SUMMARY OF HYDROLOGIC STUDIES IN THE MAMM CREEK FIELD AREA, GARFIELD COUNTY, COLORADO

Prepared by Science Based Solutions LLC, for Garfield County, Colorado

Presented to Garfield County Board of County Commissioners
February 10, 2014

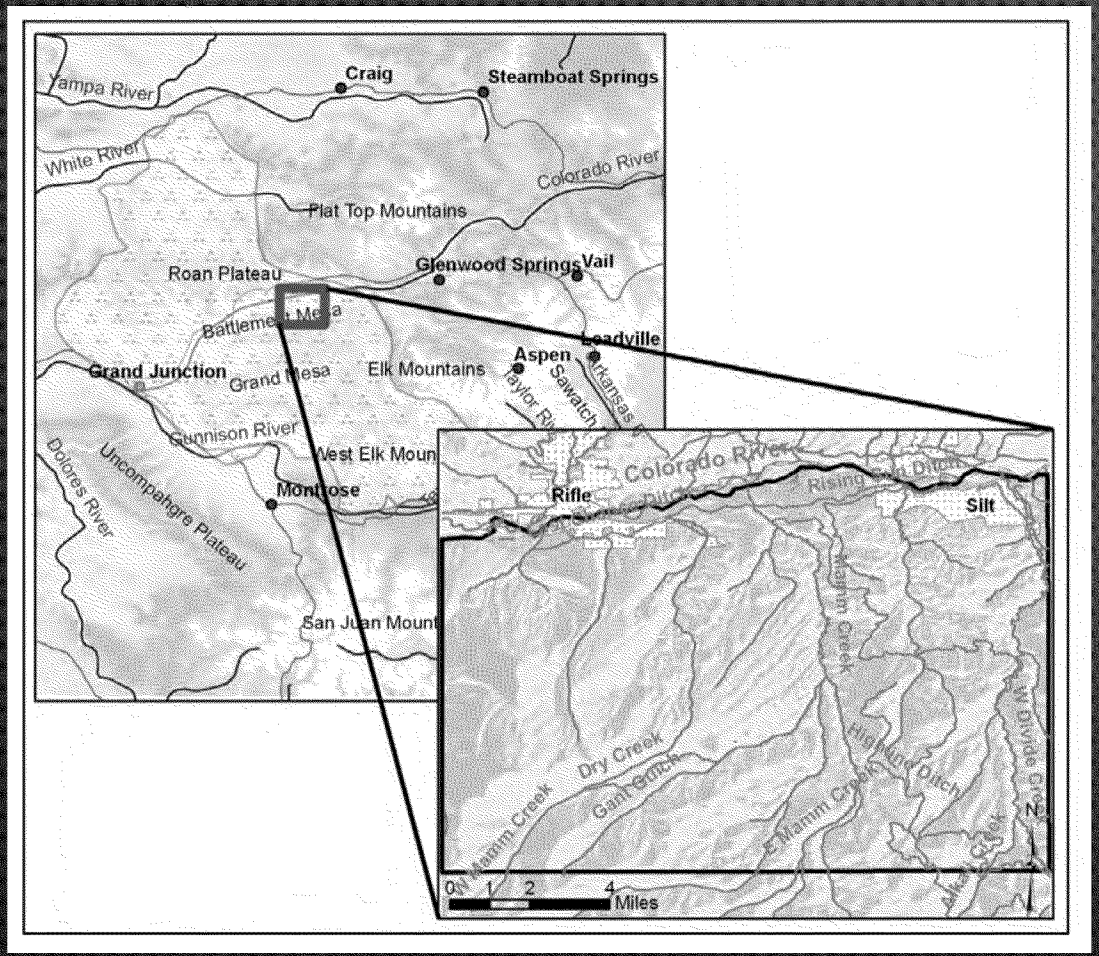
ISSUES 2004

- THERMOGENIC GAS IN WATER WELLS.
- CITIZEN COMPLAINTS ABOUT WATER WELLS.
- VERIFIED SURFACE CONTAMINATION.
- CONTINUED SEEP AT WEST DIVIDE CREEK.
- NO BACKGROUND STUDIES.
- STATE REGULATORY PROTOCOLS ON DRILLING AND COMPLETION PROVING INSUFFICIENT.

SITUATION 2014

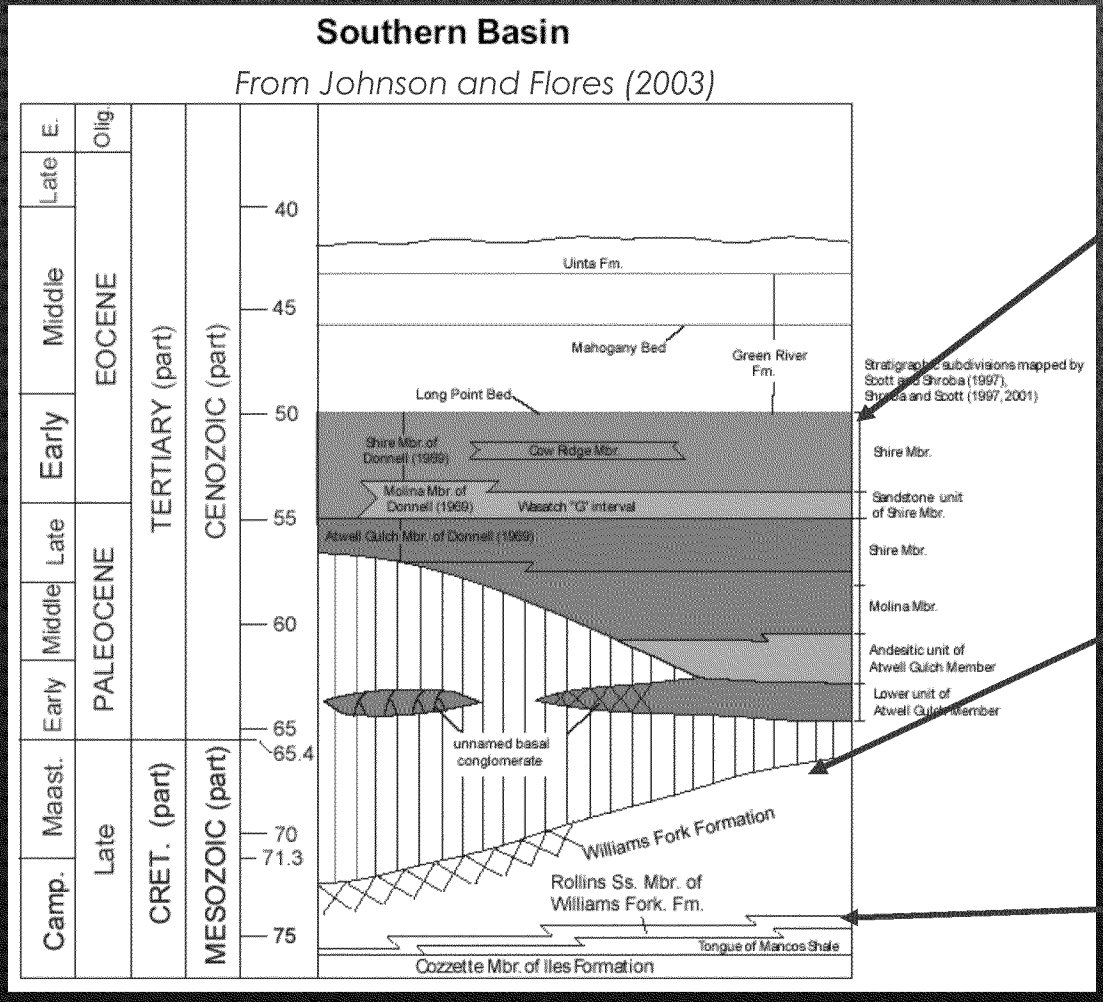
- No additional verified surface contamination.
- Declining seep at West Divide Creek.
- Three background studies.
- Revised drilling and completion protocols.
- Revised state rules.

Mamm Creek Field Area



South of the Colorado River between Silt and Rifle.
Drainage to the north by small streams.
Rural with ranches.
Wells are in Wasatch Formation have low yields and generally good to poor quality water.

Geologic Framework



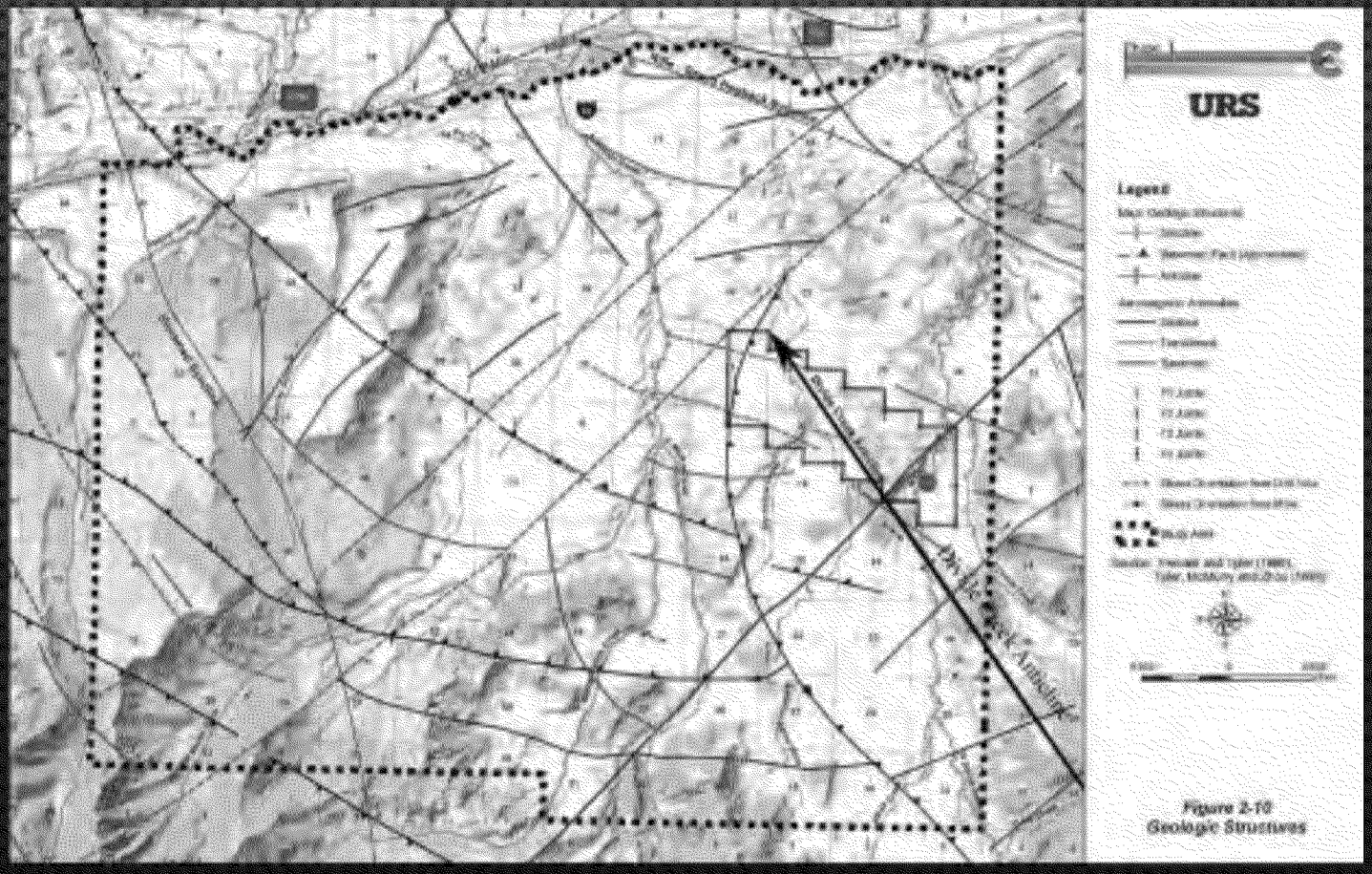
Wasatch Formation: 1,200-5,400ft thick; mudstone with lenticular and amalgamated sandstones; one interval has more tabular sand units

Williams Fork Formation: fluvial sandstone, marginal marine shale and coal beds and natural gas production

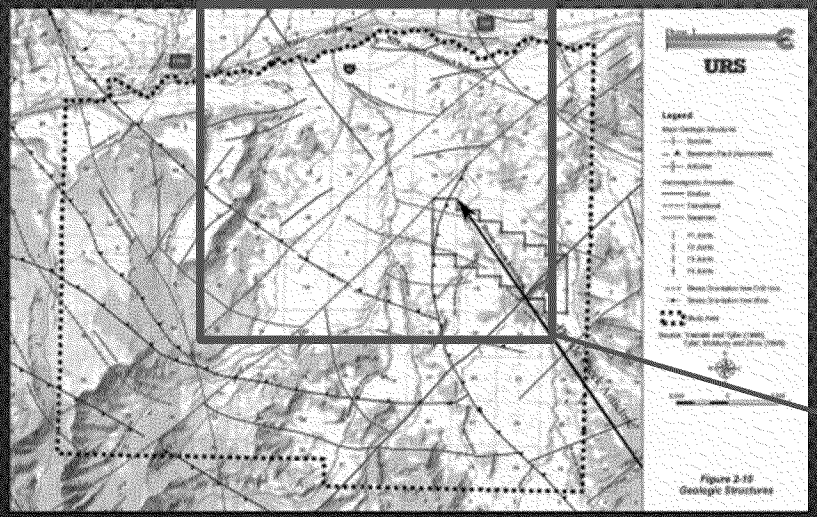
Mancos Shale

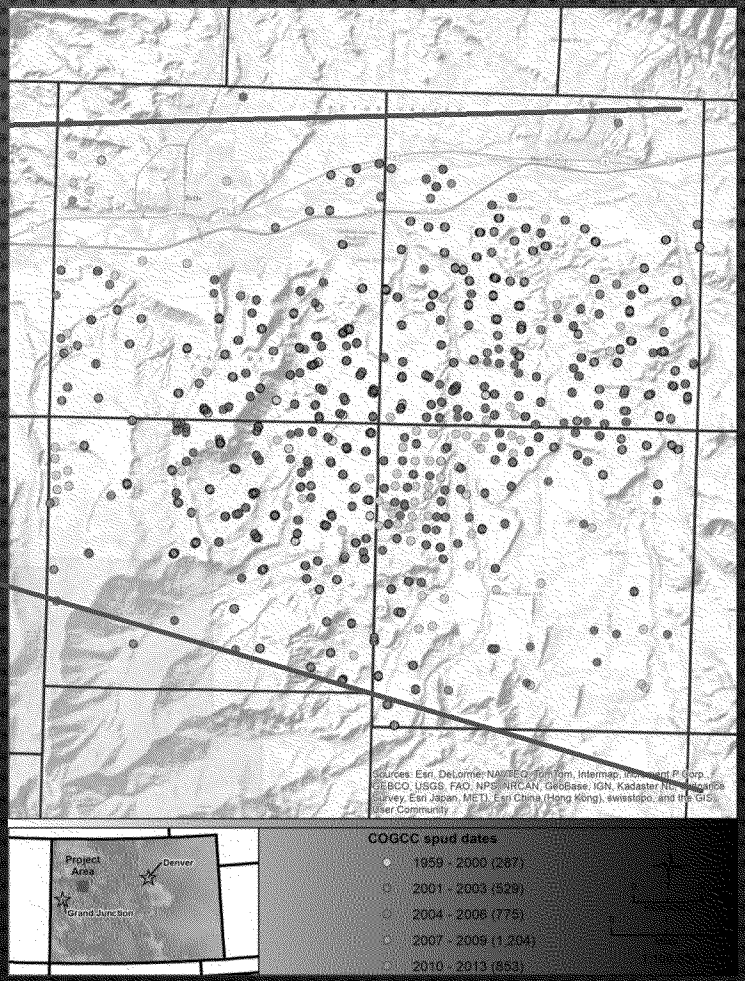
GEOLOGY OF AREA

- STRUCTURAL FEATURES – FAULTS, LINEAMENTS AND FOLDS
- PROVIDES PATHS OF WEAKNESS FOR FLUID AND GAS MOVEMENT
- MAJOR FEATURE IS THE DIVIDE CREEK ANTICLINE



GEOLOGY OF AREA





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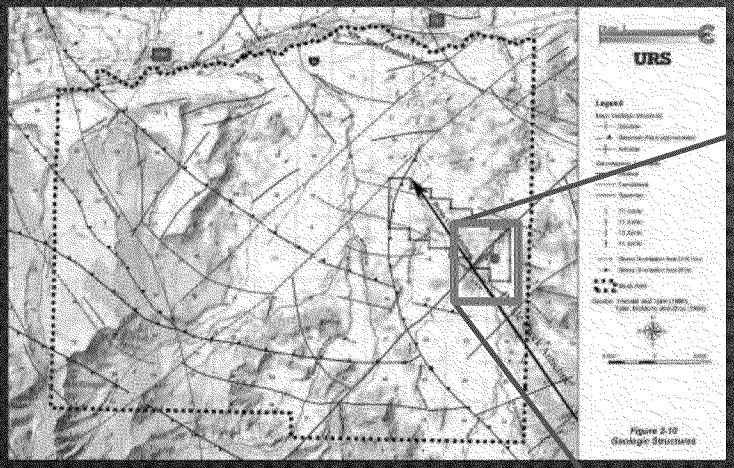
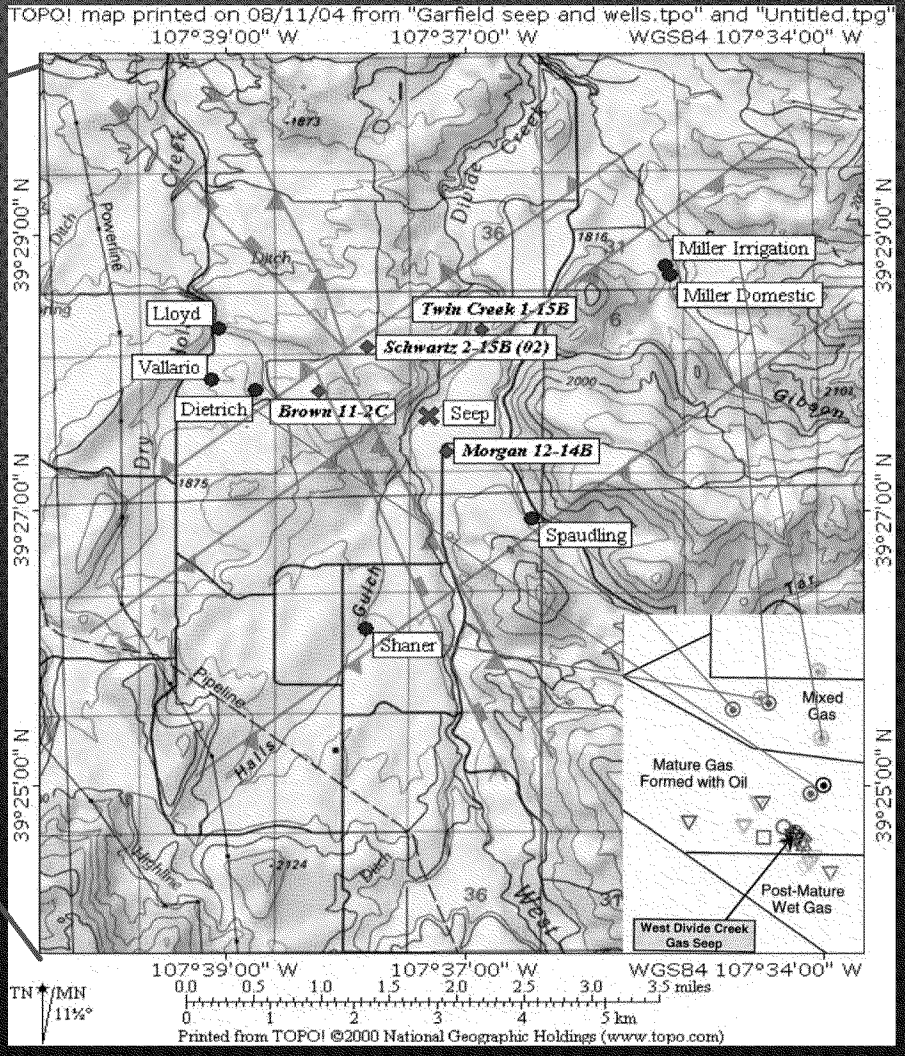
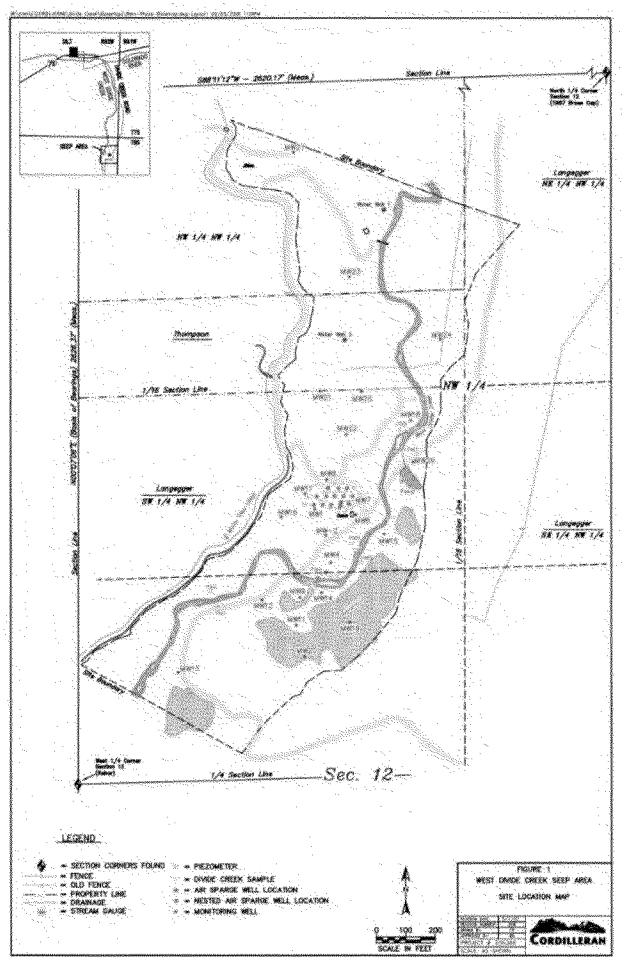
STRUCTURAL INFLUENCE ON [illegible]ATION OF THERMOGENIC GAS SEEP[illegible]GE





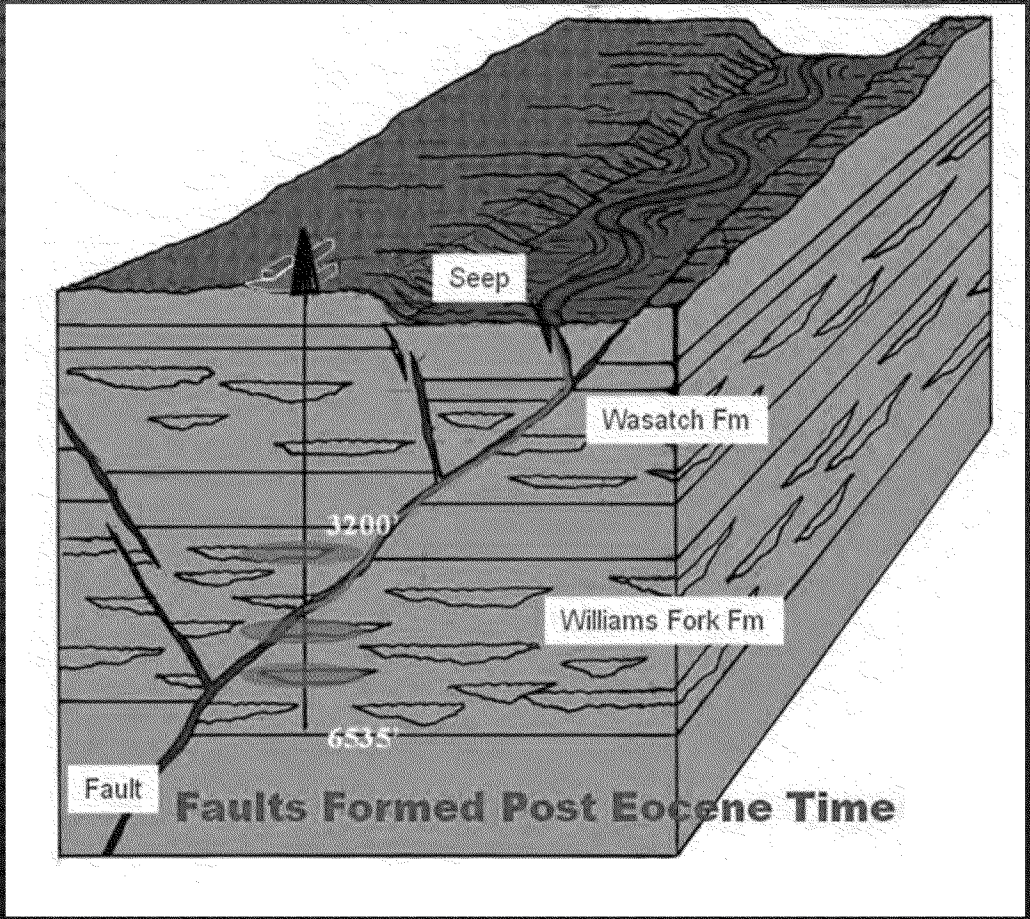
Note proximity of mapped faults to Moon and Miller wells

WEST DIVIDE CREEK SEEP



WEST DIVIDE CREEK SEEP

- Drilling into highly fractured and faulted area (Divide Creek anticline)
- Lost containment on well
- Gas escaped into shallow Wasatch formation and reached surface



Courtesy EnCana

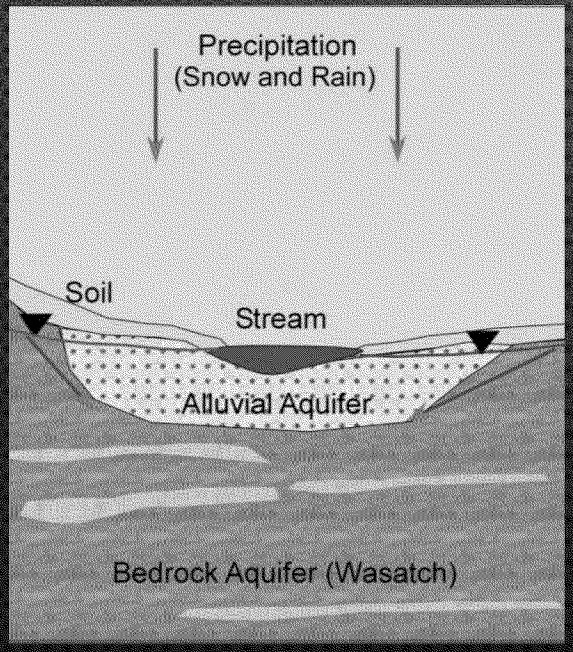
SEEP TRIGGERS ACTION

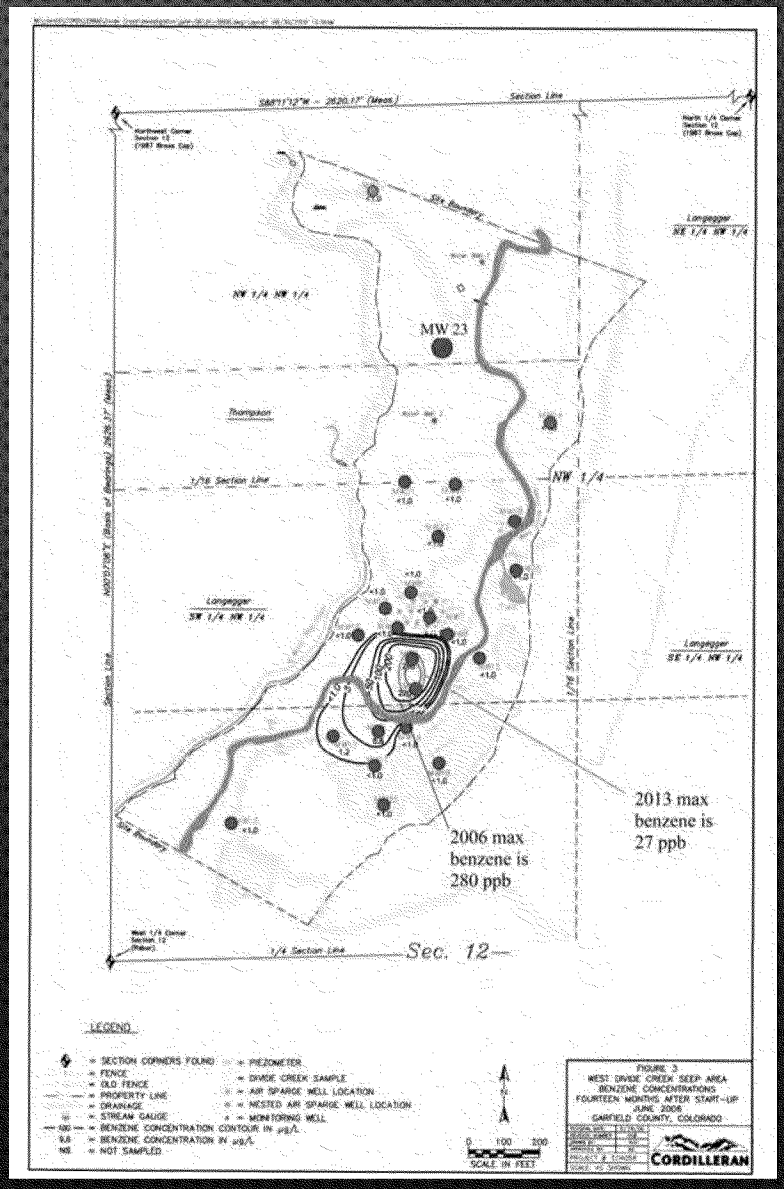
- REMEDIATION STARTED IN SUMMER 2004.
- MONITORING WELLS INSTALLED AND SAMPLED.
- AIR SPARGING SYSTEM INSTALLED.
- HEARING IN FALL OF 2004 FOUND ENCANA WAS RESPONSIBLE FOR THE SEEP (COGCC ORDER 1V-276).
- FINED ENCANA $371,200.
- GARFIELD COUNTY USES FINES FOR PHASE I STUDY.
- COUNTY FOLLOWS WITH PHASE I AND PHASE II STUDIES.
- ENCANA AND COGCC STUDIES.
- USGS STUDY.
- QUARTERLY MONITORING OF SEEP POSTED ON COGCC WEBSITE.

Hydrogeologic Model

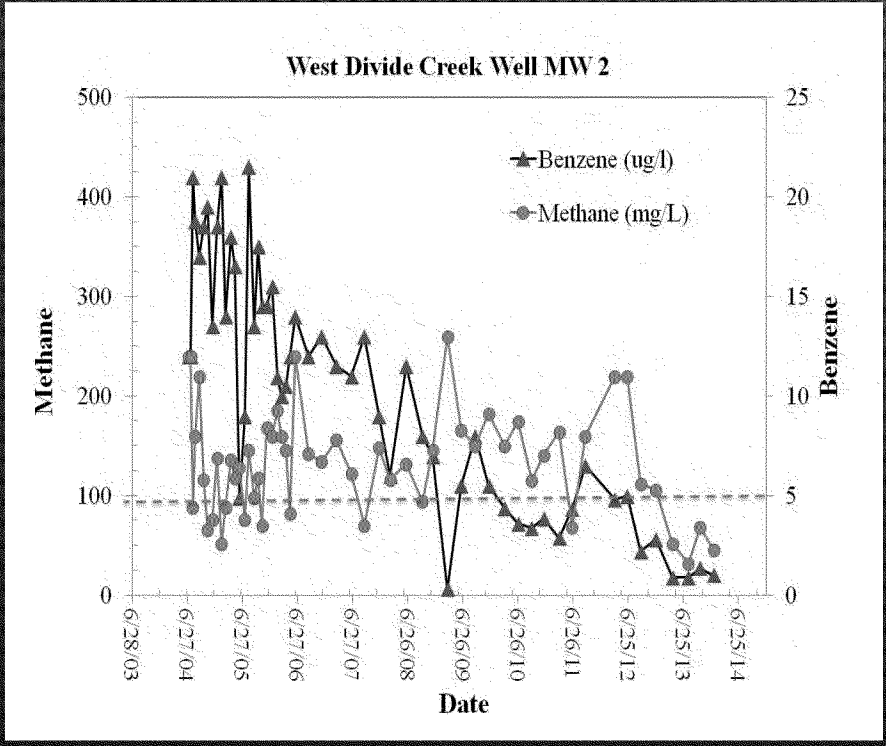
Water moves at
10 - 50 feet/day

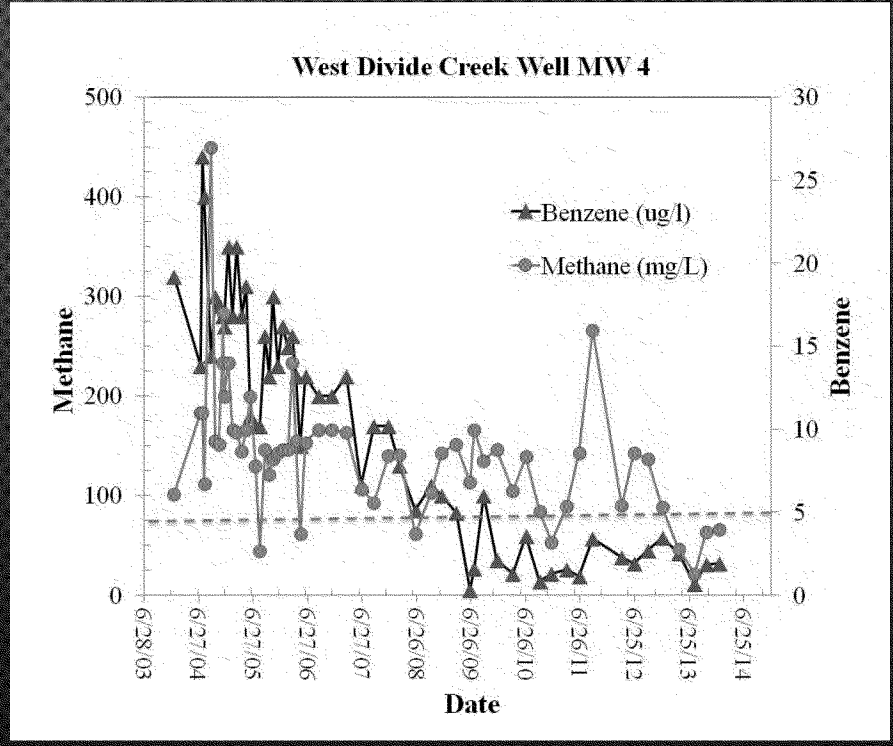
Water moves at
0.0007 - 0.23 feet/day





WDC SEEP GROUNDWATER

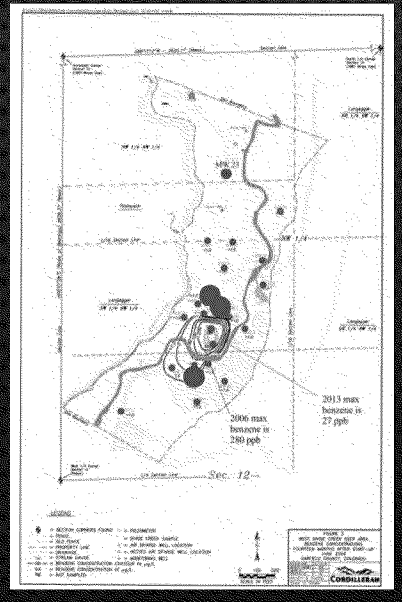


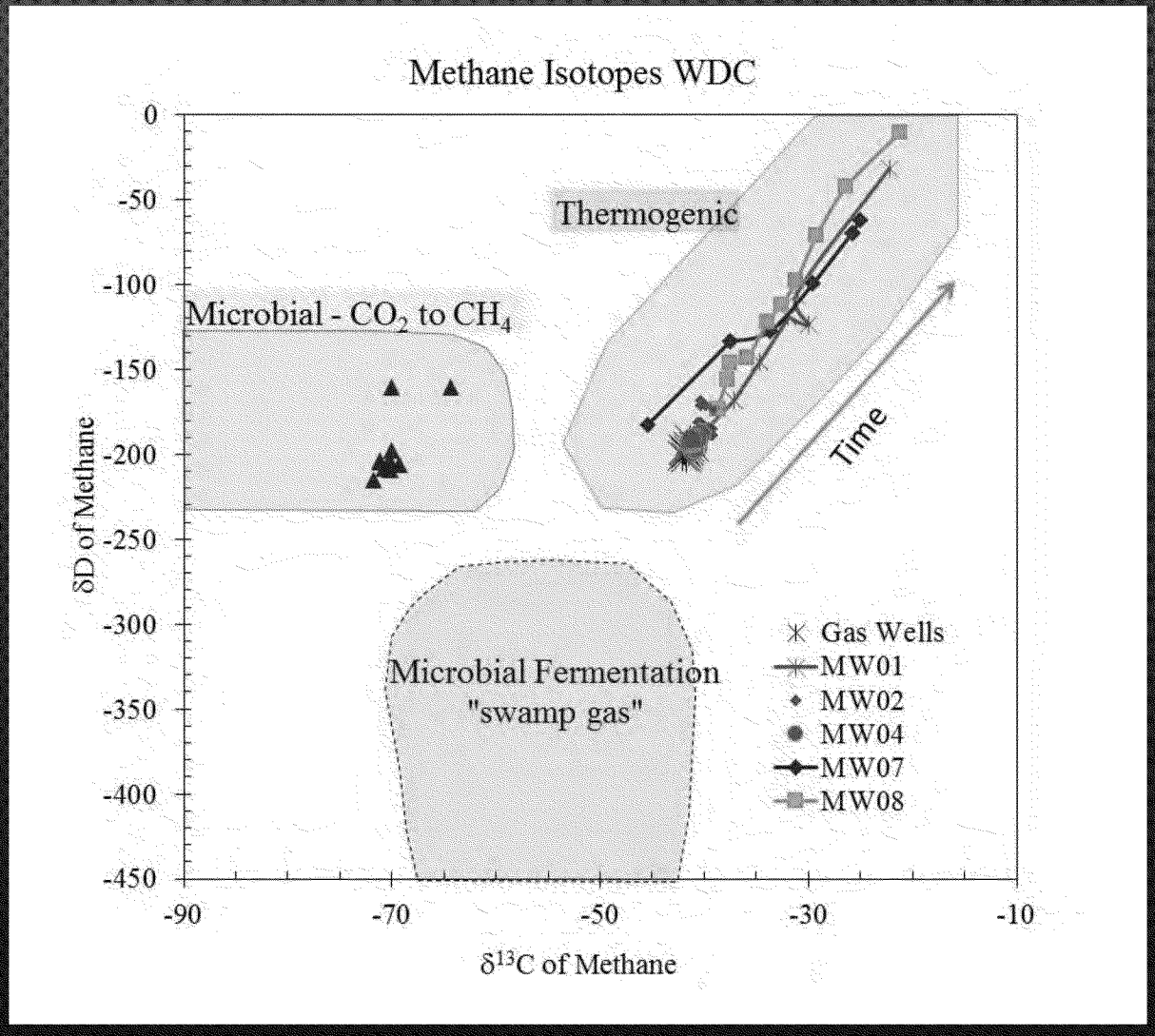


- Benzene declined, Methane in monitoring wells had stable concentration with seasonal pattern each year until 2012

METHANE ISOTOPIC DATA

- CENTER OF SEEP METHANE IS STILL THERMOGENIC
- EXCEPTION IS MW03
- OUTER SEEP METHANE IS DEGRADING BY NATURAL ACTION





PROGRESS (2006-2012)

- WEST DIVIDE CREEK MONITORING DATA PROVIDES FORENSIC METHODOLOGY TO IDENTIFY GAS WELL LEAKAGE.
- PHASE I AND II HYDROGEOLOGIC STUDIES PROVIDE AQUIFER FRAMEWORK AND GEOLOGIC ANALYSIS OF AREA.
- WASATCH (BELOW WATER WELLS) HAS GAS IN SANDSTONE INTERVALS.
- EMOS CEMENTING STUDY DETERMINES ADDITIONAL CARE MUST BE TAKEN TO IDENTIFY AND REMEDIATE WASATCH GAS SOURCES DURING DRILLING.
- COGCC LINEAMENT STUDY CONFIRMS ROLE OF FAULTS AND FRACTURES IN DIVIDE CREEK AREA ARE MAJOR CONTAMINANT PATHWAYS.
- COGCC CONTINUES PROCEDURAL REFINEMENTS (NTC'S) AND DATA GATHERING.

GARFIELD COUNTY PHASE III STUDY 2011-2013

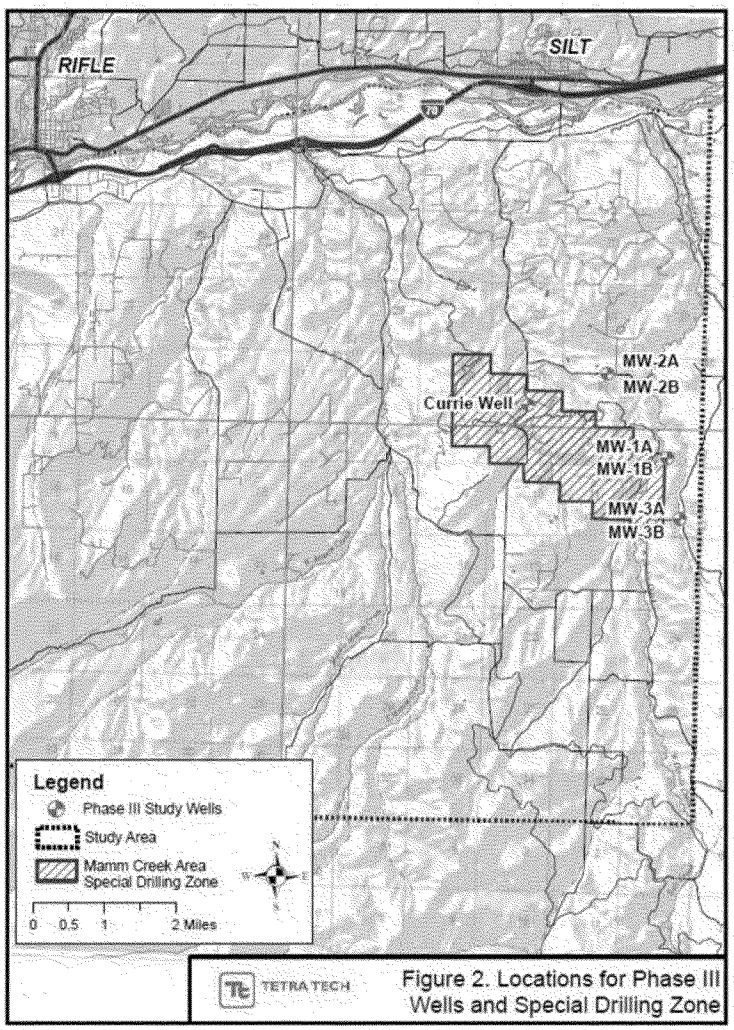
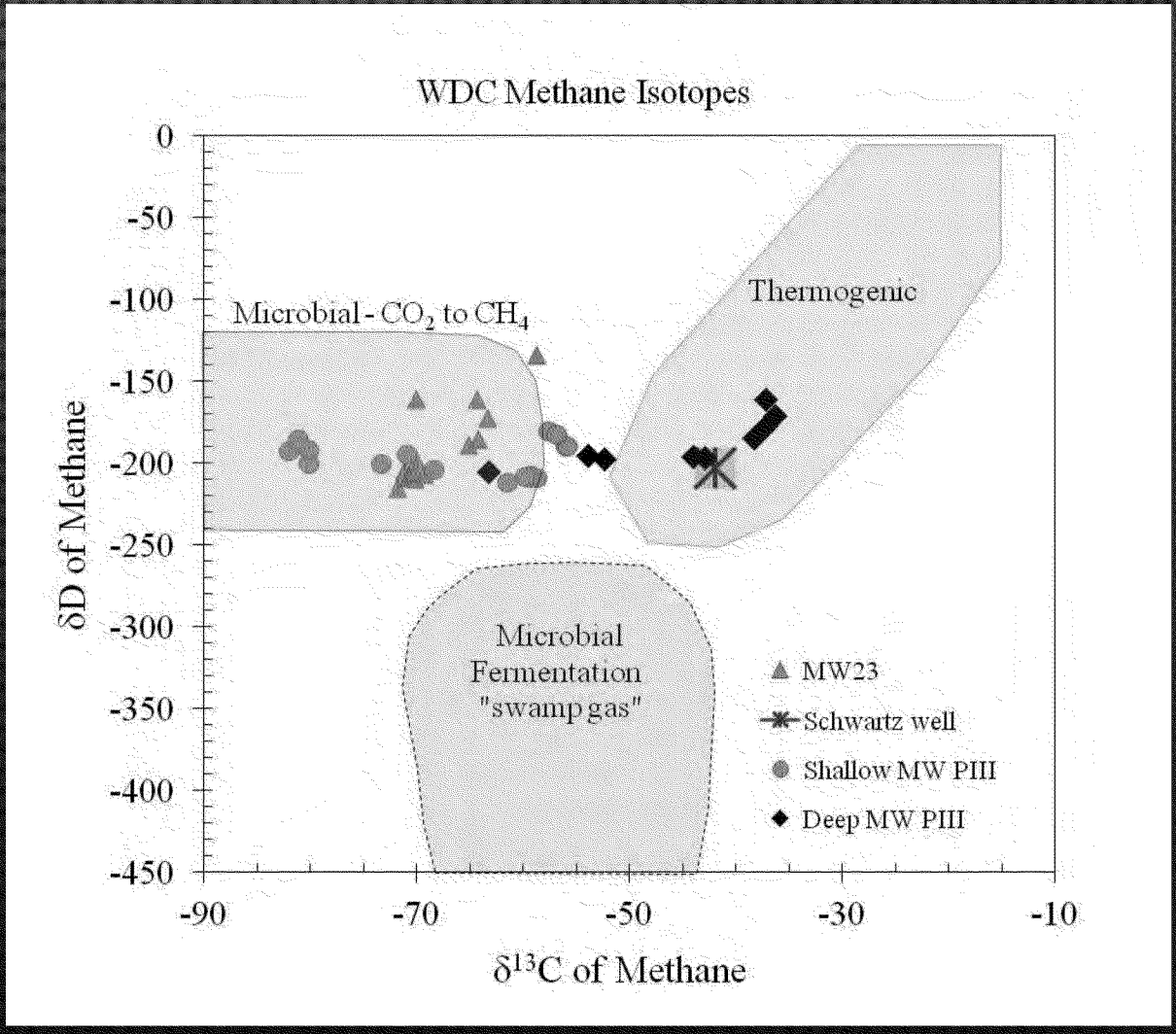


Figure 2. Locations for Phase III Wells and Special Drilling Zone

Sample deeper Wasatch aquifer to determine vertical gradient
And background chemistry

WASATCH AQUIFER NEAR WDC

- SHALLOW AQUIFER HAS BIOGENIC METHANE
- DEEPER AQUIFER HAS BIOGENIC AND THERMOGENIC METHANE
- WATER QUALITY IS NOT GOOD WITH HIGHER SULFATES AND TDS
- LOW BACKGROUND BENZENE



CONCLUSIONS

- BACKGROUND STUDIES POINT TO STRUCTURAL GEOLOGY AS BASIS CAUSE OF VULNERABILITY, BUT MISTAKES DURING DRILLING CAN CAUSE CONTAMINATION.
- REVISED DRILLING AND COMPLETIONS REGULATIONS HAVE PREVENTED FURTHER SEEPS.
- PHASE III STUDY SHOWS NATURAL BACKGROUND IN AREA HAS SHALLOW BIOGENIC METHANE, DEEPER WASATCH HAS THERMOGENIC LEAKAGE FROM DEEPER WILLIAMS FORK IN DIVIDE CREEK AREA.
- SEPARATING WELL LEAKAGE FROM BACKGROUND IN THIS AREA IS CHALLENGING.
- NEW STATE REGULATIONS FOR PRE- AND POST DRILL TESTING WILL BE A BIG STEP FORWARD.