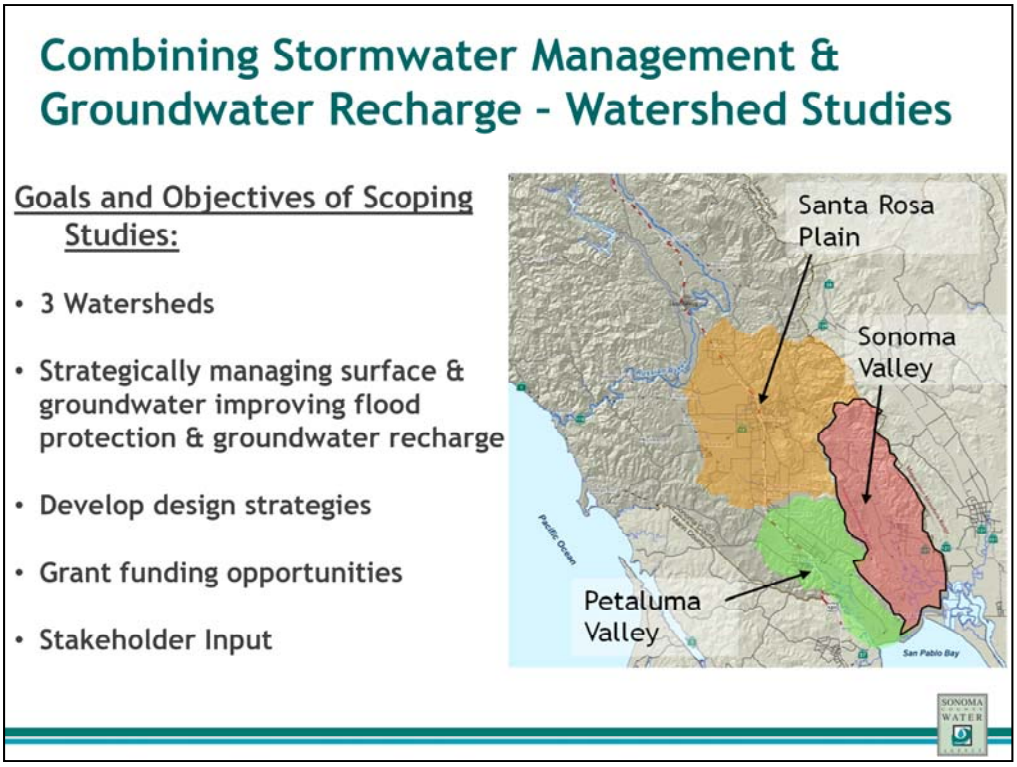
Adapt to Climate Change - Climate Variability, Sea Level Rise, Habitat Changes, Increased Water Demand (ET, soil moisture)

Balancing Surface Water & Groundwater - Increased reliance on groundwater could lead to localized areas of declining groundwater levels/salt-water intrusion if not well planned and coordinated with surface water resources.

Management Strategies from Sonoma Valley GMP

- **CONSERVATION** of Urban, Non-Urban, & Agriculture
- **RECYCLED WATER** use to offset groundwater pumping
- **STORMWATER** to recharge of groundwater
- **BANKING** Russian River water to recharge groundwater basin

The importance of pursuing both studies in a strategic manner was recognized by the Basin Advisory Panel in Sonoma Valley, which identified both stormwater recharge and groundwater banking as primary strategies for sustaining groundwater resources in Sonoma Valley, in addition to increased conservation and use of recycled water to offset groundwater pumping.



The Stormwater Management/Groundwater Recharge studies are being conducted in 3 separate watersheds which the Sonoma County Water Agency has flood control responsibilities.

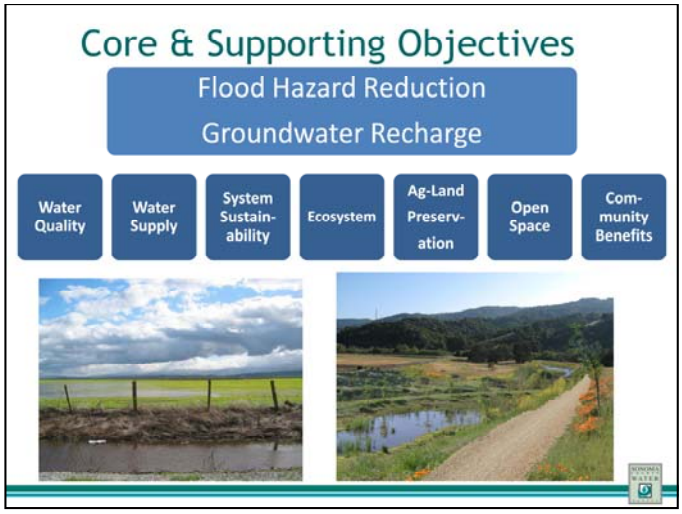
•Laguna-Mark West (Santa Rosa Plain)

•Sonoma Valley

•Petaluma Valley

The goal of the studies is to identify projects that improve both flood protection and groundwater recharge.

The Scoping phase of the study was conducted in 2011 through 2012 with the objectives of developing design strategies, screening potential projects and assessing potential grant funding opportunities through the input from local stakeholders.



The core objectives of any project identified through the scoping study include both flood hazard reduction and groundwater recharge. Supporting objectives identified as important to stakeholders include:

•Protecting or improving groundwater and surface water quality

•Enhancing water supplies by increasing recharge to groundwater aquifers

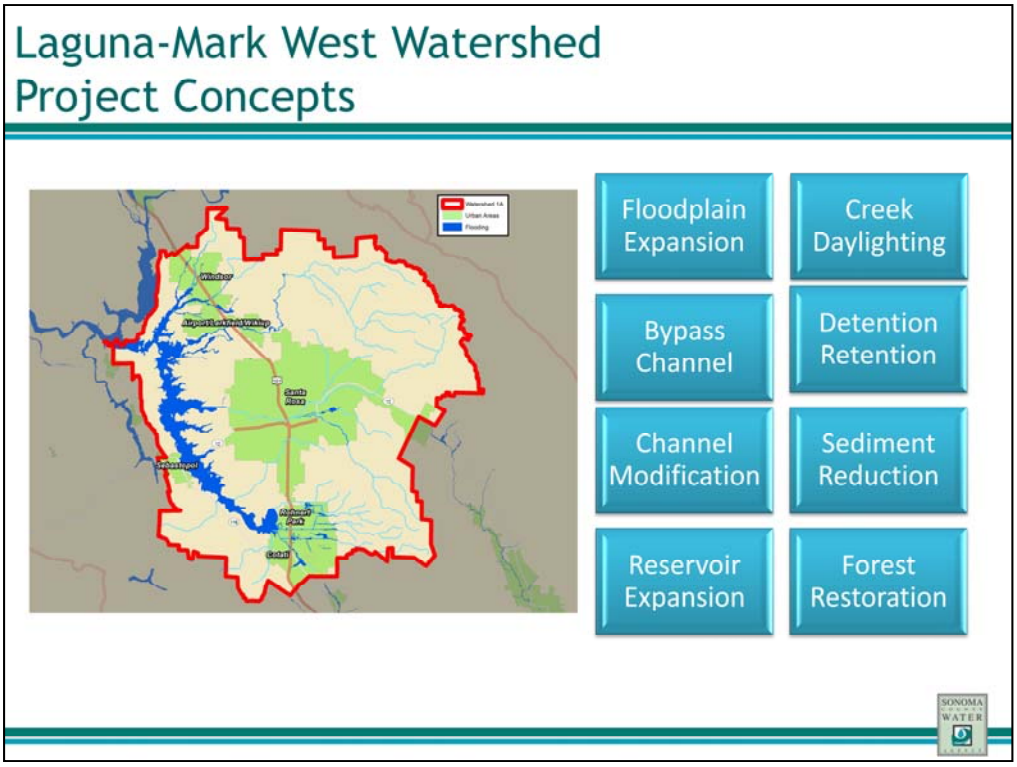
•Promoting the sustainability of local water resources

•Improving ecosystem conditions either by incorporating habitat improvements as part of projects or through enhancing baseflows to streams through groundwater recharge to shallow aquifers

•Pursuing projects that are compatible with and encourage the preservation of agricultural lands

•Preservation of open space

•Provide community benefits through recreational opportunities and public education regarding local water resources



For the Laguna-Mark West Watershed, the consultant team includes:

- GHD - Project Management, Hydrology and Hydraulics
- Todd Engineers - Hydrogeology
- Horizon Water and Environment - Geomorphology and Feasibility

Through stakeholder meetings and workshops the consultant team identified a number of project concepts to meet the core and ancillary objectives. These concepts include the following types of projects:

•Floodplain expansion

•Creek Daylighting

•Bypass Channel

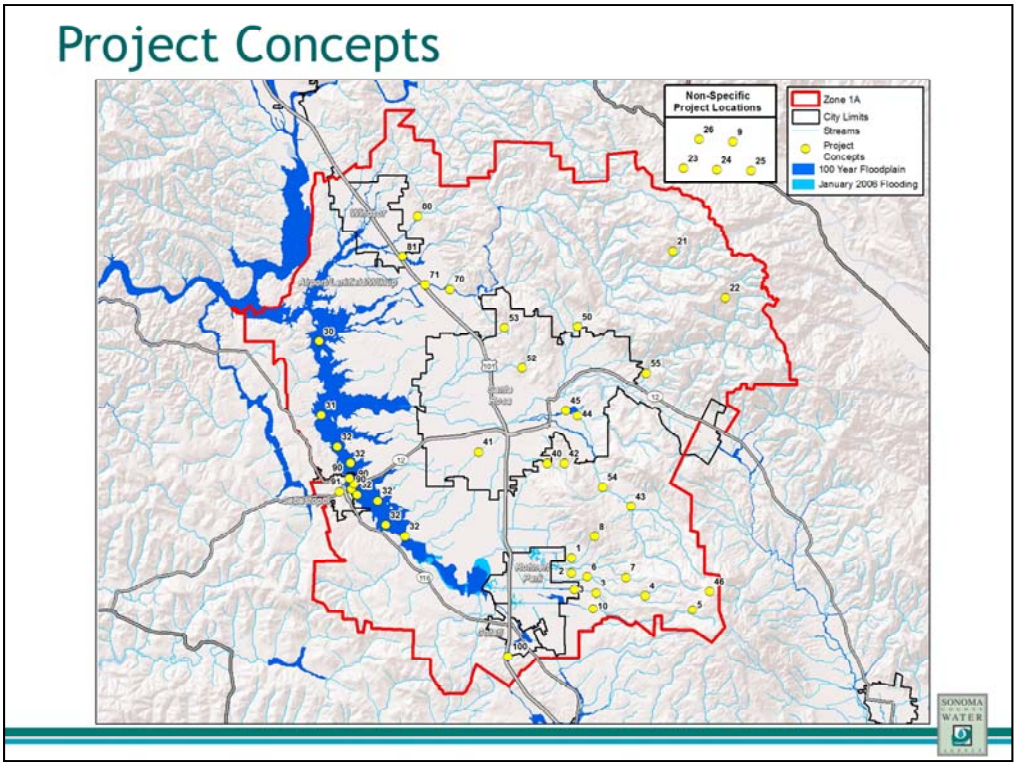
•Detention/Retention

•Channel Modification

•Sediment Reduction

•Reservoir Expansion

•Forest Restoration



Through stakeholder workshops on April 27, 2011 and February 27, 2012 and through individual meetings, the consultant team initially identified 39 potential projects and project concepts that meet the criterion laid out for the study.

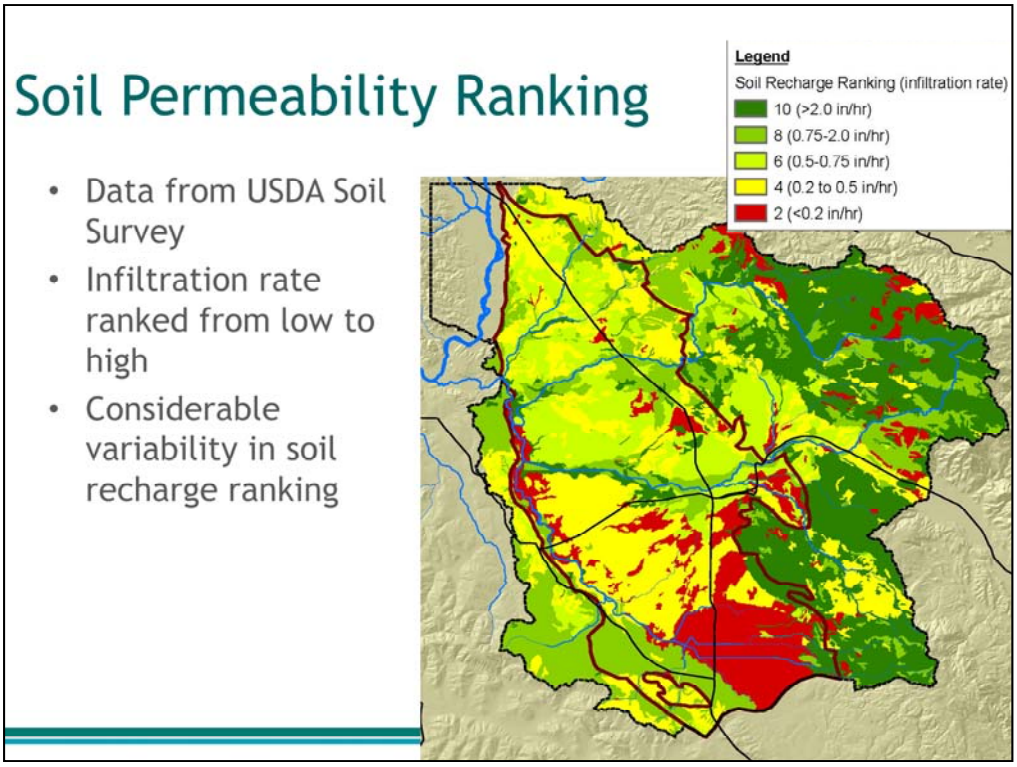
These potential projects and concepts were then screened using GIS techniques to evaluate which projects have the potential to meet both core objectives by looking at recharge potential and flood protection potential.

Recharge Potential Assessment

Recharge Maps

1. Natural Recharge: Soil/Slope/Geology
   - Assumes shallow soils remain in place
2. Engineered Recharge: Geology/Slope
   - Assumes shallow soils are excavated

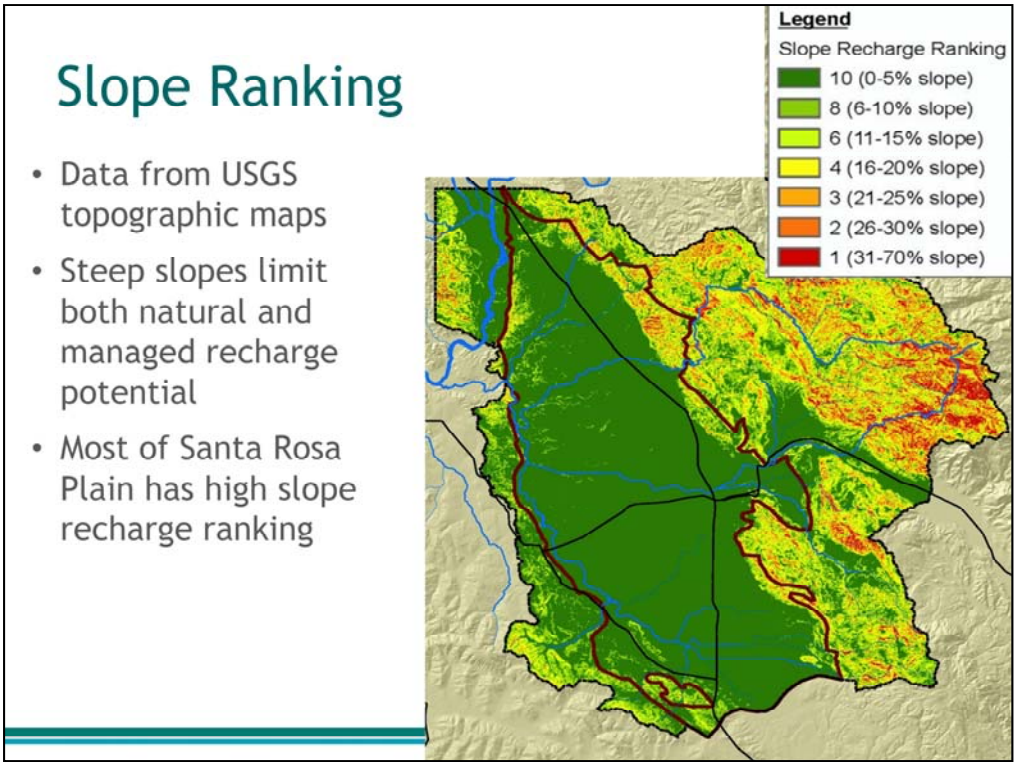
Two types of recharge conditions were analyzed and mapped. One which assumes that shallow soils remain in place (Natural Recharge condition which takes into account Soil, Geology and Slope) and one which assumes shallow soils are excavated (Engineered Recharge condition which takes into account Geology and Slope).



Data from the USDA Soil Survey was mapped and ranked by infiltration rate.

Some of the highest values occur in the upland areas where soils are thinnest and along stream channels.

Some of the lowest values occur in the Southern Santa Rosa Plain (vicinity of Rohnert Park and Cotati) and along the floodplain of the Laguna.

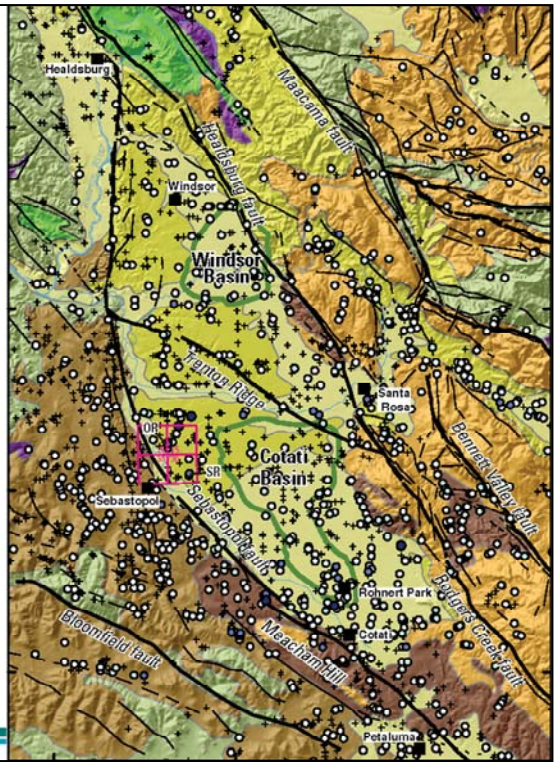


Topographic slope was mapped and ranked with flatter slopes where surface water is more likely to pond ranked higher and steeper slopes where surface water is more likely to run-off ranked lower.

Not surprisingly, the Plain and Valley areas within the watershed were ranked highest.

Recent Refined Geologic Data

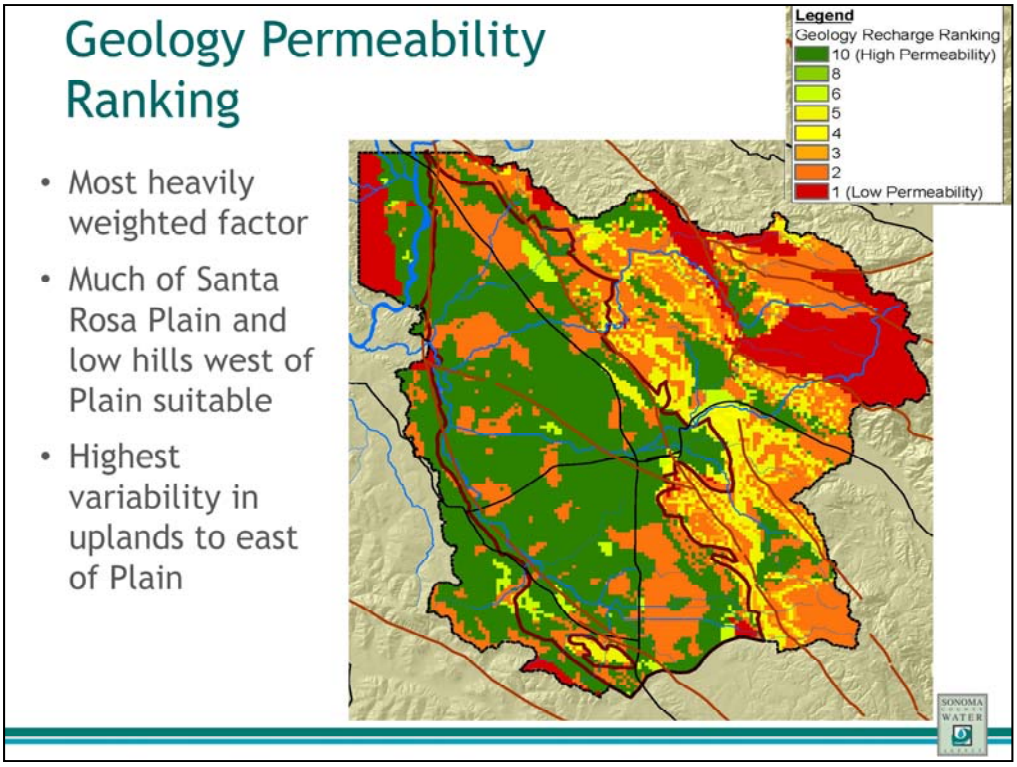
- Data from USGS June 2010 publication on Lithologic Model of Santa Rosa Plain
- Data from 2,683 well logs interpreted
- Formation and texture interpretations used to rank permeability of geologic materials



The project consultants utilized data and analysis from USGS 2010 publication by Sweetkind et al, *Three-dimensional geologic modeling of the Santa Rosa Plain, California.* The USGS study interpreted, processed and modeled geologic characteristics from 2,683 water well logs within the study area to develop a 3-dimensional geologic model.

Formation and texture descriptions from this model were used to rank and map the permeability of geologic materials.

For the Stormwater Management/Groundwater Recharge study, the shallowest layer of the model representing depths ranging from 0 to 50 ft were used.

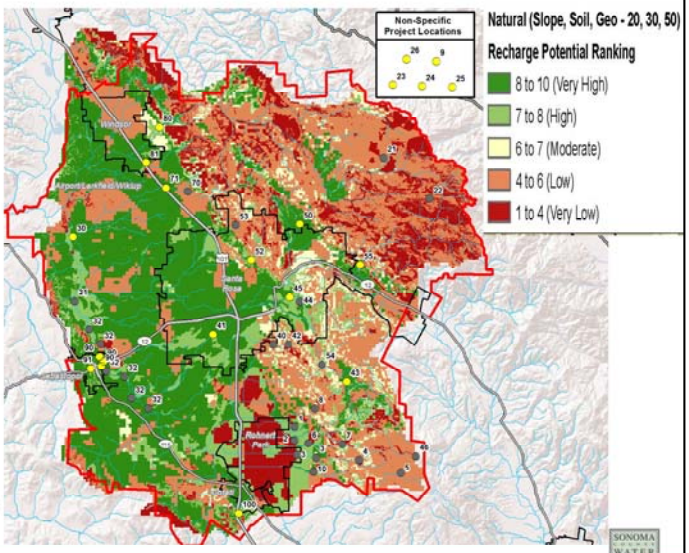


The resultant Geology permeability map represents the most heavily weighted factor in determining Recharge Potential.

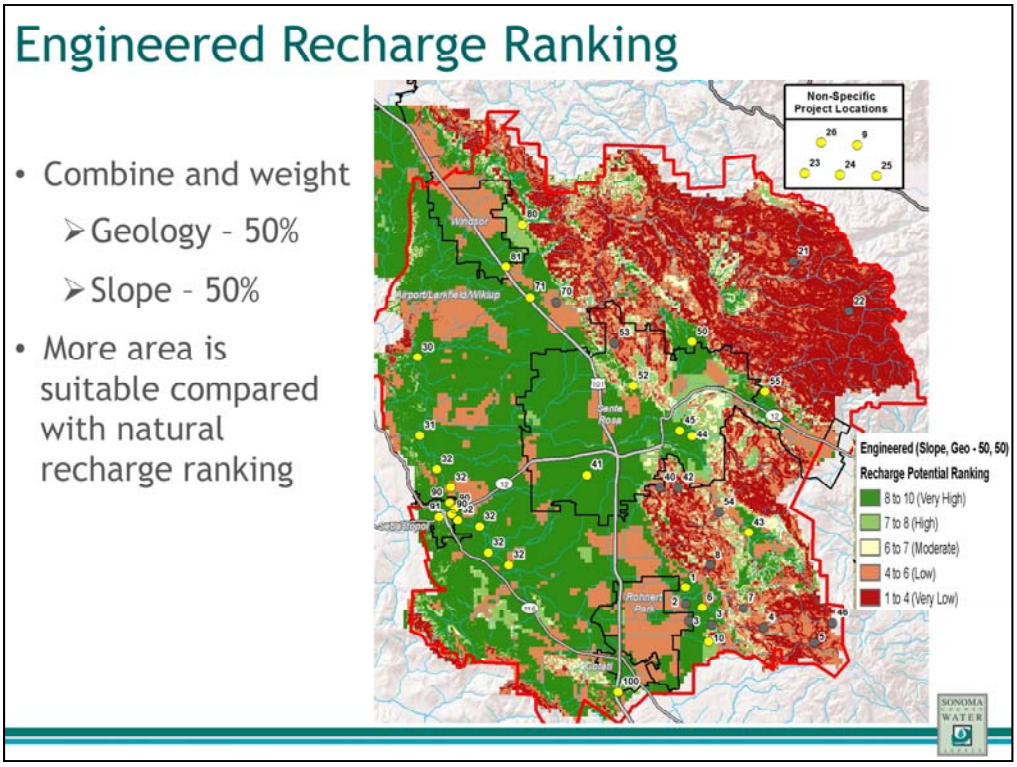
The results indicate that much of the Santa Rosa Plain and low hills west of the Plain appear suitable for recharge with the highest variability occurring in the uplands to the east of the Plain.

Natural Recharge Rating

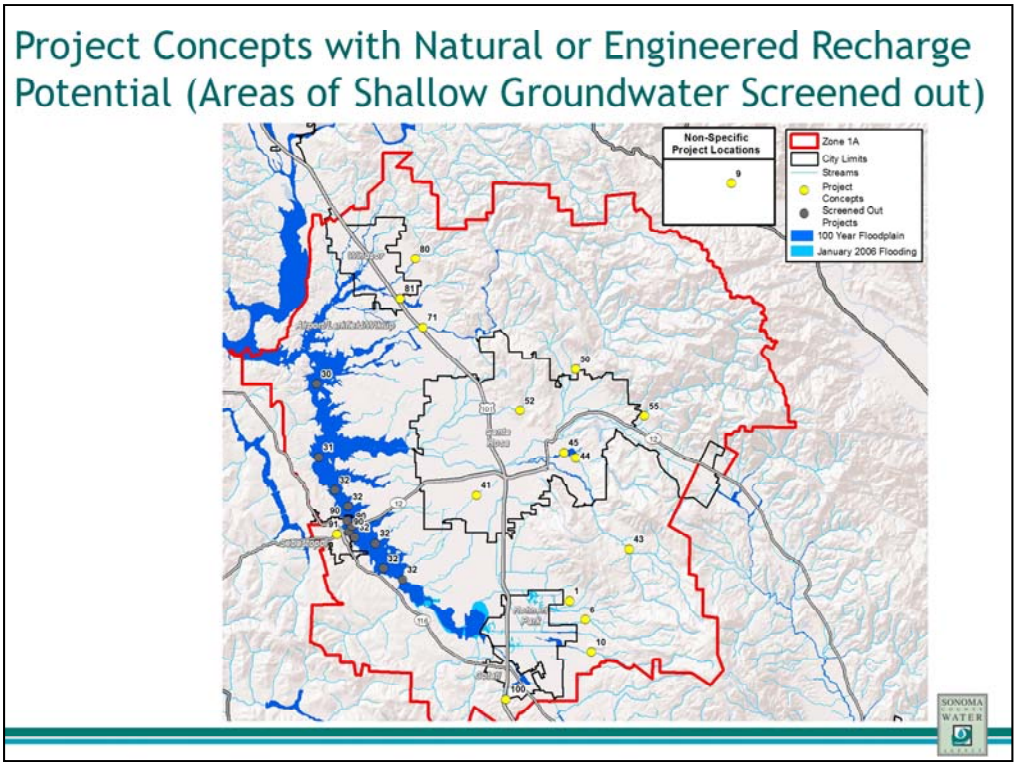
- Project types
  - Minimal or no excavation of surface soils
  - Swales
  - Small diversions
  - Land spreading
- Combines and weights
  - Soil permeability - 30%
  - Slope - 20%
  - Geologic unit permeability - 50%



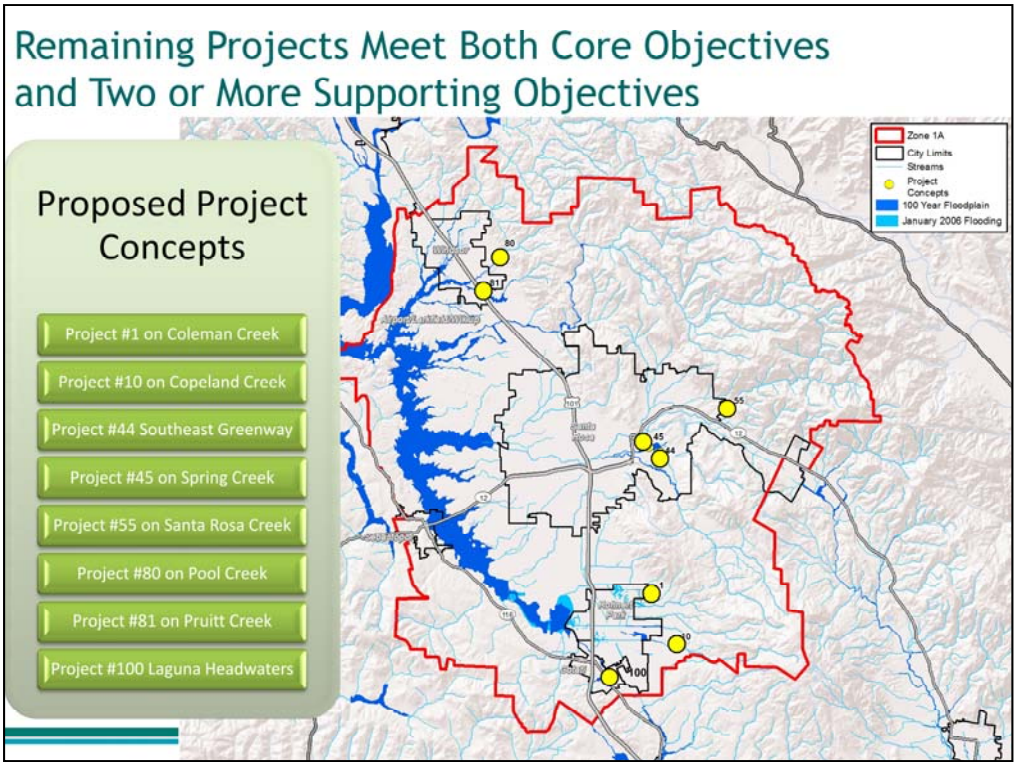
The Natural Recharge Potential ranking assumes that minimal to no excavation of surface soils occurs and would be appropriate for assessing project concepts such as floodplain expansion and channel bypasses.



- Engineered recharge rankings assume soil less than 6 feet deep can be excavated for engineered recharge projects
- Example Engineered Recharge Projects
  - ➢ Spreading basins
  - ➢ Detention basins



Project concepts with Natural or Engineered Recharge Potential were carried forward after screening out for areas that are within or downstream of flooding areas and areas with anticipated shallow groundwater conditions.

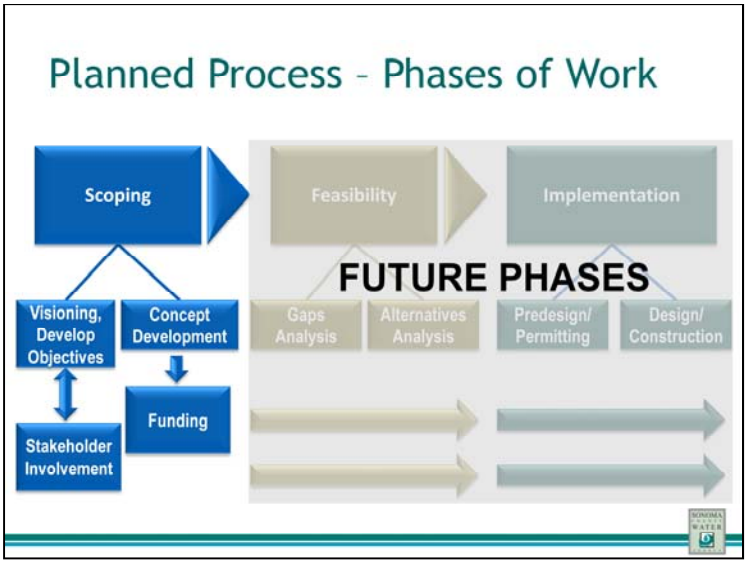


The resultant projects/project concepts were then further screened and ranked according to whether they met both core objectives and two or more supporting objectives.

The highest ranking projects generally occur along an arc at the eastern margins of the Santa Rosa Plain along the alluvial fans of creeks draining the Sonoma and Mayacamas Mountains.

Preliminary feasibility assessment suggests that Project 1 on Coleman Creek, Project 45 on Spring Creek, Project 55 on Santa Rosa Creek, and Project 100 in the

upper Laguna watershed, may be the easiest to implement.

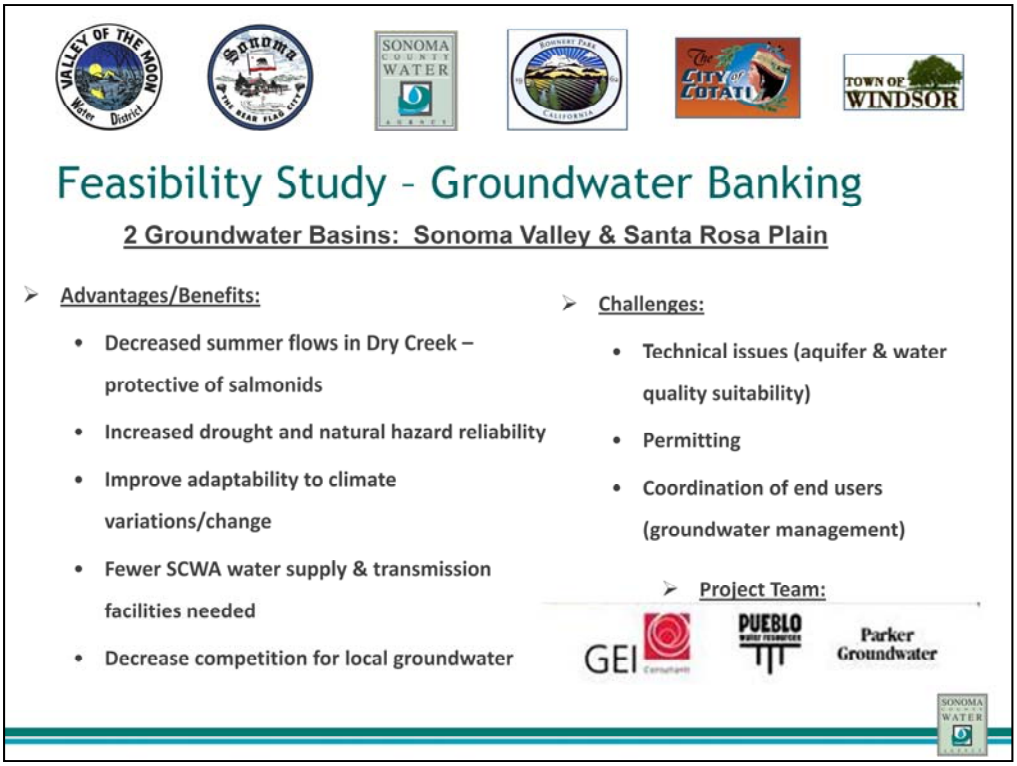


The next phase of the Scoping Study will include a Feasibility Study Scoping wherein identification of data gaps will be made and a scope of work for a future Feasibility Study will be developed. In addition, a Funding Support task may be initiated in which specific funding related goals and funding priority guidelines would be developed.

Questions/Discussion

http://www.scwa.ca.gov/stormwater-groundwater/

The scoping study report which more fully describes the study and potential projects is located on the Water Agency's website at: http://www.scwa.ca.gov/stormwater-groundwater/



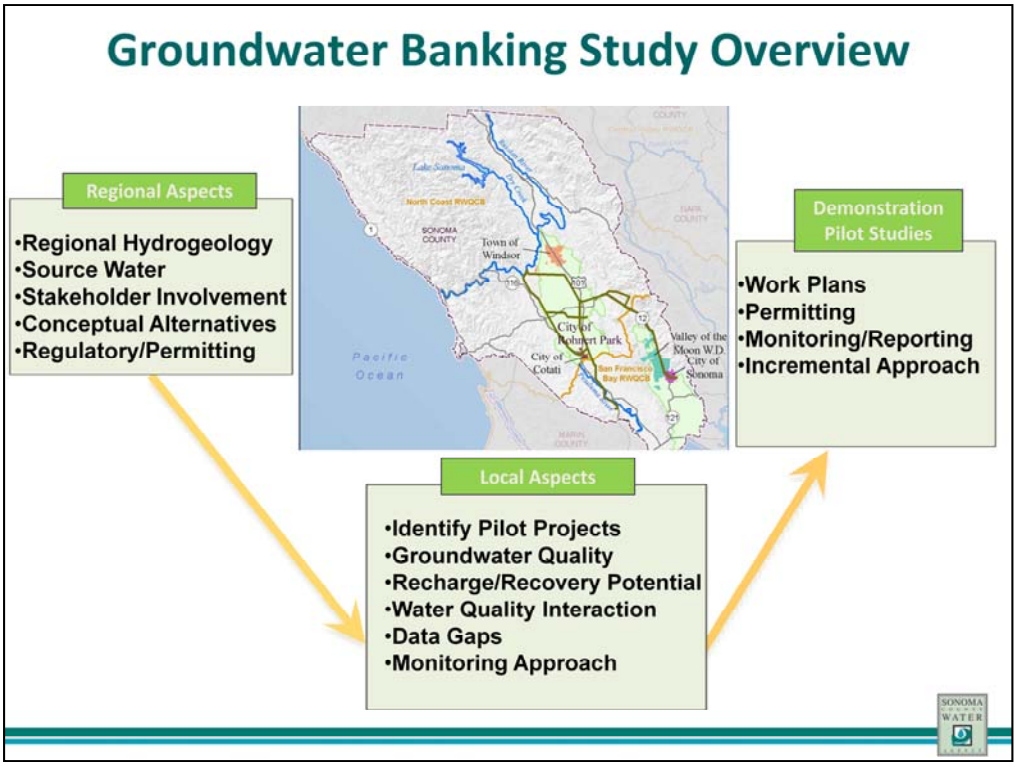
Feasibility Study for regional groundwater banking program being conducted by Water Agency and its partners, the Cities of Cotati, Rohnert Park and Sonoma, Valley of the Moon Water District, and the Town of Windsor (study participants).

Diversion and transmission of surplus Russian River water produced at existing drinking water production facilities during wet weather conditions (i.e., the winter and spring seasons) for storage in aquifers beneath the Santa Rosa Plain and/or Sonoma Valley. The stored water would then be available for subsequent recovery and use during dry weather conditions (i.e., the summer and fall seasons) or emergency situations. By incorporating a water management strategy that more closely matches the natural hydrologic cycle, several potential benefits can be realized:

•In combination with existing and planned conservation and recycled water projects, would provide enhanced reliability of the regional water supply during droughts, natural hazard events (e.g., earthquakes), and periods of peak seasonal water demands.

•Improve habitat conditions by enhancing tributary base flows by reducing groundwater pumping, or in the case of Dry Creek, reducing summer releases from Warm Springs Dam (due to reduced peak demands) thus improving flow conditions for ESA-listed salmonids.

To pursue these potential benefits, the study participants are exploring groundwater banking in a systematic and phased approach utilizing information obtained from completed and ongoing scientific studies and groundwater management activities sponsored by the Water Agency and its partners.



Regional Aspects of Study:
•Evaluate regional opportunities and constraints, including regional hydrogeologic conditions
•Characterize source water availability and quality
•Evaluate available information and develop data gap analysis.
•Stakeholder involvement and participation at key stages.
•Develop conceptual project alternatives.
•Evaluate regulatory and permitting needs

Local Aspects of Study
•Identify specific potential pilot-scale projects for testing
•Assess existing groundwater quality data
•Evaluate existing well conditions
•Evaluate specific potential recharge and recovery locations and methods.
•Assess potential site-specific water quality interactions and issues.
•Assess data gaps and likely monitoring and permitting needs

Pilot-Scale Demonstration Studies
•Prepare Work Plans
•Permitting (RWQCB, CDPH, CEQA, etc)
•Monitoring and reporting
•Incremental scaling of projects (start small and evaluate results)
•Recommendations for next steps based on pilot-scale results

Primary Components of Groundwater Banking Feasibility Study

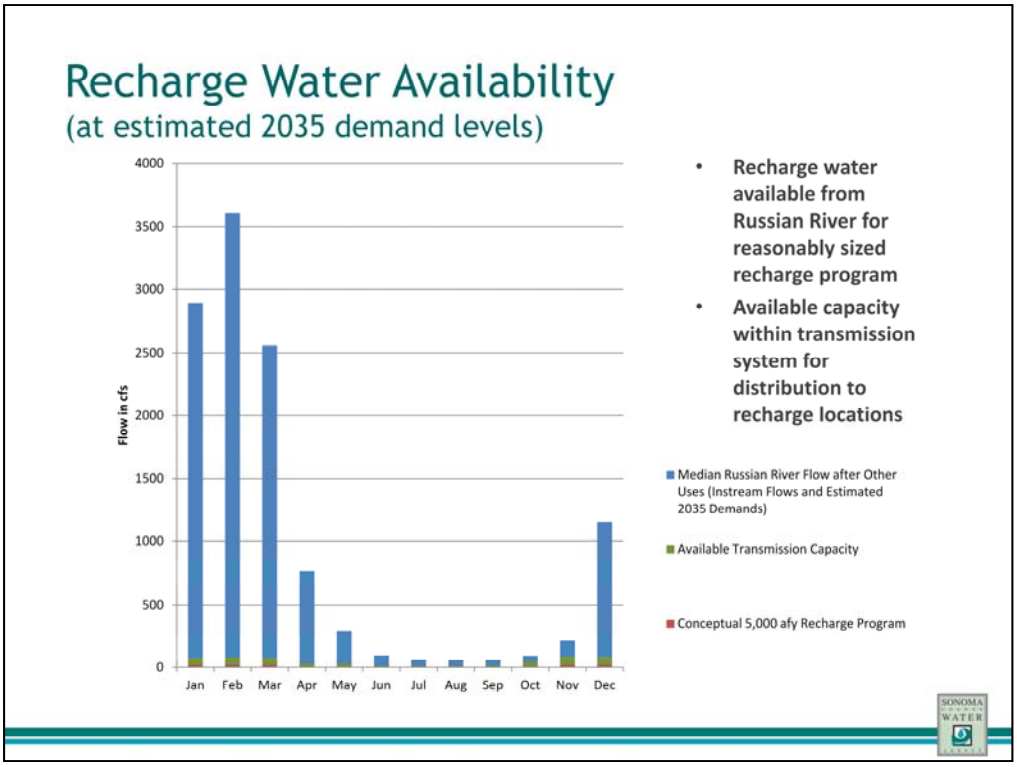
- What's available to bank? – **Source Water Characterization**
- Where can it be banked? – **Hydrogeology/Conveyance**
- How? – **Technical Considerations**
  - Water Quality Testing & Modeling
  - Permitting
  - Incrementally phased pilot-scale testing

Primary questions being addressed by the feasibility study are:

•What is available to bank? Seasonal availability of wintertime Russian River drinking water for recharge.

•Where can it be banked? Hydrogeologic evaluation of potential aquifers suitable for banking.

•What is best method for banking and what is needed for developing a program? Aquifer Storage and Recovery, surface spreading, in-lieu, etc. Water quality testing and modeling has been conducted to assess potential geochemical interactions. Coordination with regulatory agencies for permitting needs has been initiated. Small-scale pilot-testing is required in order to collect data to fully assess feasibility

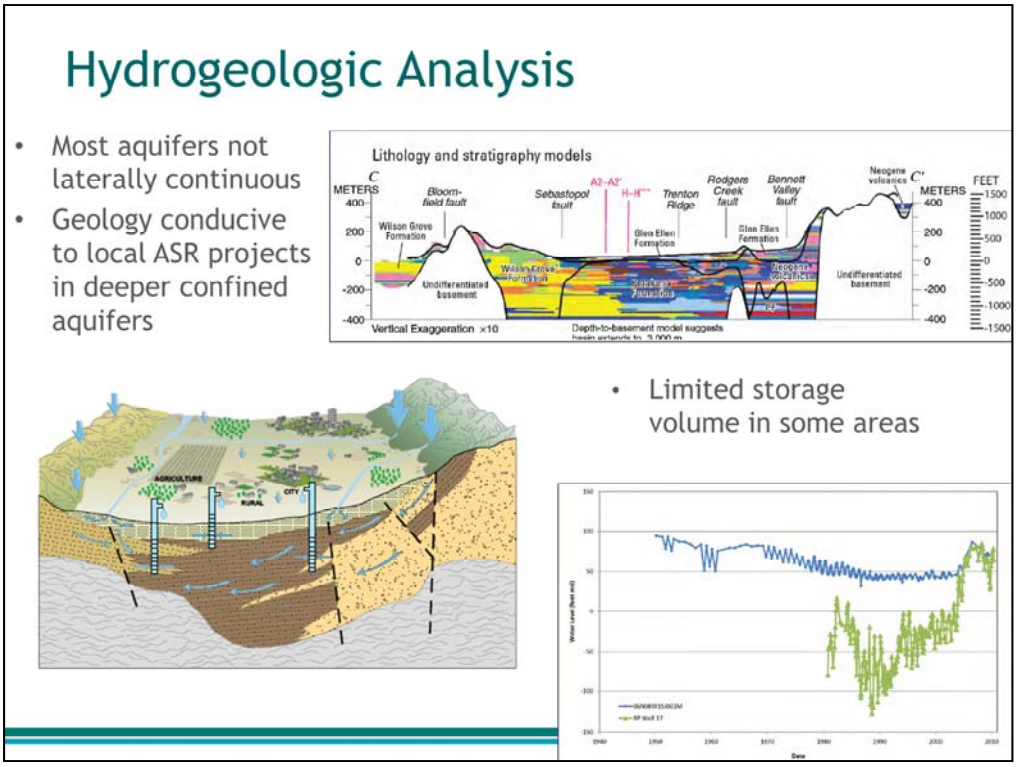


Estimated 2035 water demands from 2010 Urban Water Management Plans (UWMPs) were utilized to model the median Russian River Flow at Guerneville after other uses, including required Instream Flows).

For the purposes of the feasibility study assessment a preliminary conceptually sized groundwater banking program consisting of the recharge and storage of approximately 5,000 acre feet per year was evaluated.

The amount of source water required for such a program is assumed to be recharged over five months (from Nov to Mar) and is graphed along with the available transmission system capacity and median Russian River flow.

Results indicate there appears to be adequate winter-time Russian River water supplies and transmission system capacity to meet this conceptual storage targets.



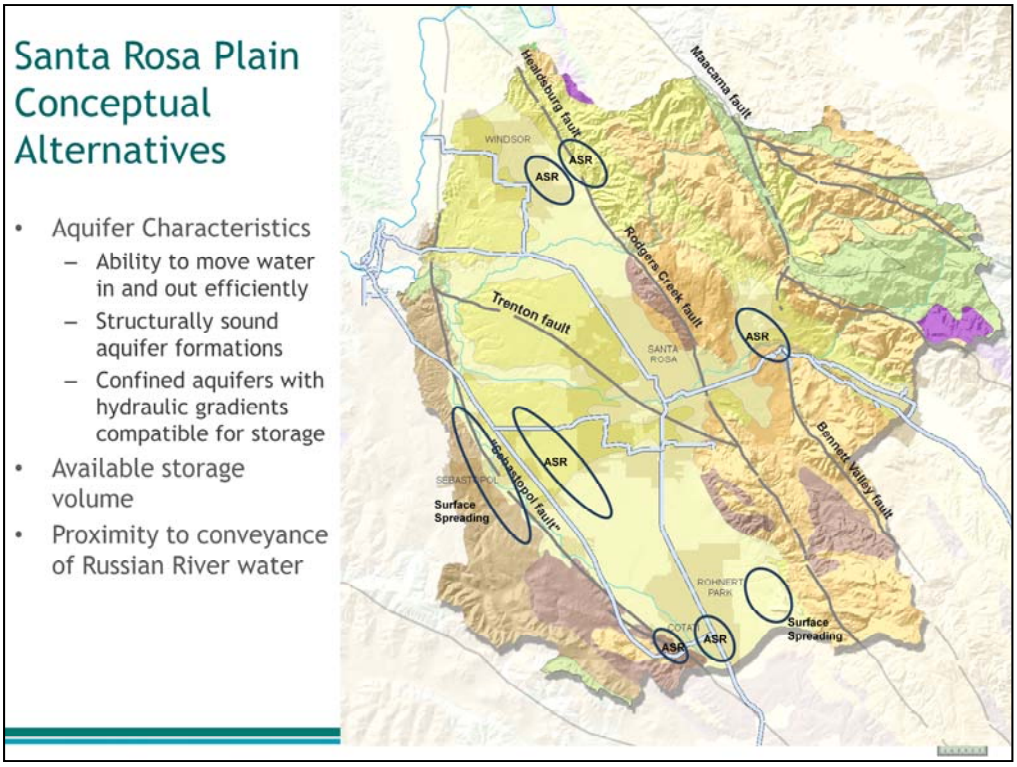
Regional Evaluation of the geology, production aquifers, groundwater levels and flow directions, groundwater quality, and the potential for subsidence and liquefaction.

Examined existing data sources and again utilized 3-dimensional modeling work of Sweetkind et al (2010).

Most aquifers are not laterally continuous and areas where deeper confined aquifers connect with the surface are limited.

There are limited opportunities for surface water recharge, but the intermediate and deep aquifers appear suitable for ASR recharge.

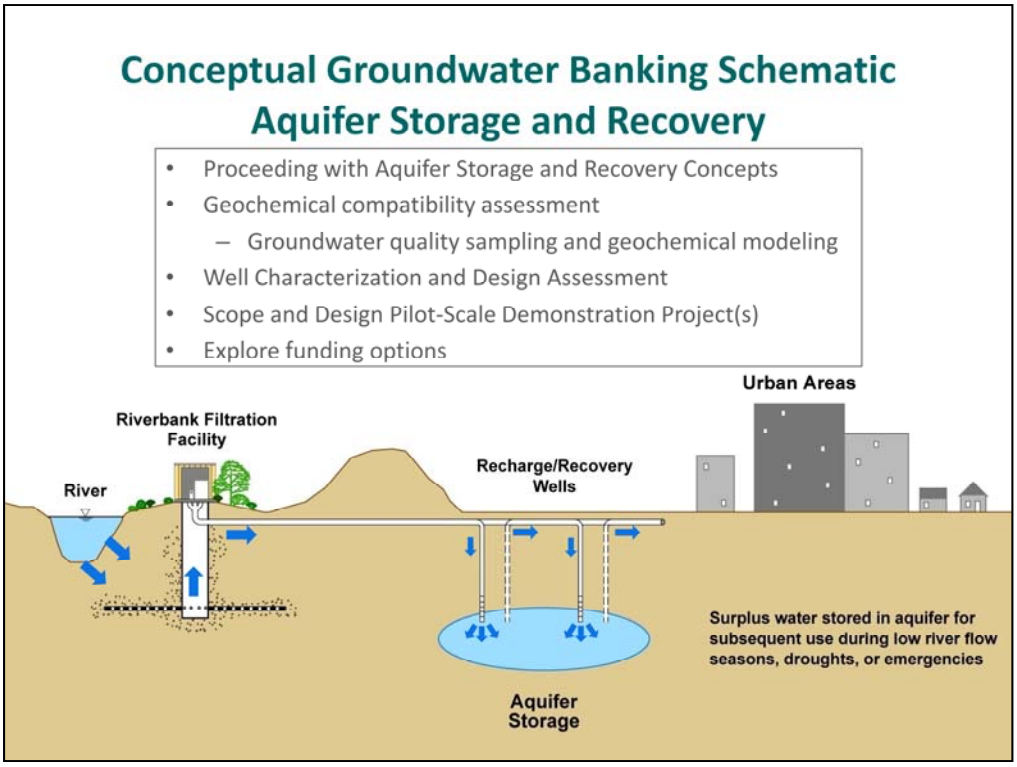
Increasing groundwater levels in some areas has limited the currently available storage capacity.



Evaluation of regional hydrogeologic and geochemical conditions has identified 14 potential groundwater banking alternatives in the Santa Rosa Plain and Sonoma Valley, including 9 within the Santa Rosa Plain. These include a combination of indirect (in lieu) and direct (surface spreading and ASR) recharge methods.

Two potential groundwater banking locations have been identified in the SRP that have potential for surface water spreading basins that could recharge the intermediate aquifers. One area located in the Wilson Grove Formation between Sebastopol and Llano may recharge the intermediate aquifer. The other location is along alluvial fans east of Rohnert Park underlain by coarse grained soils that appear to extend to the intermediate aquifer.

Four potential groundwater banking locations have been identified in the SRP that have potential for use of ASR well technology. One alternative is proposed for regional in-lieu water banking. For this alternative the use of local groundwater is reduced during seasons and years when surface water supplies are more plentiful, allowing groundwater levels to recover and be available when surface water is not readily available.



Of the two direct recharge methods, ASR is deemed to be the most practical to implement in the near term based on:

(1) the ability to incrementally establish an ASR program;

(2) the ability to pilot test ASR alternatives in a phased manner;

(3) the relatively lower costs associated with ASR; and

(4) uncertainties related to the ability of surface spreading alternatives to convey water to aquifers suitable for storage and subsequent recovery.

Water Quality Assessment

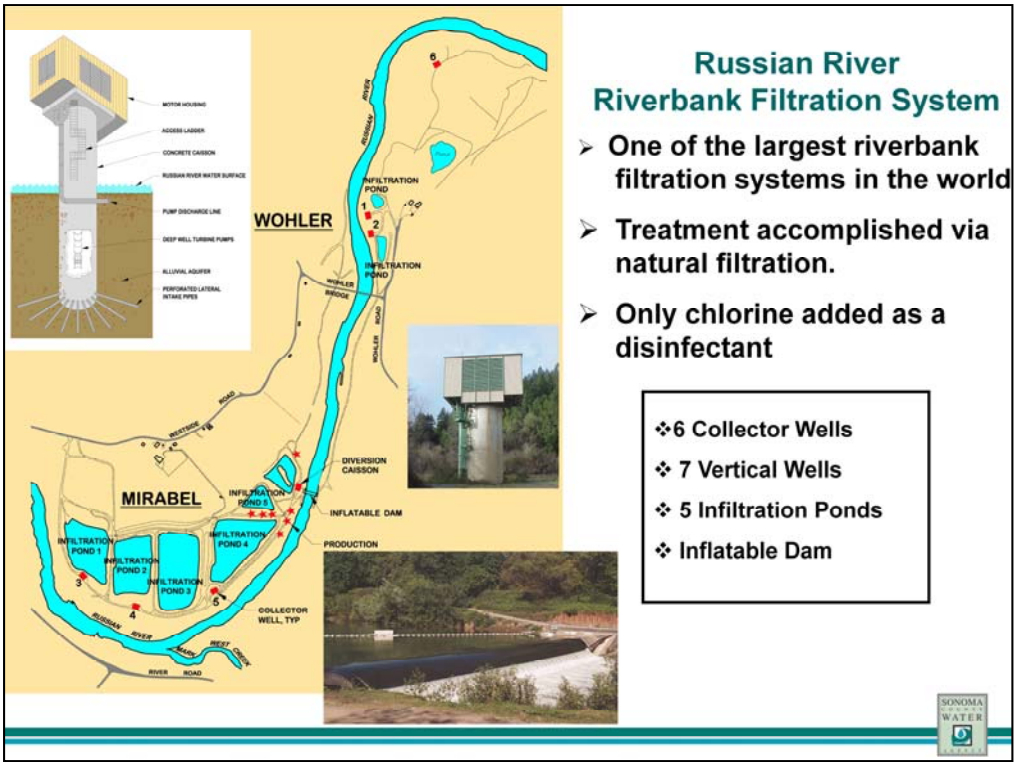
- Source Water Quality Characterization (Russian River) - **Complete**
  - Physical quality (particulates)
  - Mineral saturation (over/under equilibrium)
  - Redox condition
  - Disinfection by-products (e.g. THMs, HAAs)
  - Reactive compounds
  - 'Fingerprint' compounds
  - Title 22 potability
- Groundwater Quality Characterization - **Complete**
- Mixing of Source Water and Groundwater - Geochemical Modeling for Compatibility -**Ongoing**
  - Potential redox changes
  - Plugging potential

Elements of Water Quality Assessment:

•Collect data to determine the suitability of the Russian River drinking water as source water for recharge during potential future ASR operations.

•Collect site specific groundwater quality data at potential pilot study locations

•Conduct geochemical modeling to assess compatibility of Russian River water and local groundwater within aquifer sediments.



Overview of Water Agency Riverbank Filtration System

Six radial collector wells at the Wohler and Mirabel production facilities adjacent to the Russian River. Each collector well consists of a 13 to 18 foot diameter concrete caisson extending approximately 60 to 110 feet into the alluvial aquifer.

Russian River Well Field consisting of seven vertical wells located in the Mirabel area. These wells are currently not operated as primary production facilities, but are maintained for standby production and may be used as primary production facilities as needed.

Inflatable dam on the Russian River near Mirabel that allows for operation of five infiltration ponds at Mirabel that increase the area of infiltration along the Russian River.

The pumping capacity of the six radial collector wells is estimated to be approximately 92 mgd; however, significant variations to this estimated capacity can occur due to seasonal variations in river flows, operation of infiltration ponds, and sedimentation patterns along the riverbed.

Source Water Quality Overview – Comparison with Other ASR Source Waters

	SCWA – Russian R. North Coast	Tracy – Stanislaus R. Central Valley	MPWMD – Carmel R. Central Coast	EBMUD – Mokelumne R. San Francisco Bay	Maximum Contaminant Level
Total Dissolved Solids	164	98	343	41	1,000**
Chloride	6.5	9	35	5	250**
Mercury (ug/L)	ND (<0.025)	--	--	--	2
Dissolved Organic Carbon	0.96	1.4	1.4	1.5	NA
pH	8.29	8.31	7.51	8.9	NA
Sulfate	17	11	91	15	500**
Haloacetic Acids (ug/L)	3.3	24	13	16	60
Total trihalomethanes (ug/L)	15.5	38	47	37	80
Dissolved Oxygen	6.0	5.0	3.0	6.0	NA
Silt Density Index	0.3	1.1	3.3	2.2	NA

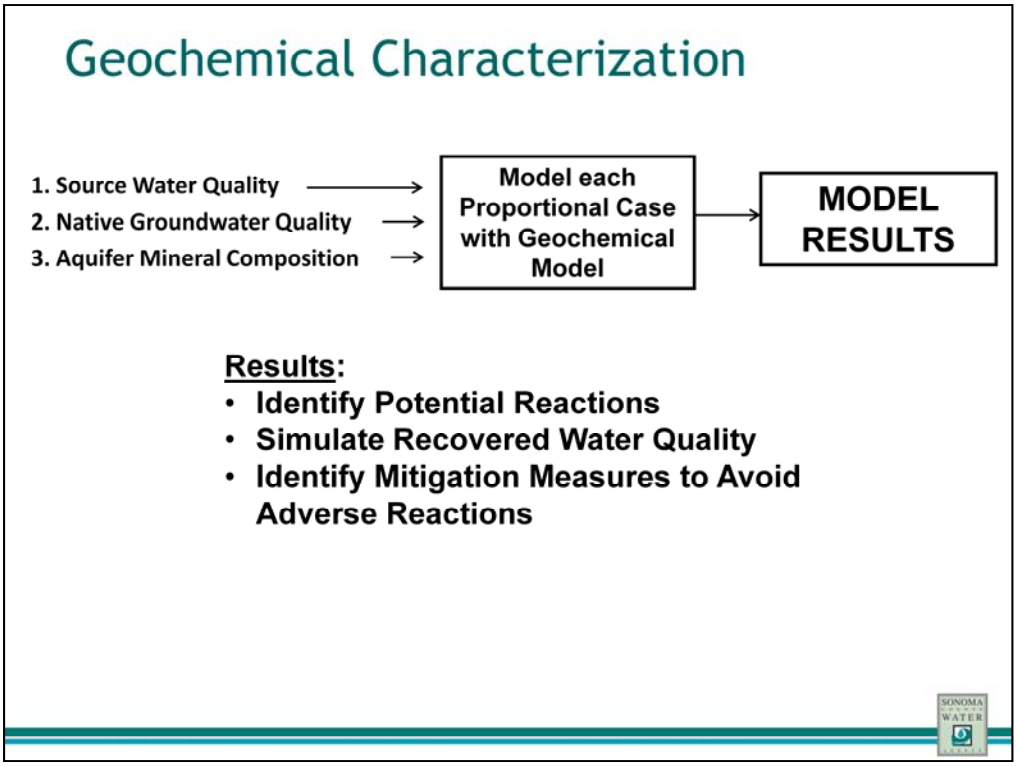
•All values in mg/L except where noted otherwise.
•**Secondary MCL

- **Very high quality drinking water**
- **Low levels of disinfection byproducts**
- **Low potential for clogging**

Water quality samples collected and analyzed from Russian River drinking water facilities and conveyance piping indicate that the source water represents an excellent candidate for direct recharge and ASR operations. Some general findings include:

- Very high quality drinking water
- Relatively low levels of disinfection byproducts (haloacetic acids and trihalomethanes)
- Relatively low levels of dissolved organic carbon
- Low potential for clogging (based on silt density index)

The very high water quality, low particulate and nutrient content should provide long recharge cycles with minimal plugging potential. Geochemical interaction modeling is being performed prior to pilot testing to assess native groundwater and aquifer matrix interactions with recharged water.



Site specific geochemical characterization consists of collecting groundwater quality samples from potential candidate wells and incorporating into a geochemical model.

Data geochemically matched and modeled with the specific native groundwater and mineral conditions present at a site to complete a 3-component chemical interaction analysis. This modeling effort assesses the potential for water intermixing and reaction with the sediments in the subsurface during aquifer storage.

ASR Pilot-Scale Demonstration Testing Need & Purpose

- Assess aquifer capacity for recharge and recovery
- Evaluate water quality during and following testing
- Gather data needed to assess feasibility of and properly scope potential permanent/full-scale system
- Test ASR viability in incremental steps and costs

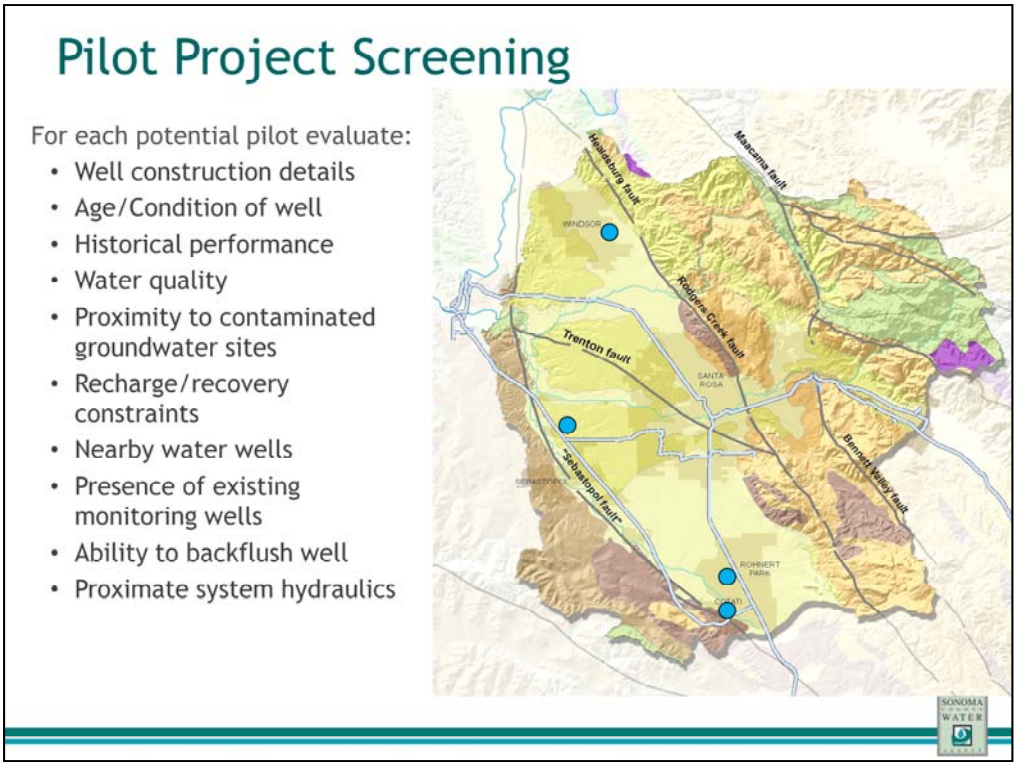
In order to fully evaluate the feasibility of ASR, pilot-scale demonstration testing is needed to:

•Assess aquifer capacity for recharge and recovery

•Evaluate water quality during and following testing

•Gather data needed to assess feasibility of and properly scope potential permanent/full-scale system

•Test ASR viability in incremental steps and costs



Suitable locations for performing pilot-scale ASR demonstration testing consisting of existing active and inactive municipal supply wells are being evaluated.

Approach for ASR Pilot-Scale Demonstration Testing

- Incremental, stepwise investigation allows 'stop & pause' progress
- Limited scale/duration of pilot programs
  - Duration dependant on water/well site availability
  - Short-term testing initially - 4-6 months minimum
  - Repeated cycles of recharge/storage/recovery
    - each cycle with longer duration and larger volumes
- Highly monitored
  - Extensive water level & water quality at pilot well and nearby wells (Background and through each cycle)
  - Recharge/Recovery efficiency
- Permitted through RWQCB
- CEQA compliance

The overall approach to ASR Pilot-scale demonstration testing is to develop an incrementally-phased data collection program that allows "stop and pause" progress.

The initial testing would be short-term in duration (e.g., 4 to 6 months) with relatively small volumes of water recharged (e.g., 50 to 75 acre feet) with extensive groundwater level and water quality monitoring.

In addition to water quality effects, the testing would also evaluate the aquifer and water well's efficiency for recharge and recovery.

Testing would be permitted by the RWQCB and would comply with CEQA.

Next steps for establishing a groundwater banking program:

•Identifying suitable locations for performing pilot-scale ASR demonstration testing;

•Developing work plans for the pilot-scale testing ;

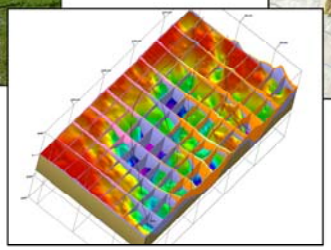
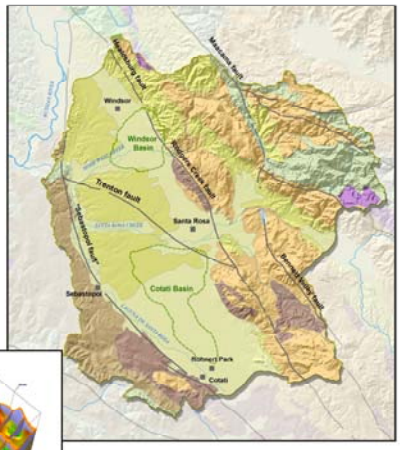
•Briefing local stakeholders and applicable regulatory entities on this study and recommended next steps; and

•Identifying funding sources for performing pilot-scale demonstration testing.

Potential Benefits of Enhanced Recharge

- Increased drought and natural hazard reliability
- Flood risk reduction
- Better maintain stream baseflows
- Improve adaptability climate variations/climate change
- Decrease competition for local groundwater
- May allow for reducing peak summer flows in Dry Creek – protective of salmonids

Potential Benefits of Enhanced Recharge

- May delay or eliminate need for future expensive capital projects by addressing peak summertime demands
- Further align with State policies on conjunctive management and integration of water supplies
  - **North Coast RWQCB Basin Plan:** Groundwater Recharge listed as Beneficial Use for surface water of the Russian River basin
  - **CA Dept of Water Resources:** Consistent with recommendations in State Water Plan and MOU between SCWA and DWR
  - **SWRCB:** Consistent with previous direction for conjunctive management and "replenishment of groundwater resources"

Discussion/Questions