Enhanced Groundwater Recharge Through Site Development

Presented by:

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Enhanced Groundwater Recharge Through Site Development

- Presentation Outline
  - Meeting enhanced recharge objectives
  - Enhanced recharge case study
    - Quantification methods
    - Recharge performance
  - Benefits and concerns

Land development can increase groundwater recharge in arid regions

- Natural recharge in semi-arid climates is very low (averaging mm/year)
- Land development adds impervious surfaces (roof tops, pavement, etc.)
- Runoff increases
- Utilizing retention basins for stormwater control can provide significant recharge

Meeting Enhanced Recharge Objectives

- Communities can increase groundwater supplies and lessen aquifer depletion
- Developers can reduce water consumption impact of new growth
- Water rights can be gained for return flow credits from recharge
- Quantifying return flow is needed for water rights to be granted
- Recharge promotes sustainable water supply

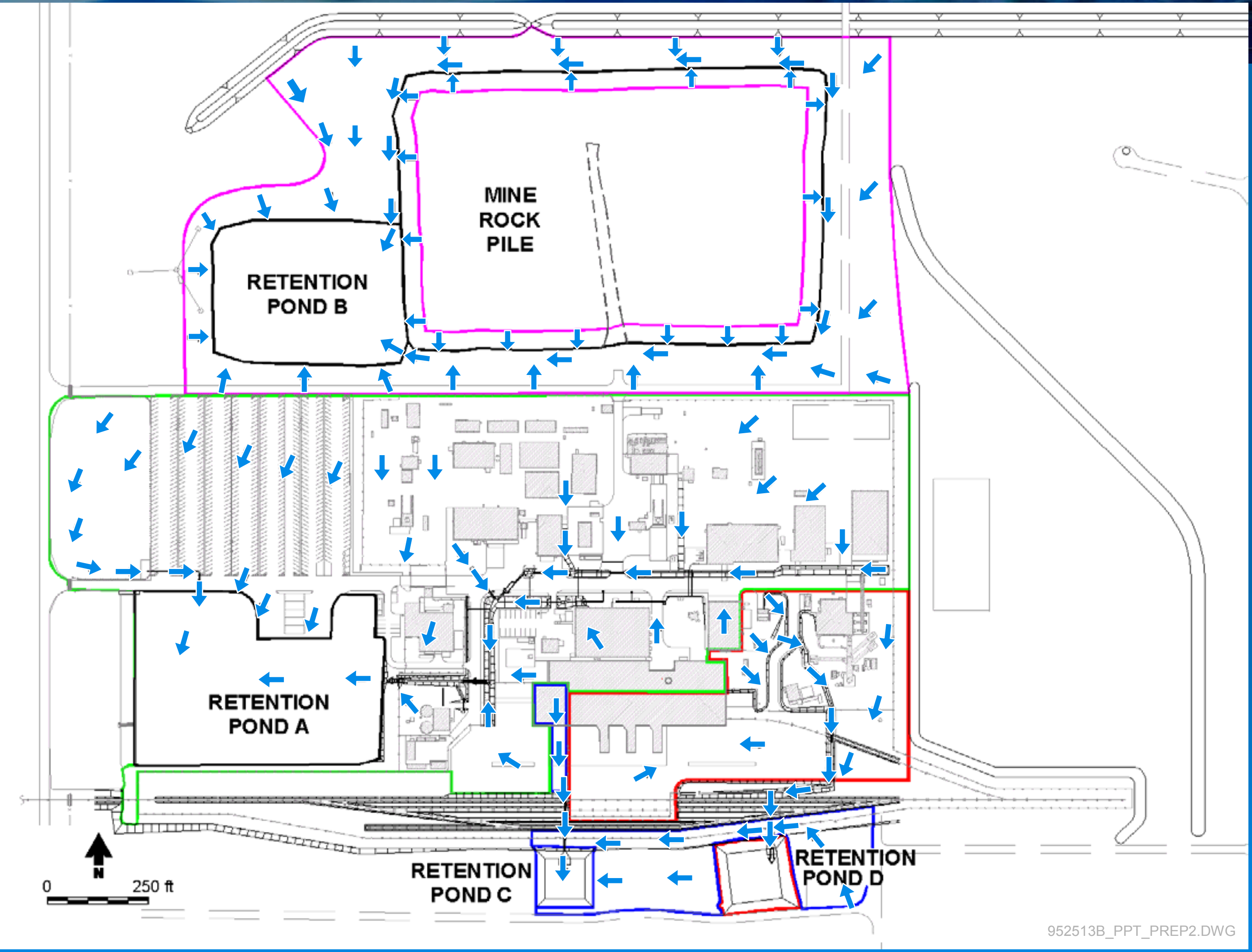
Return Flow Credits

- Water rights for diversions are administered with credit granted under return flow plans
- Credits are gained when a portion of water diverted is returned to rivers or groundwater
  - Treated wastewater
  - Irrigation seepage
- Enhanced recharge from site development provides a return flow from new water that was not initially diverted or pumped

Enhanced Recharge Case Study

- Site-wide water balance used to quantify recharge rates from retention ponds
- 85-acre mine site developed in 1980s with buildings, roadways, bare-ground
- 13 in/yr average annual precipitation
- Recharge rate in desert soil <0.1 in/yr
- 4 stormwater retention ponds
- Enhanced recharge was not an objective

Site Surface Drainage Plan



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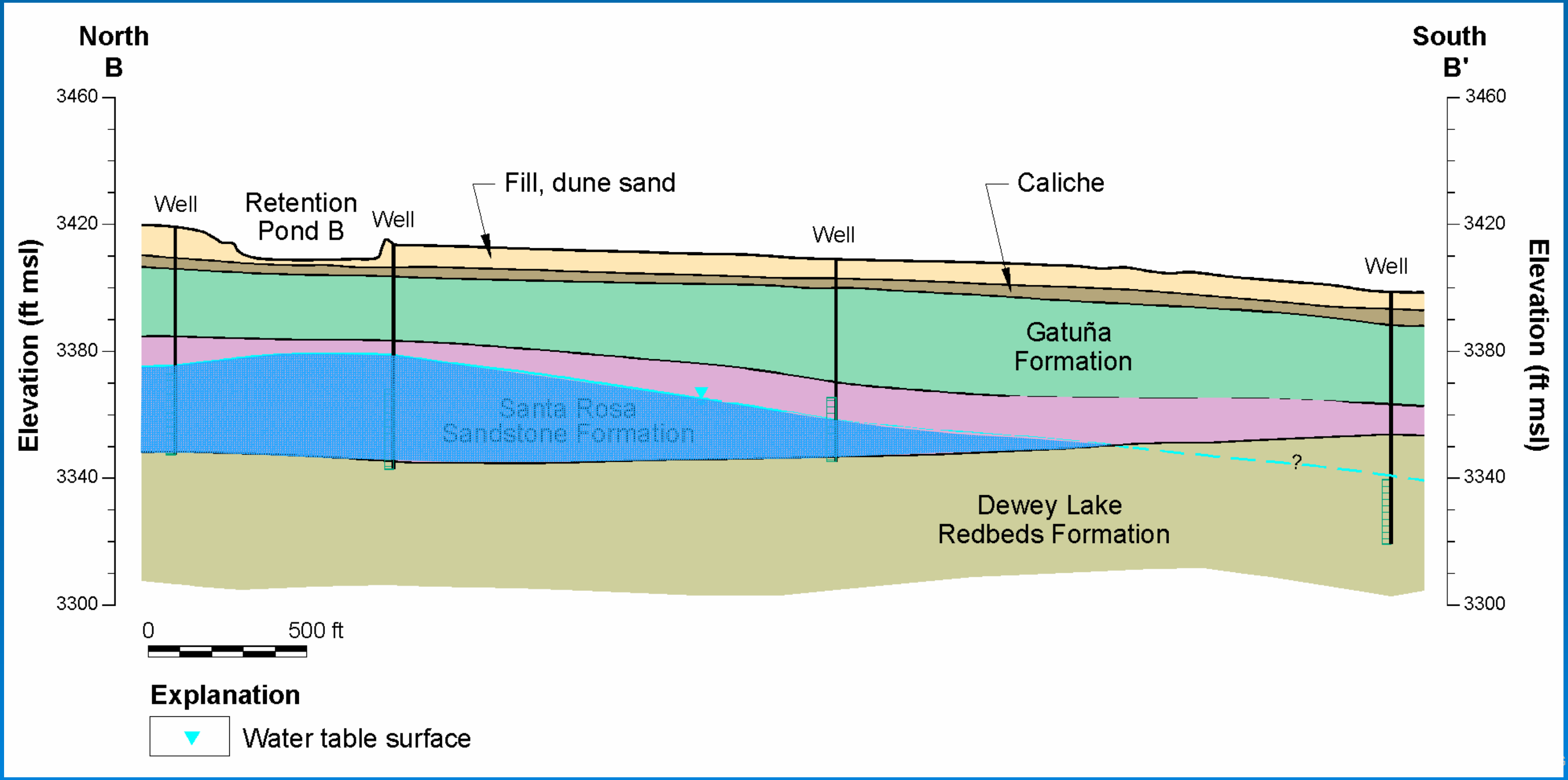
Stormwater Runoff Watershed Summary

Watershed	Pervious (acres)	Impervious (acres)	Pond (acres)	Total (acres)
Retention Pond A	11.5	20.4	5.8	37.7
Retention Pond B	16.6	0	3.6	20.2
Retention Pond C	2.7	0.4	0.5	3.6
Retention Pond D	2.3	5.1	0.7	8.1
Mine Rock Pile	14.9	0	0	14.9
TOTAL	48.0	25.9	10.6	84.5
PERCENT	57%	31%	12%	100%

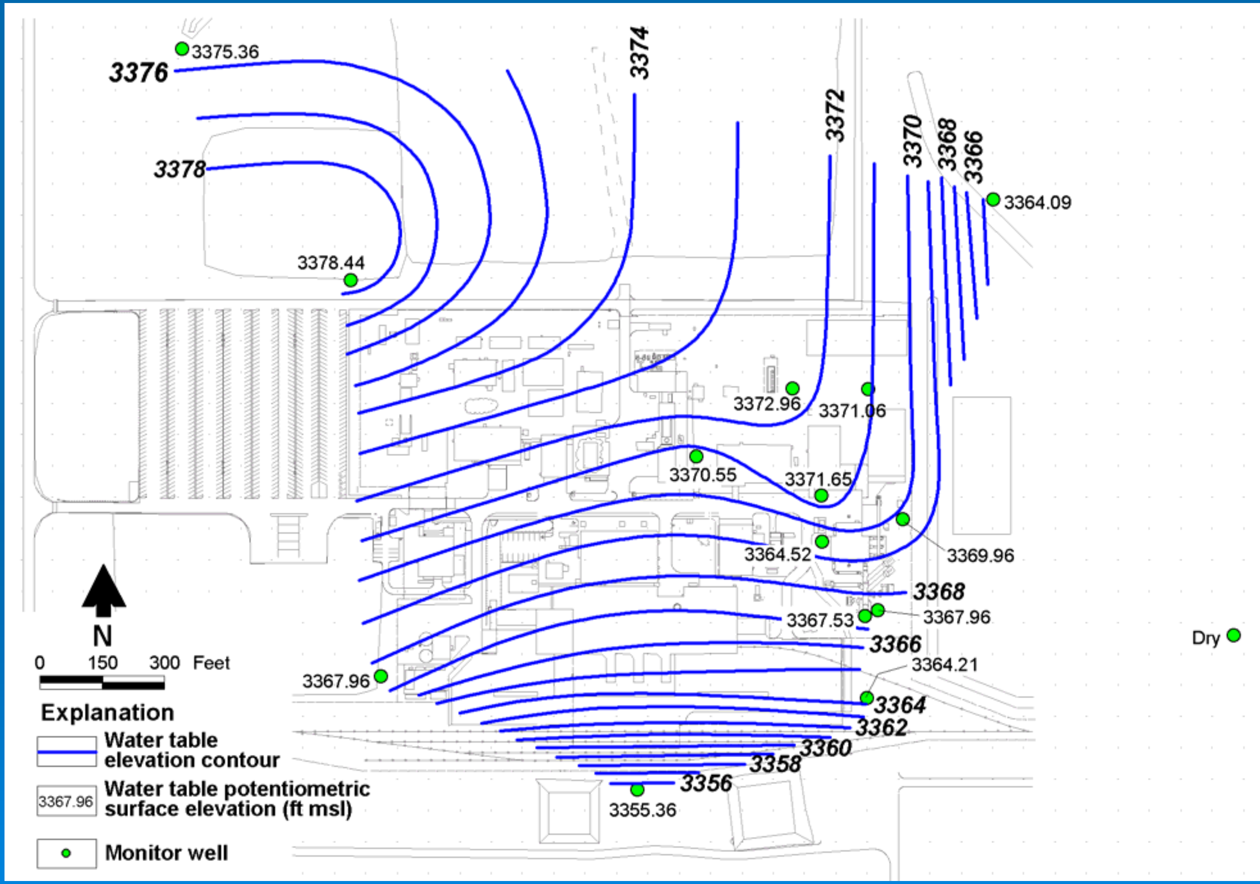
Site Hydrogeologic Conditions

- Formation stratigraphy (variable thickness)
  - Surficial dune sand over caliche (0-10 feet)
  - Gatuña Formation sediments (10 - 30 feet)
  - Santa Rosa Sandstone (30 - 60 feet)
  - Dewey Lake Redbeds (60 - 550 feet)
- Depth to regional water table 200 feet
- 1980s drilling showed vadose zone unsaturated
- 1996 drilling found a perched lens in the Santa Rosa Sandstone 12 - 32 feet saturated thickness

Geologic Cross-Section through Perched Lens



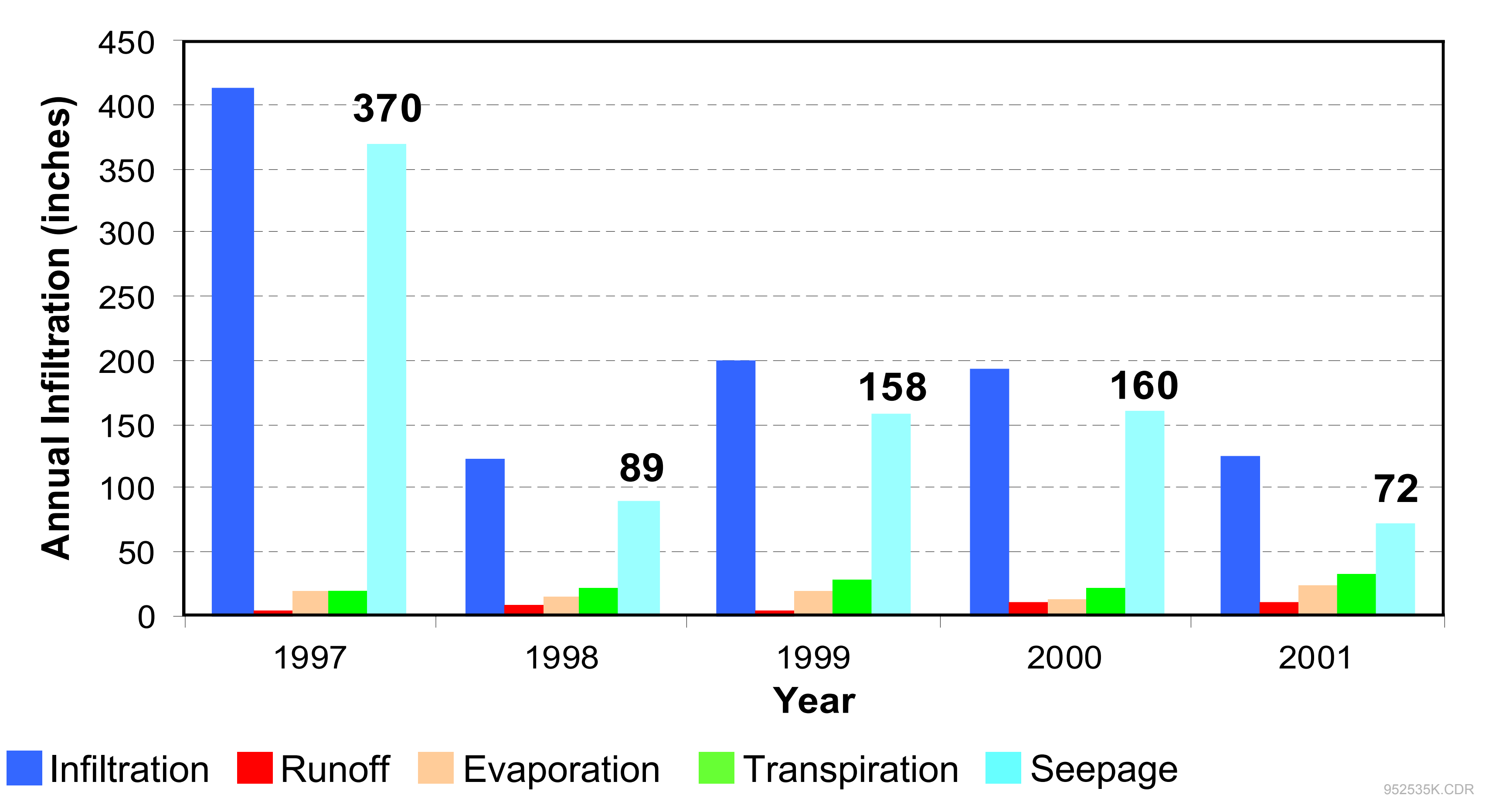
Perched Lens Water Table Contours



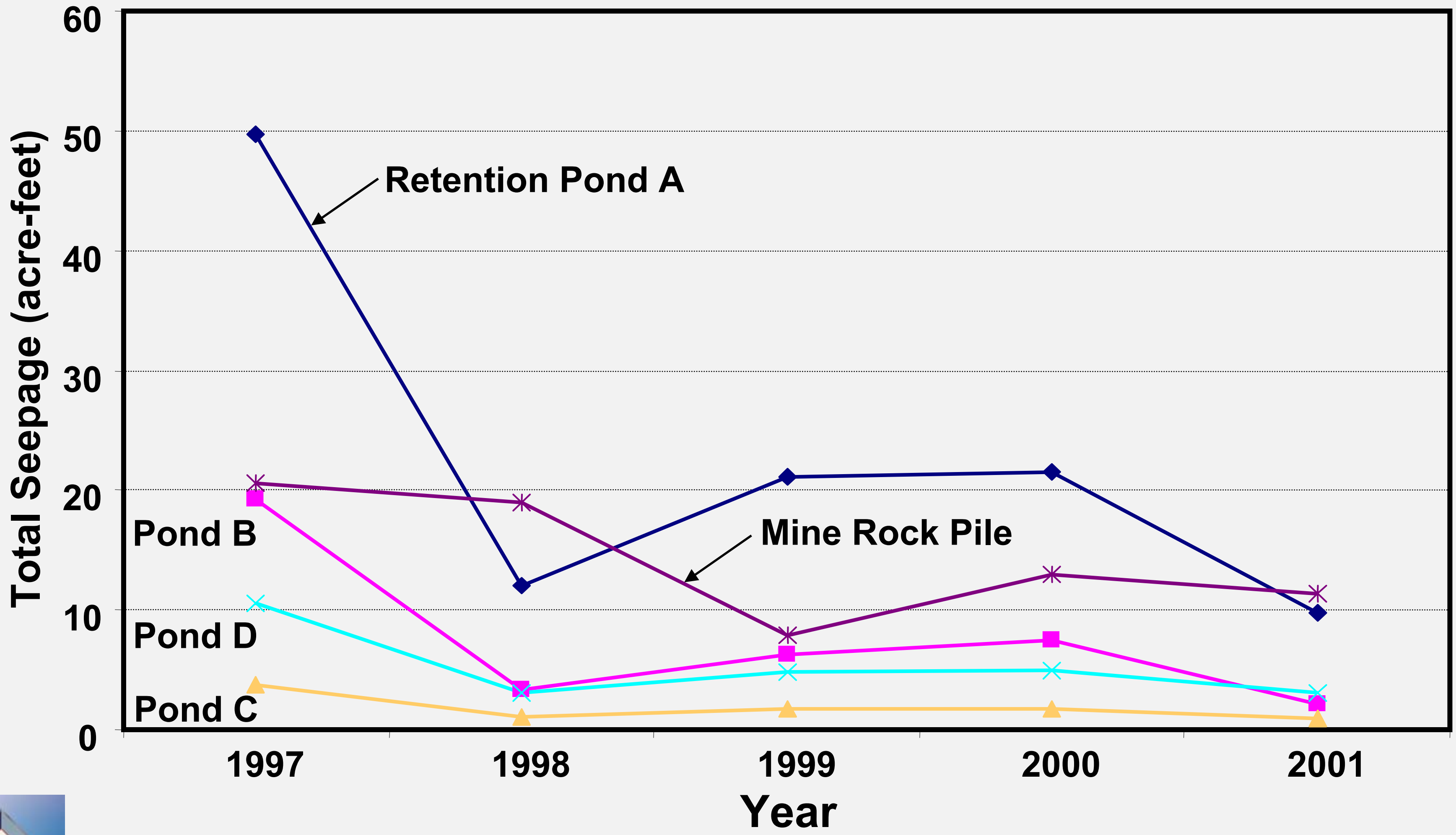
Recharge Quantification Methods

- Surface Water Infiltration Methodology
  - Stormwater runoff calculations (rational method)
  - Surface infiltration model of retention ponds and rock pile (UNSAT-H)
- Groundwater Recharge Methodology
  - Saturated/unsaturated groundwater model (MODFLOW-SURFACT)
    - Recharge to perched lens
    - Recharge to regional aquifer

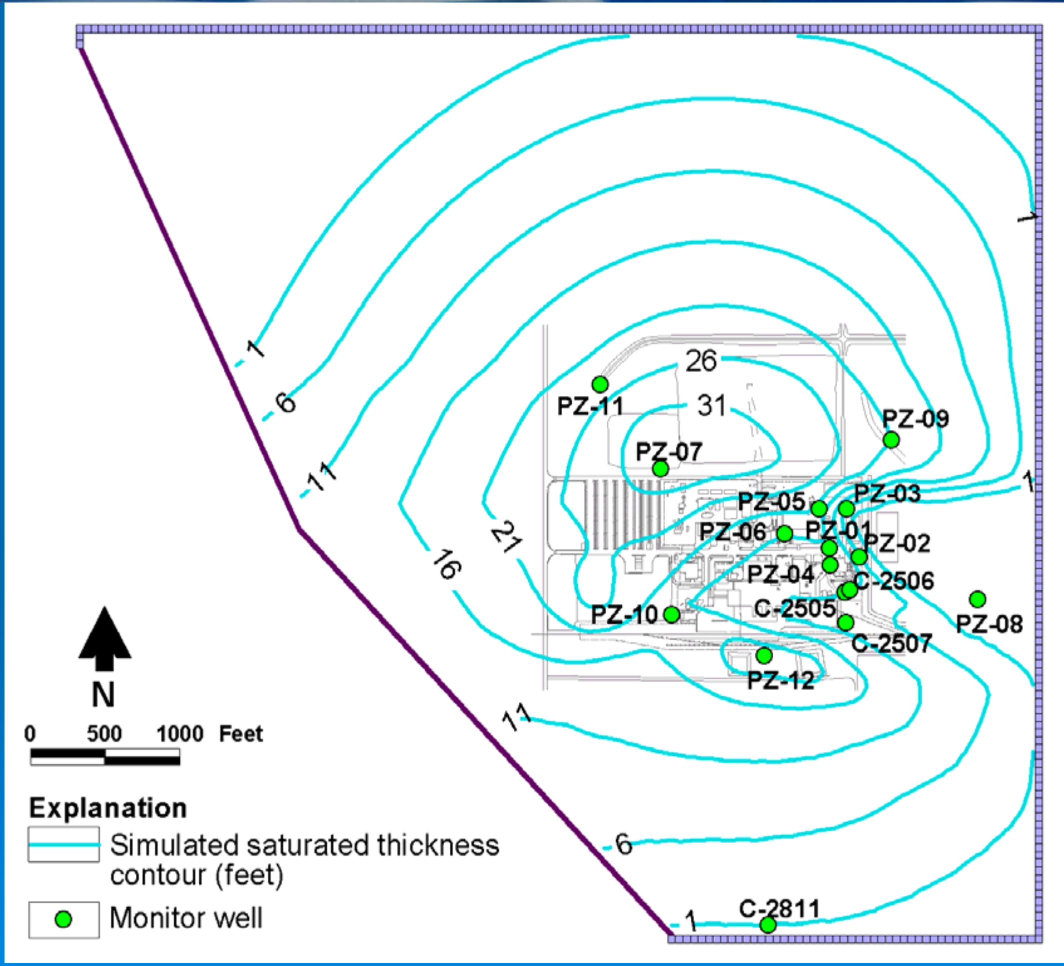
Surface Water Infiltration Results
Retention Pond A



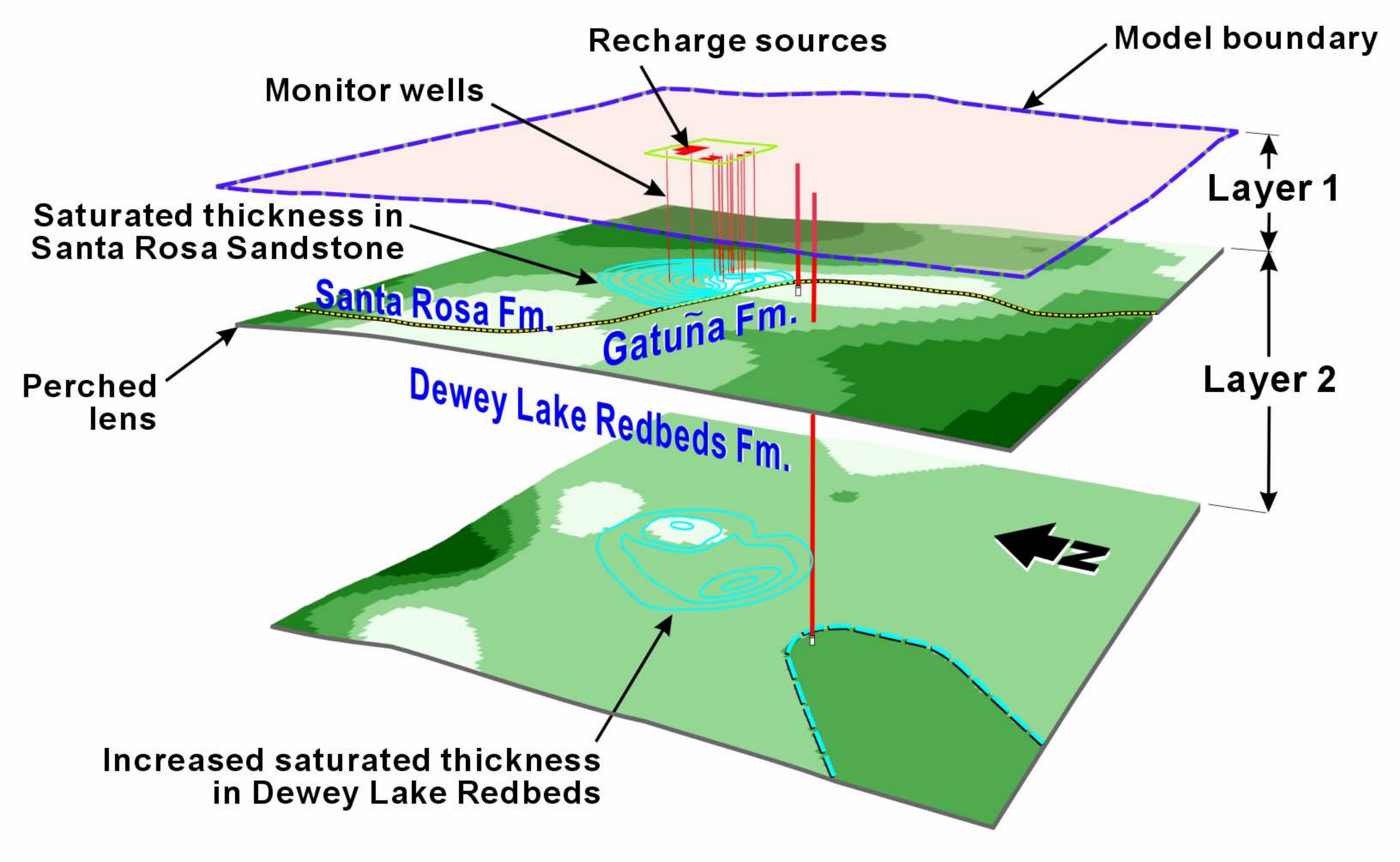
Surface Water Infiltration Results



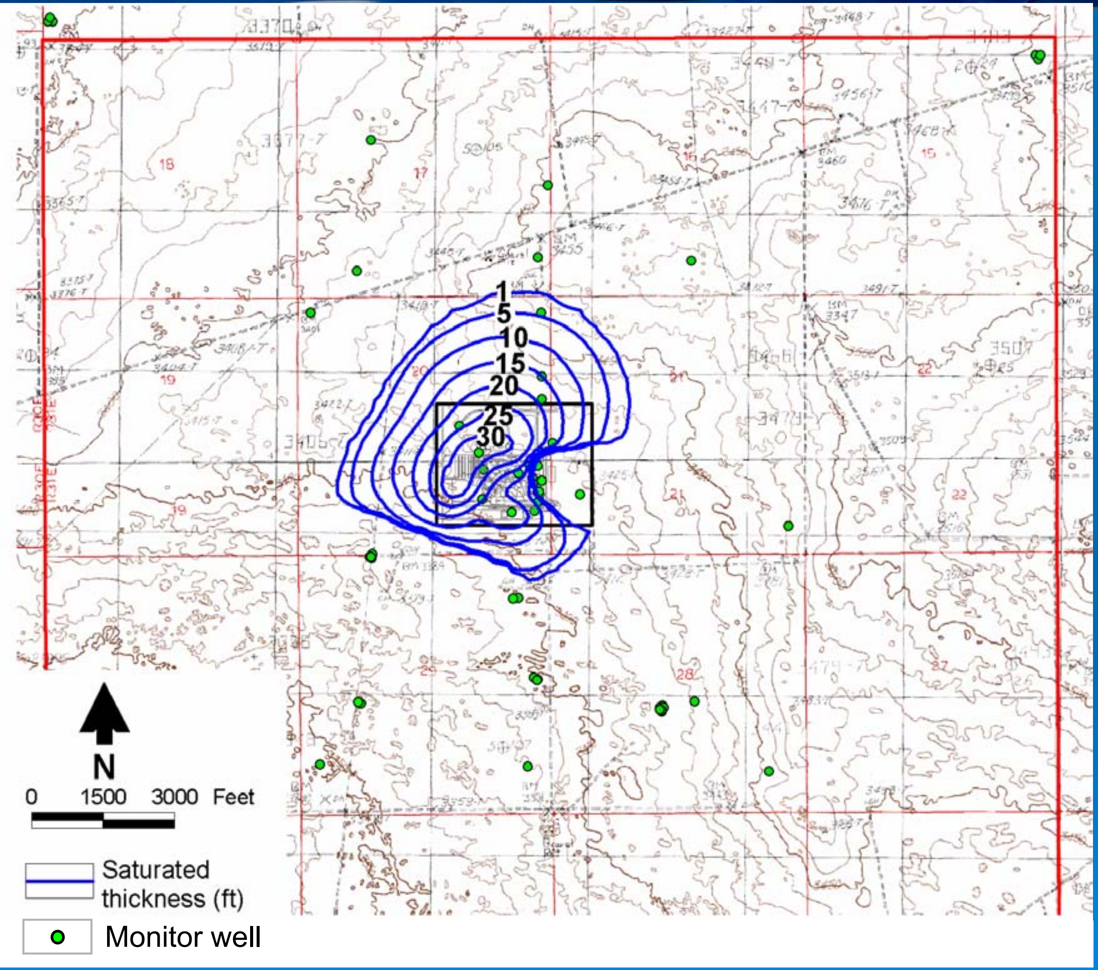
Groundwater Recharge Results
Perched Lens



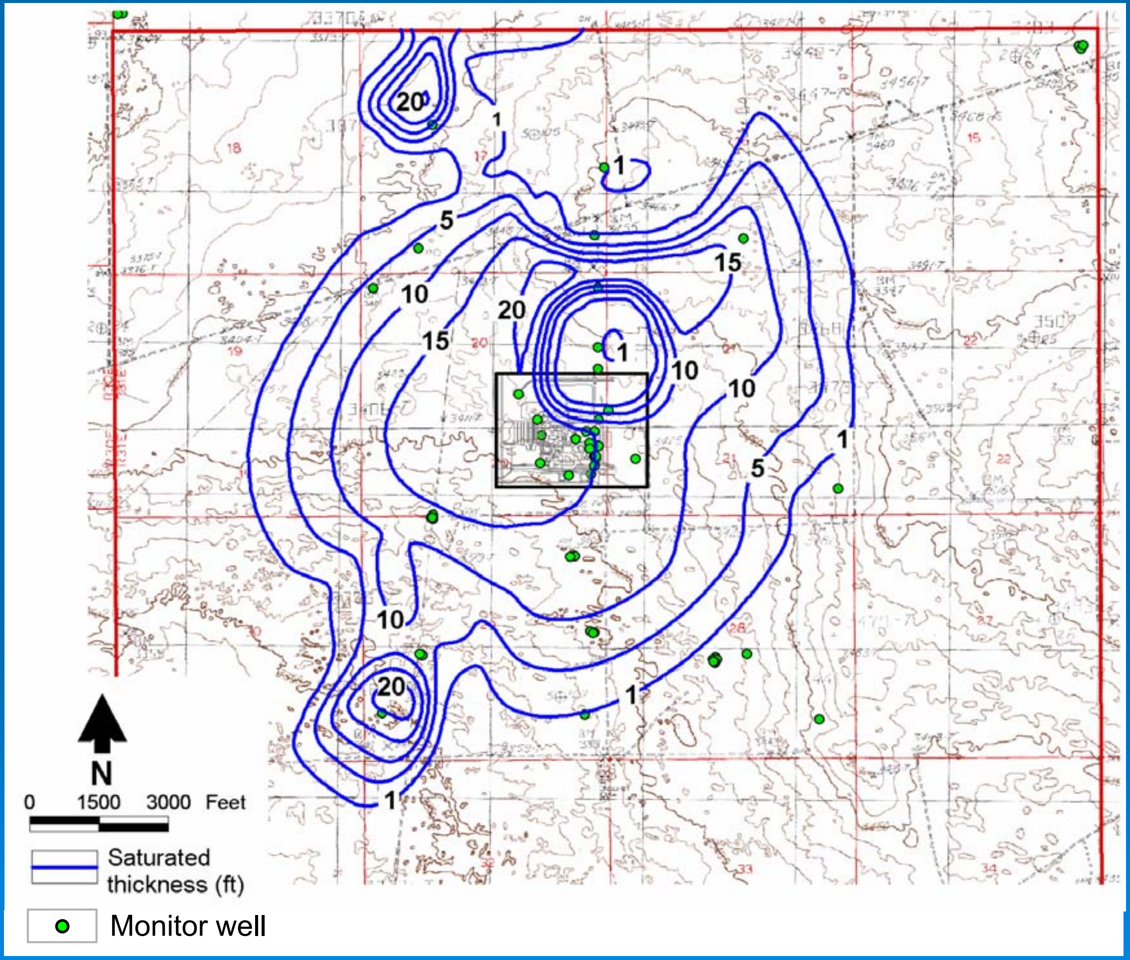
Groundwater Recharge Results
Regional Aquifer



Groundwater Recharge Results
Current Perched Lens from 20-year Recharge



Groundwater Recharge Results
Regional Aquifer Recharge after 50-Years



Summary of Case Study Results
Recharge Performance

- Groundwater recharge increased from almost none to approximately 50% of on-site precipitation with site development

Recharge Source	ac-ft/yr	percent
Total Precipitation	83	100%
Surface Infiltration Model	48	58%
Groundwater Recharge Model	32	39%

Enhanced Recharge Benefits
Example Scenario

- 100-acre Subdivision consumption and recharge
  - 80 acres with 5 homes per acre = 400 homes
  - 20 acres roads and common areas
  - Each home uses 0.5 ac-ft/yr = 200 ac-ft/yr
  - Average annual precipitation is 12 in/yr
  - 50% recharge provides 50 ac-ft/yr
  - Net consumption is 150 ac-ft/yr
- Net consumption is reduced 25%

Recharge Site Issues and Concerns

- Hydrogeologic conditions must be suitable for recharge to benefit the aquifer
- Water quality concerns
  - Appropriate land use (residential, rooftops, etc.)
  - Sufficient depth to groundwater
  - Soil aquifer treatment (SAT) polishes water quality
  - Best management practices (BMPs) for stormwater quality (pre-treatment systems available)
  - Public outreach and education programs

Recharge Site Issues and Concerns

- Stormwater runoff may be diminished to downstream water bodies
  - Impact minor compared to native conditions
  - Recharge is direct to the aquifer
  - Downstream evaporative losses are avoided
- Travel-time for recharge to aquifer
  - Case study shows travel time of months
  - Typical downward migration of 100 feet per year

Enhanced Recharge Benefits
Policies to Promote Enhanced Recharge

- Establish state and local policies to promote enhanced groundwater recharge
- Design stormwater systems to capture water in recharge basins
- Off-channel basins along arroyos/washes
- Maintain retention/detention ponds
  - Gravel mulch in pond bottoms
  - Remove vegetation
  - Periodically remove sediment

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