

IMPROVING ASR RECOVERY EFFICIENCY USING MODELING

STORE



RECOVER



Sandia Waste Isolation Flow and Transport Simulator (SWIFT)

Originally developed by Sandia National Laboratories
Albuquerque, New Mexico



Modeling Can Provide:

- ROAD MAP TO THE FUTURE
- ESTIMATED TIME OF ARRIVAL





HOW DOES MODELING IMPROVE INSIGHT?

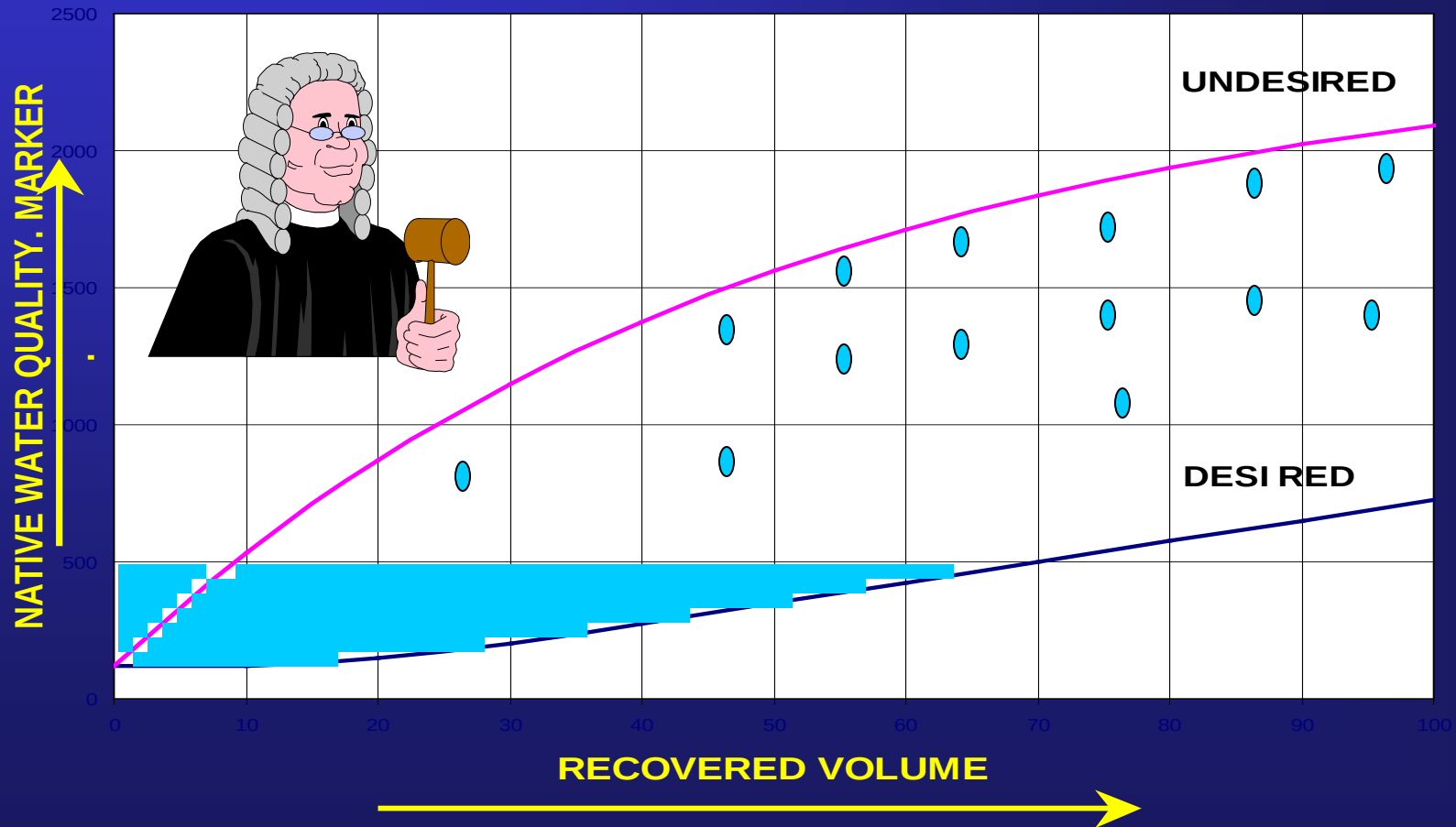
- **Integrates Formation Parameters**
 - Thickness, porosity, formation flow characteristics, dispersivity, etc.
- **Relates Water Quality**
 - Native, Injected, Recovered (mixing)
- **Provides Comparison of Actual and Predicted Results (Calibration)**

THREE EXAMPLES

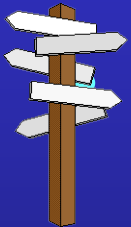
- **IMPACT OF PLUGGING ON MULTIPLE LAYER STORAGE ZONE**
- **WELLFIELD DESIGN/SPACING**
- **PERFORMANCE ENHANCEMENT**



Evaluation at a Glance Recovery Curve Shapes

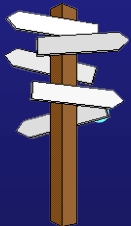


HISTORY



First cycle of 20 MG

- Recovery was 5 MG (25%)
- Addressed plugging issue

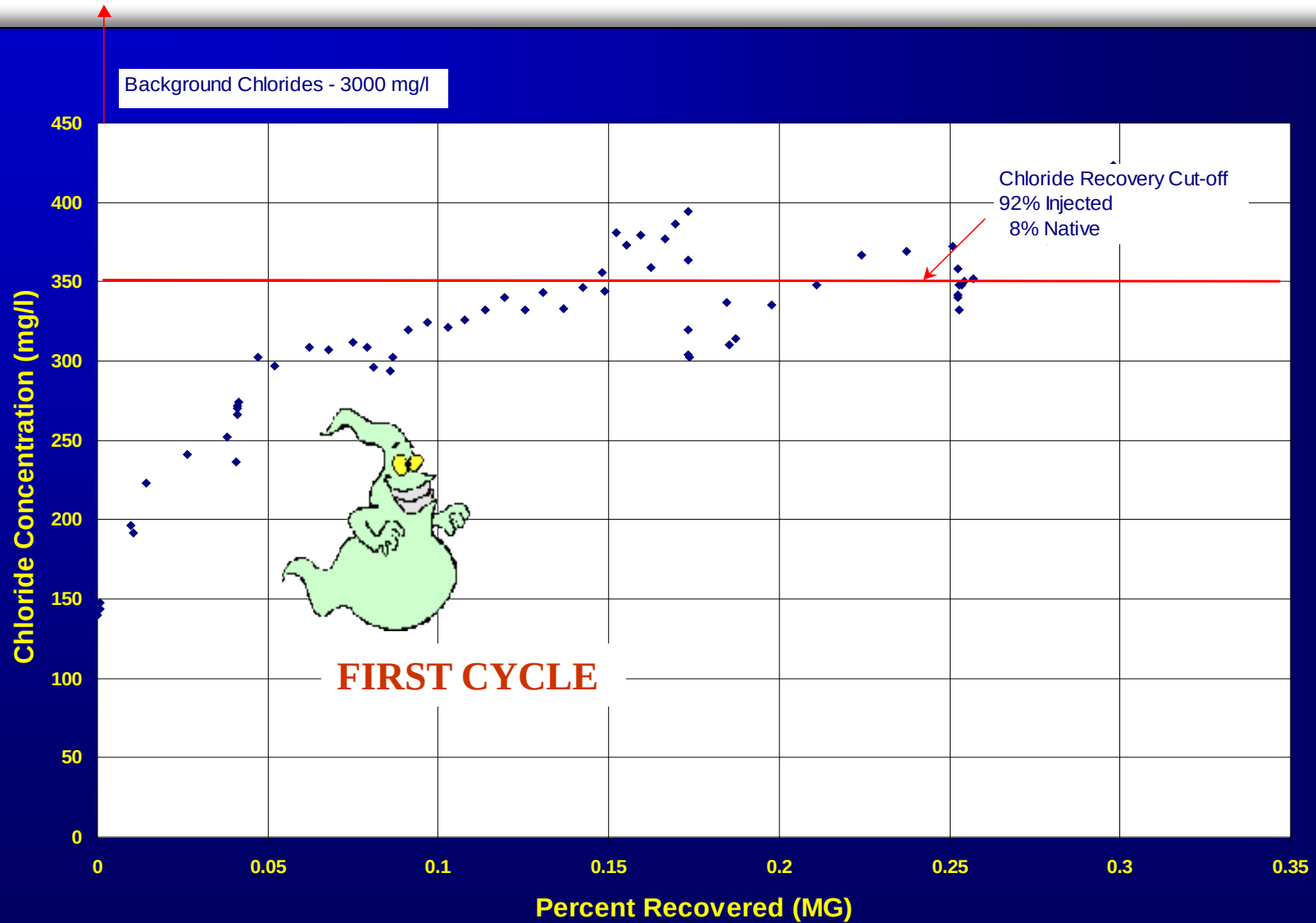


Second Cycle (approximately 100 MG)

- Reduced effort to eliminate plugging (Cost)

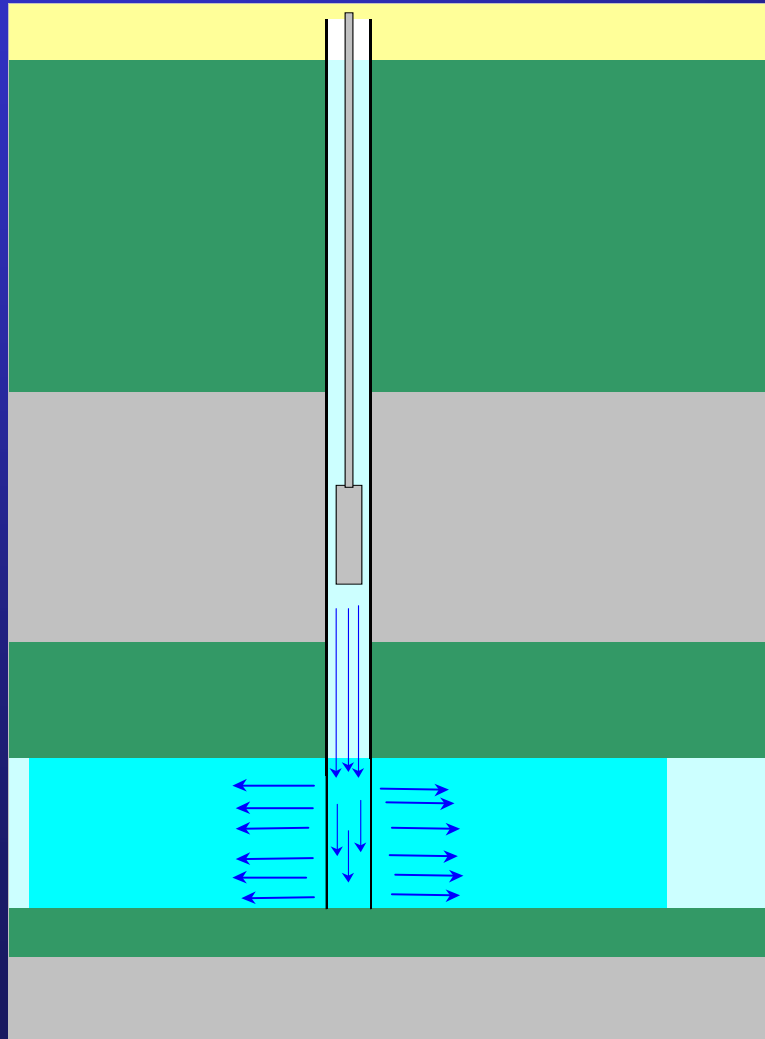


Marco Lakes 1st Cycle Recovery



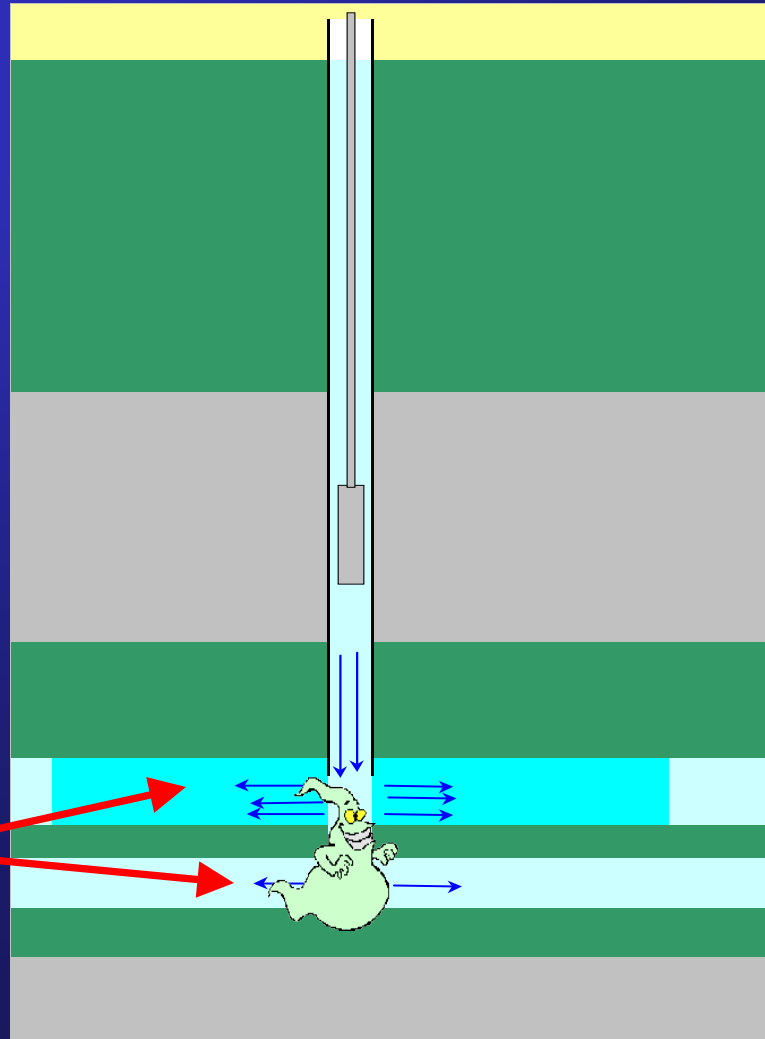
◆ ASR1

CONCEPTUAL VISION



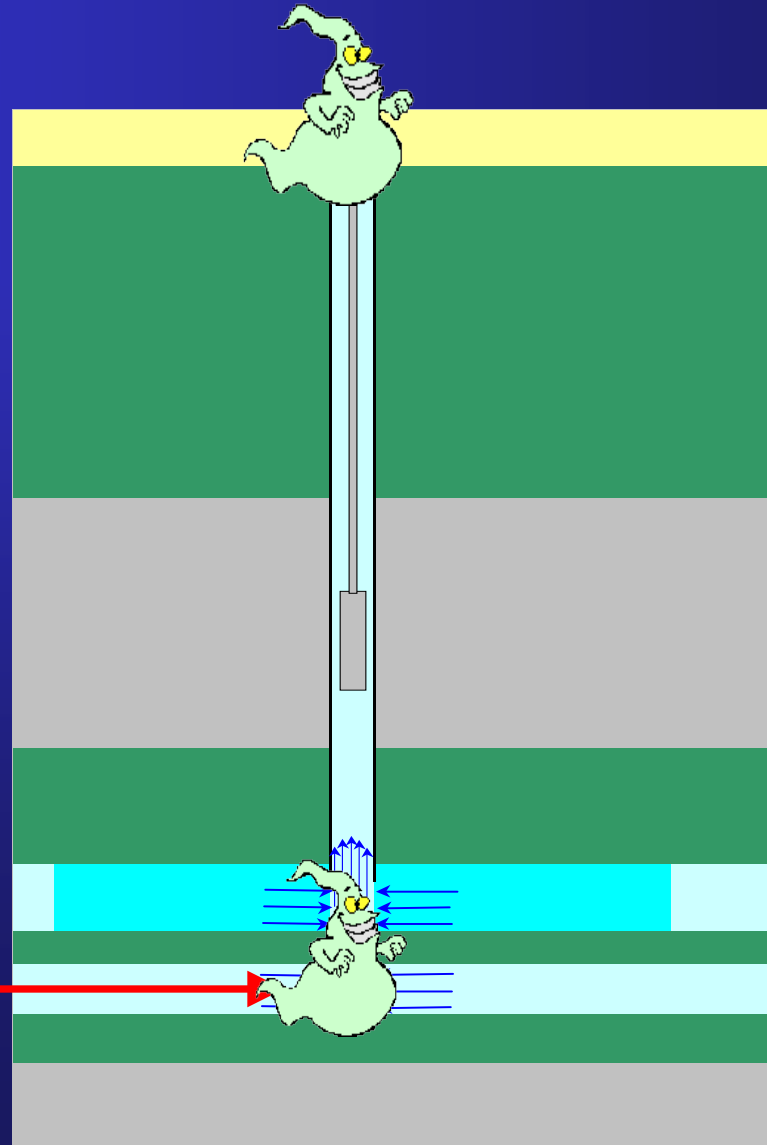
**Modeling indicated
plugging could not impact
recovery efficiency
for a single zone**

UNDESIRED DIVERSION



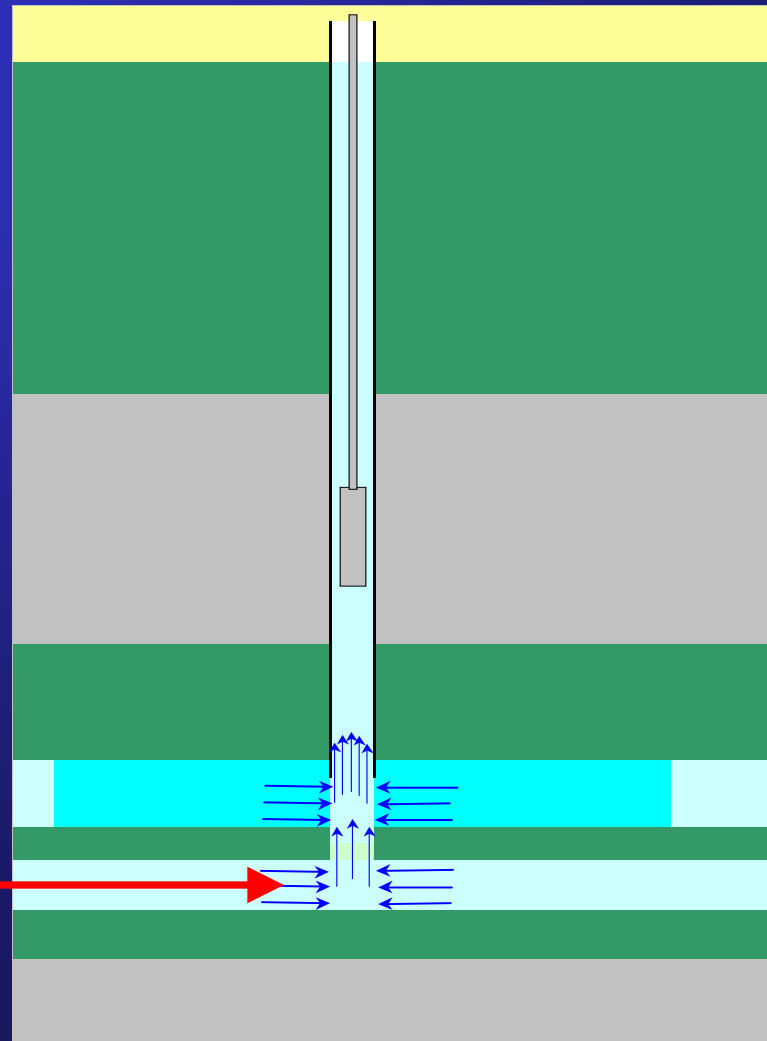
Plugging during injection

UNDESIRABLE DEVELOPMENT



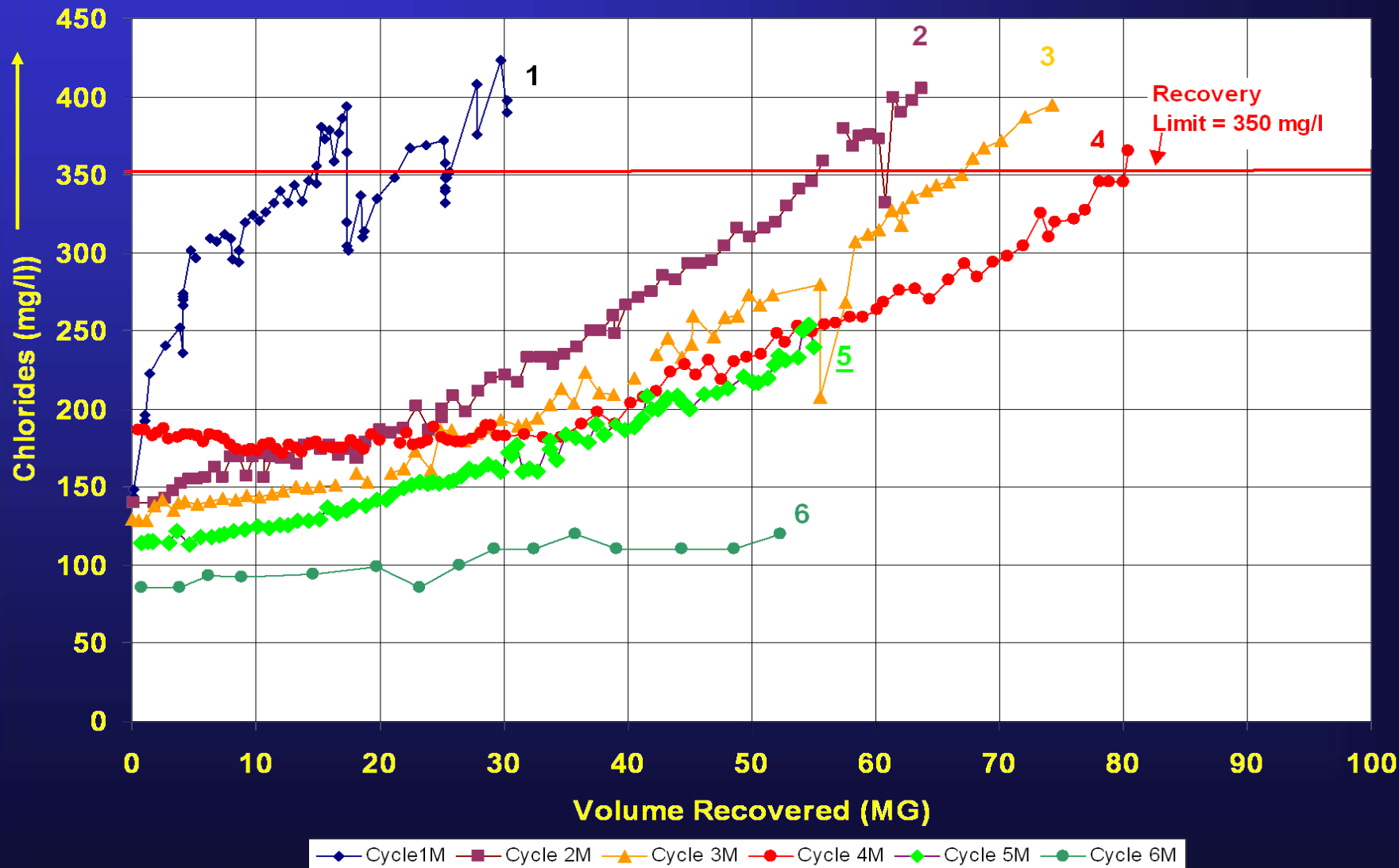
Preferential plugging
during injection, plugging
removed during recovery

UNDESIREDEVELOPMENT



Preferential plugging
during injection, plugging
removed during recovery

Marco Lakes Recovery





CONCLUSION

If your well is plugging, even if you have **sufficient injectivity**, you can experience a significant reduction in recovery efficiency.



THREE EXAMPLES

- **IMPACT OF PLUGGING MULTIPLE LAYER STORAGE ZONE**
- **WELLFIELD DESIGN/SPACING**
- **PERFORMANCE ENHANCEMENT**

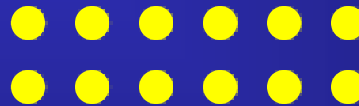
MODEL DEVELOPED TO:

- EVALUATE RECOVERY BASED ON FOUR DIFFERENT OPTIONS FOR WELLFIELD PATTERNS
- EVALUATE RECOVERY BASED ON WELL SPACING
- Example for ultimate 300 MG/Well Storage
 - 50% recovery prior to blending

Wellfield Patterns



12 Well System, Linear

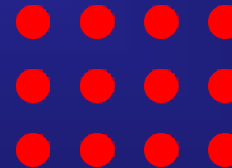


12 Well System, Two Parallel Rows



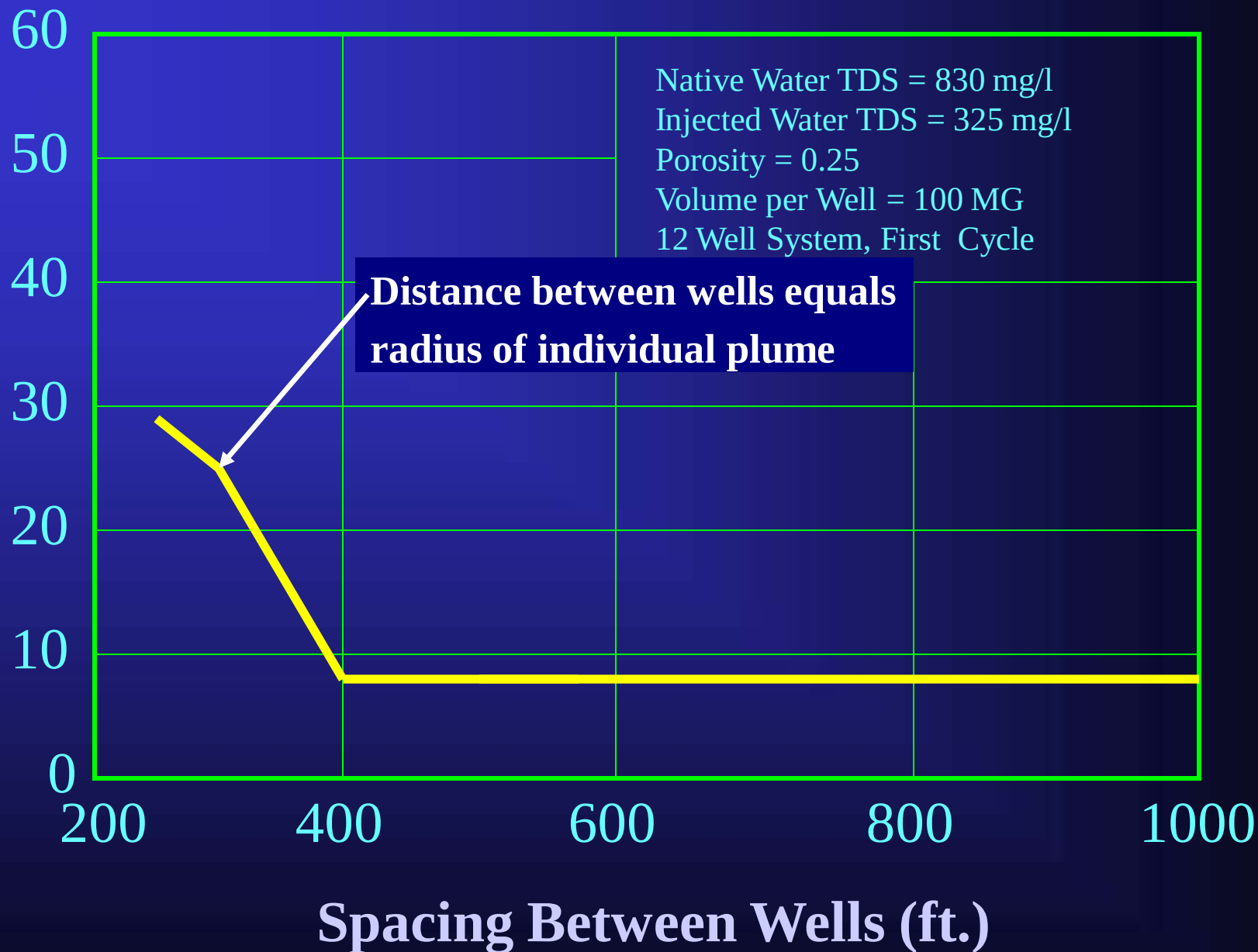
6 Well System - Separated

Requires Two of These Fields
Spaced 3000 Ft. Apart



12 Well System, 4 Rows
Close Spaced

Avg. % Recovery Efficiency/Well



12 WELL SYSTEM

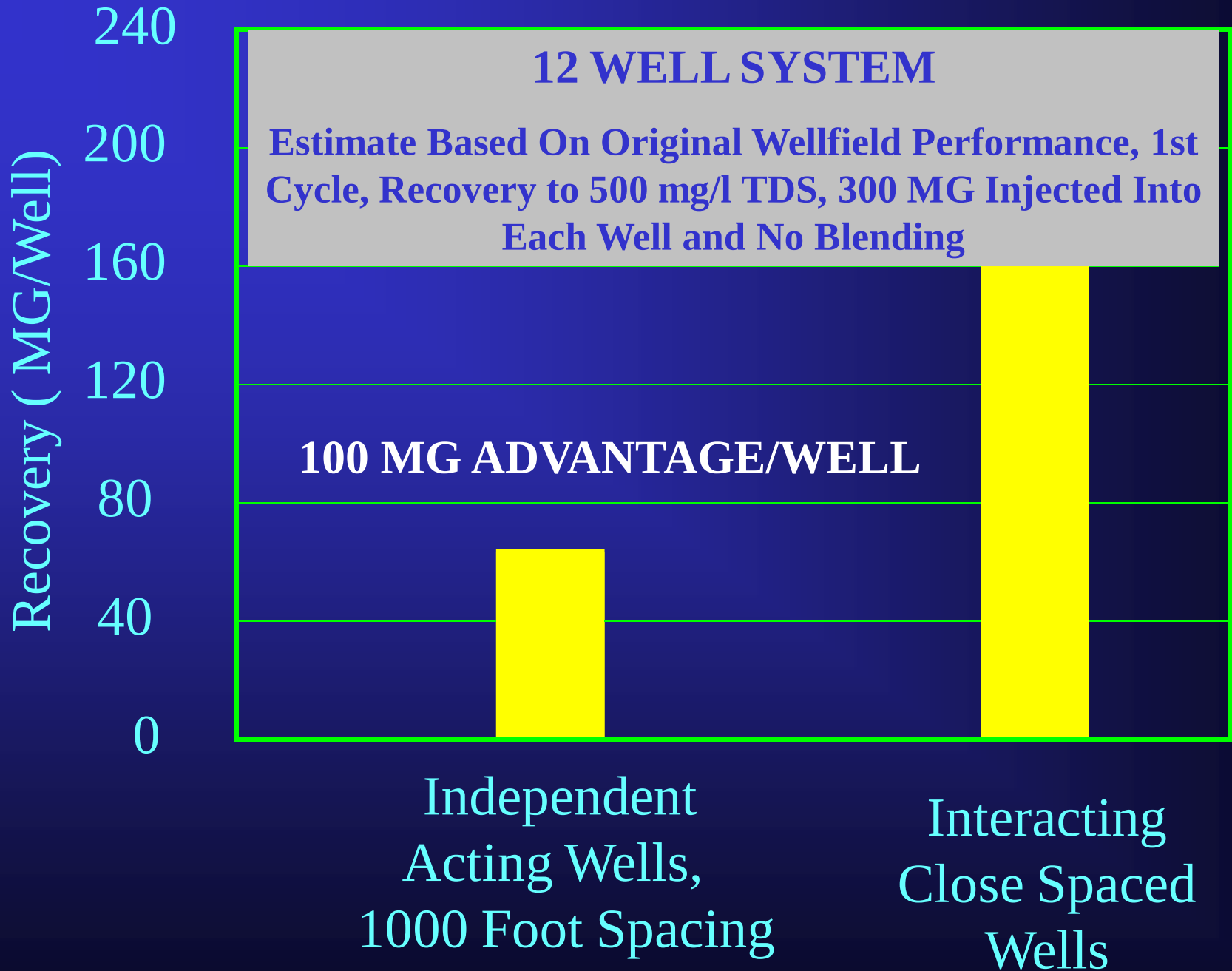
Estimate Based On Original Wellfield Performance, 1st
Cycle, Recovery to 500 mg/l TDS, 300 MG Injected Into
Each Well and No Blending

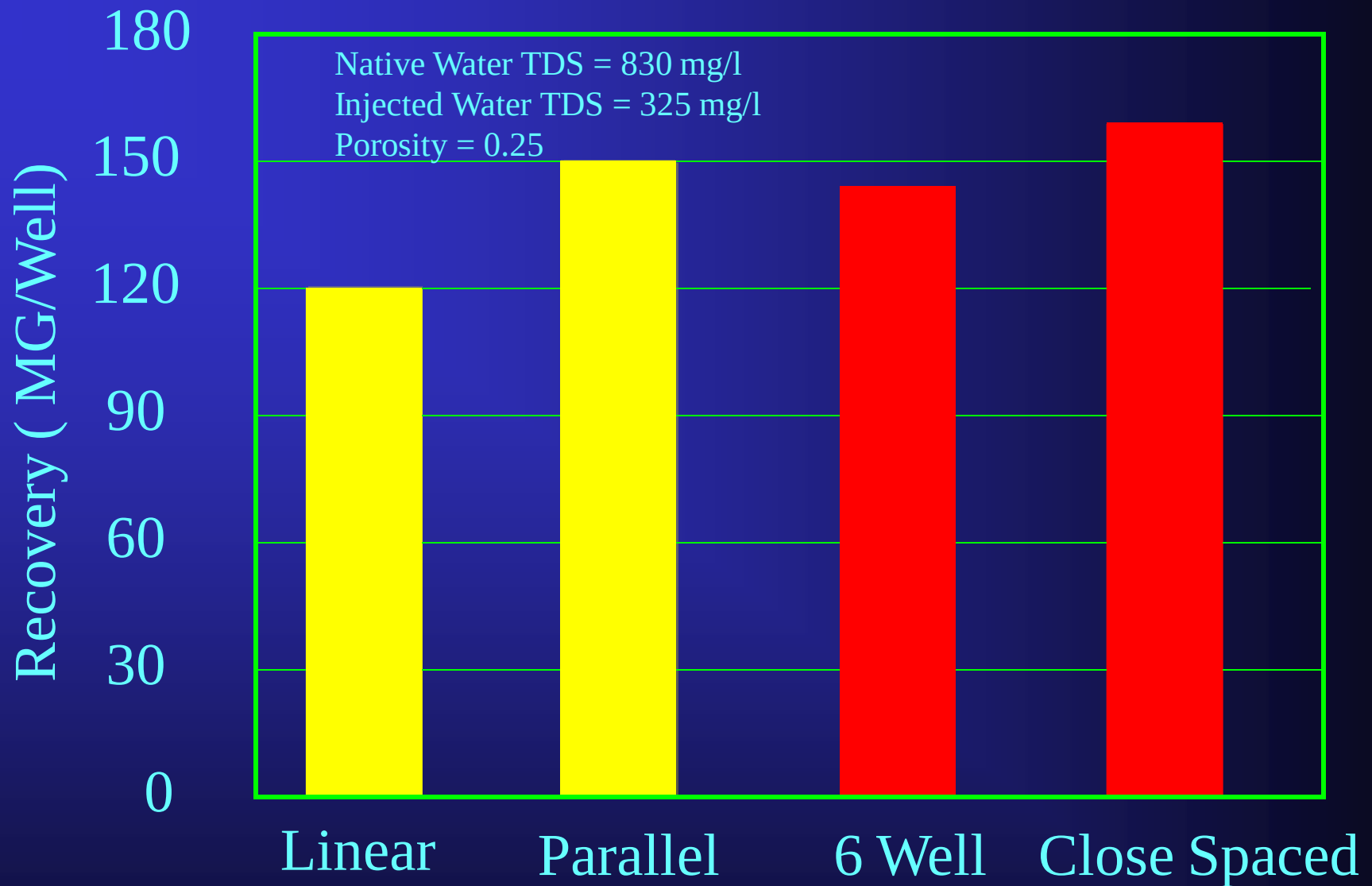
100 MG ADVANTAGE/WELL

Recovery (MG/Well)

Independent
Acting Wells,
1000 Foot Spacing

Interacting
Close Spaced
Wells





Wellfield Recovery for Different Patterns (First Cycle)

12 Well System 360 MG Advantage - Parallel over Linear

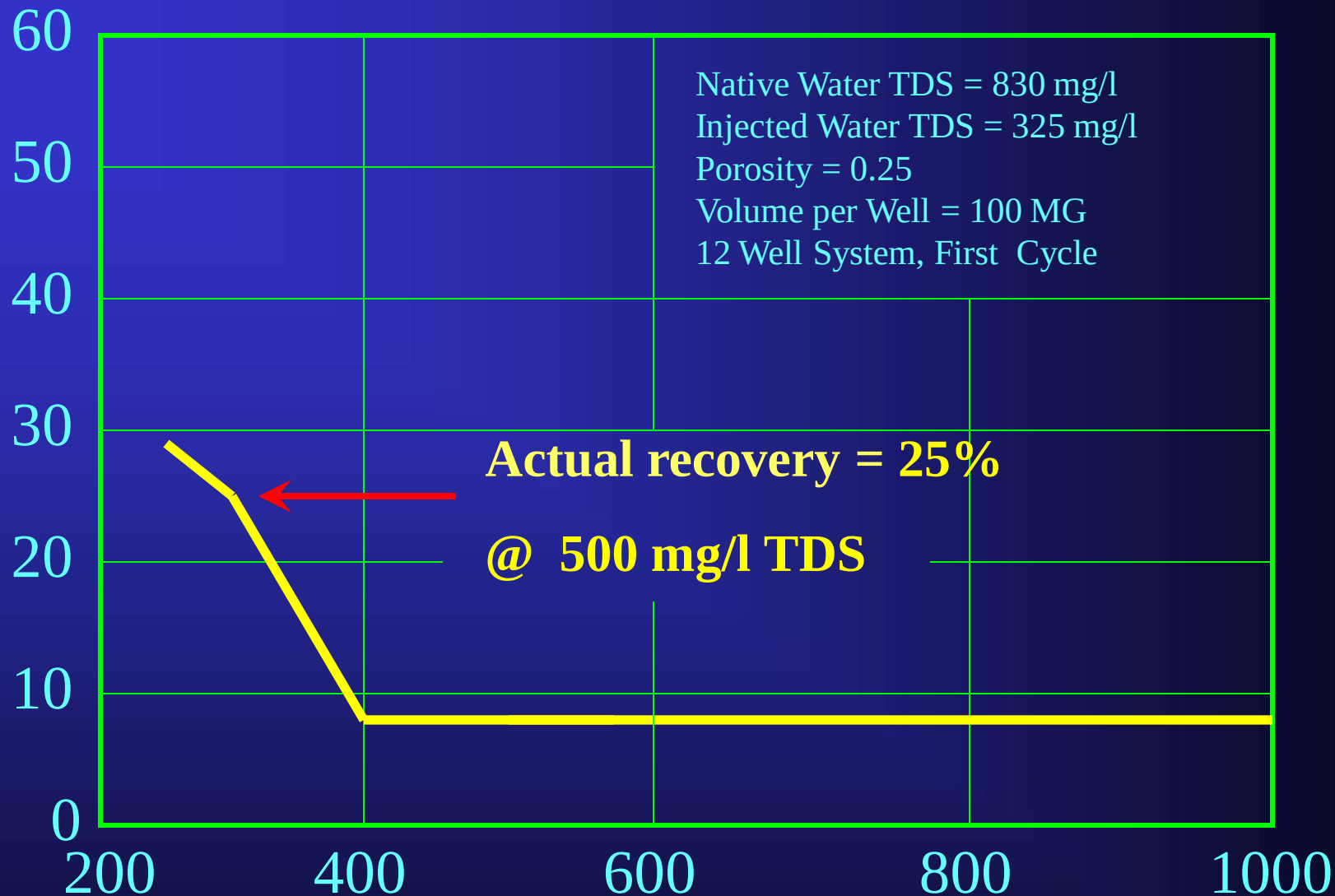
REALITY CHECK

**FIRST 100 MG CYCLE
COMPLETED LAST YEAR.**

THE ANSWER IS?

(Drums rolling)

Avg. % Recovery Efficiency/Well



Spacing Between Wells (ft.)

NEXT MILESTONE

**RECOVERY EFFICIENCY
FOR 300 MG/WELL CYCLE**

THREE EXAMPLES

- **IMPACT OF PLUGGING ON MULTIPLE LAYER STORAGE ZONE**
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PUNTA GORDA

- **FIRST LARGE CYCLE - 200 MG INJECTED INTO ASR1, 6 MG RECOVERED (3%)**
- **HAD INSTALLED THREE ADDITIONAL WELLS PRIOR TO LARGE SCALE TESTING**
- **CONCERNED ABOUT THEIR ASR PROGRAM**
- **REQUESTED ASSISTANCE IN REVIEWING THEIR ASR SYSTEM**

ISSUES IDENTIFIED BY MODEL

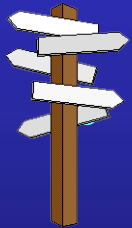


Storage zone thickness - 200 ft with multiple intervals



Injected water quality reached 200 mg/l chlorides

ASR WELLS 3 AND 4 HAD DESIRED PROPERTIES IF WE:

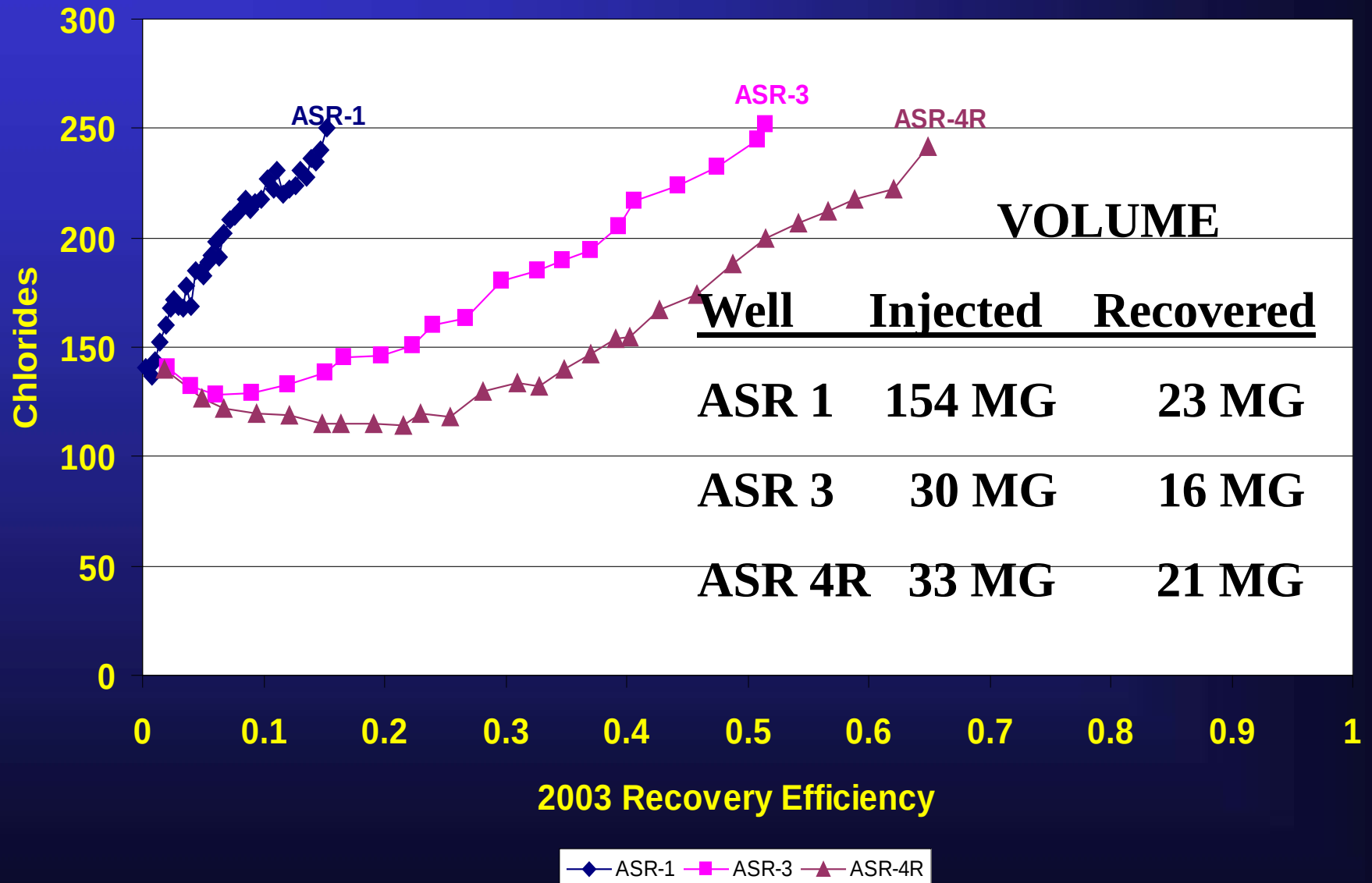


Eliminated the lower flow interval,

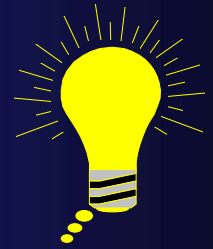


**Limited injection water quality to
150 mg/l chlorides**

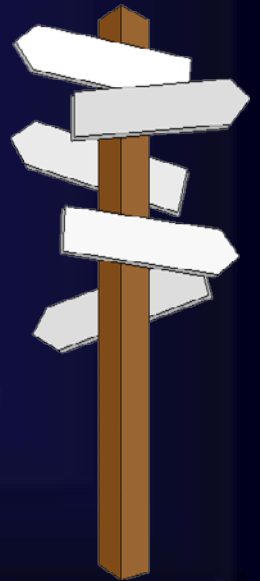
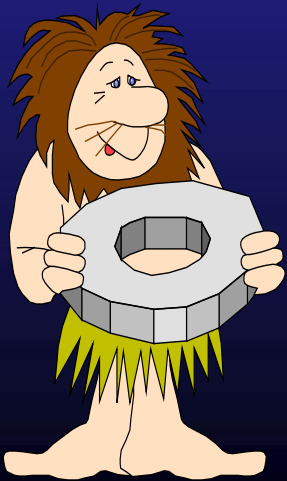
PUNTA GORDA OP-4 RECOVERY



MODELING CAN BE



IT IS A DIAGNOSTIC, PREDICTIVE
TOOL THAT CAN PROVIDE
IMPROVEMENT THROUGH
UNDERSTANDING.



BENEFITS !!

- **SAVE TIME**
- **SAVE MONEY**
- **SAVE RESOURCES**
- **SAVE PROJECTS**



Questions?

Answers?

Comments?

