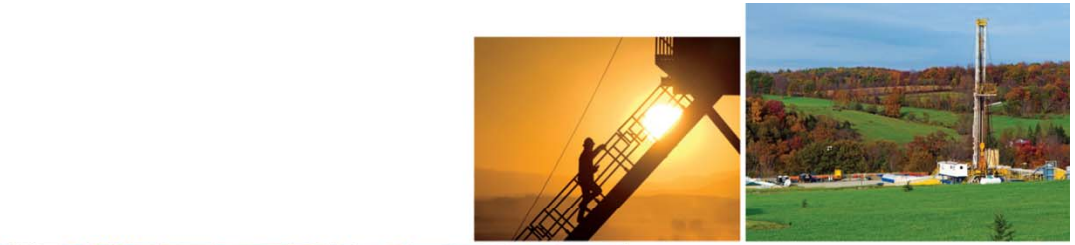
BOLD MOVES
BIG FUTURE



BASELINE WATER QUALITY SAMPLING IN SHALE GAS EXPLORATION AND PRODUCTION AREAS

Chesapeake ENERGY

Debby McElreath, Mark Hollingsworth and Dana Drury
Chesapeake Operating, Inc., Oklahoma City, OK

Nancy Pees Coleman, Ph.D.
Environmental Consultants, Oklahoma City, OK

Presented at
National Environmental Monitoring Conference
August, 2012, Washington, D.C.

Chesapeake ENERGY

CURRENT BASELINE WATER QUALITY PROGRAM CONCEPTS

- **Baseline (pre-drill) sampling is considered the backbone of CHK's prevention measures to protect drinking water supplies**
  - Risk management tool to decrease overall risk
  - Success of the program rests heavily on the accuracy, timeliness and quality of analytical data provided by environmental laboratories
  - Data from baseline sampling programs becomes the base of all subsequent environmental investigations in active drilling, completion and production areas

CURRENT BASELINE WATER QUALITY PROGRAM CONCEPTS

- **Chesapeake has had over 31,000 baseline samples collected**
  - More than 1,162,000 individual laboratory analyses
  - In some areas, as many as 92% of baseline samples have results for at least one water quality parameter that exceeds an established drinking water criteria
  - This much data requires considerable investment in management and evaluation
  - Environmental laboratories involved in baseline programs must be prepared to meet challenges associated with varying numbers of samples

CURRENT BASELINE WATER QUALITY PROGRAM CONCEPTS

- **Water Quality Analysis (pre-drill) using independent environmental consultants (sampling) and analytical laboratories (testing) based on written program documents and procedures**
  - Clarifies expectations for consultants and laboratories
- **On-going communications between all consultants and laboratories involved in the program**
  - Consistency of sampling procedures
  - Increased comparability of data between consultants and laboratories
  - Joint training activities
  - Field and laboratory auditing conducted by CHK

CURRENT BASELINE PROGRAM COMPONENTS

- **Independent Consultants**
  - Identify private water sources
  - Coordinate water sampling survey form delivery
    - Critical element in assisting to identify potential sources of variability, e.g. use prior to sampling
  - Schedule sampling times with residents/landowners, conduct sampling, and follow-up contact
    - Photo documentation during sampling – can prove to be a most critical element
    - Field notes, site sketch and field activities documentation – specific timeframes for conversion to electronic form
    - Verification of multiple contacts and adequate documentation of refusals for testing
    - Coordinate delivery of results to landowners & state agencies (where required)
  - Assist in Public Outreach Meetings in local community groups

CURRENT BASELINE PROGRAM COMPONENTS

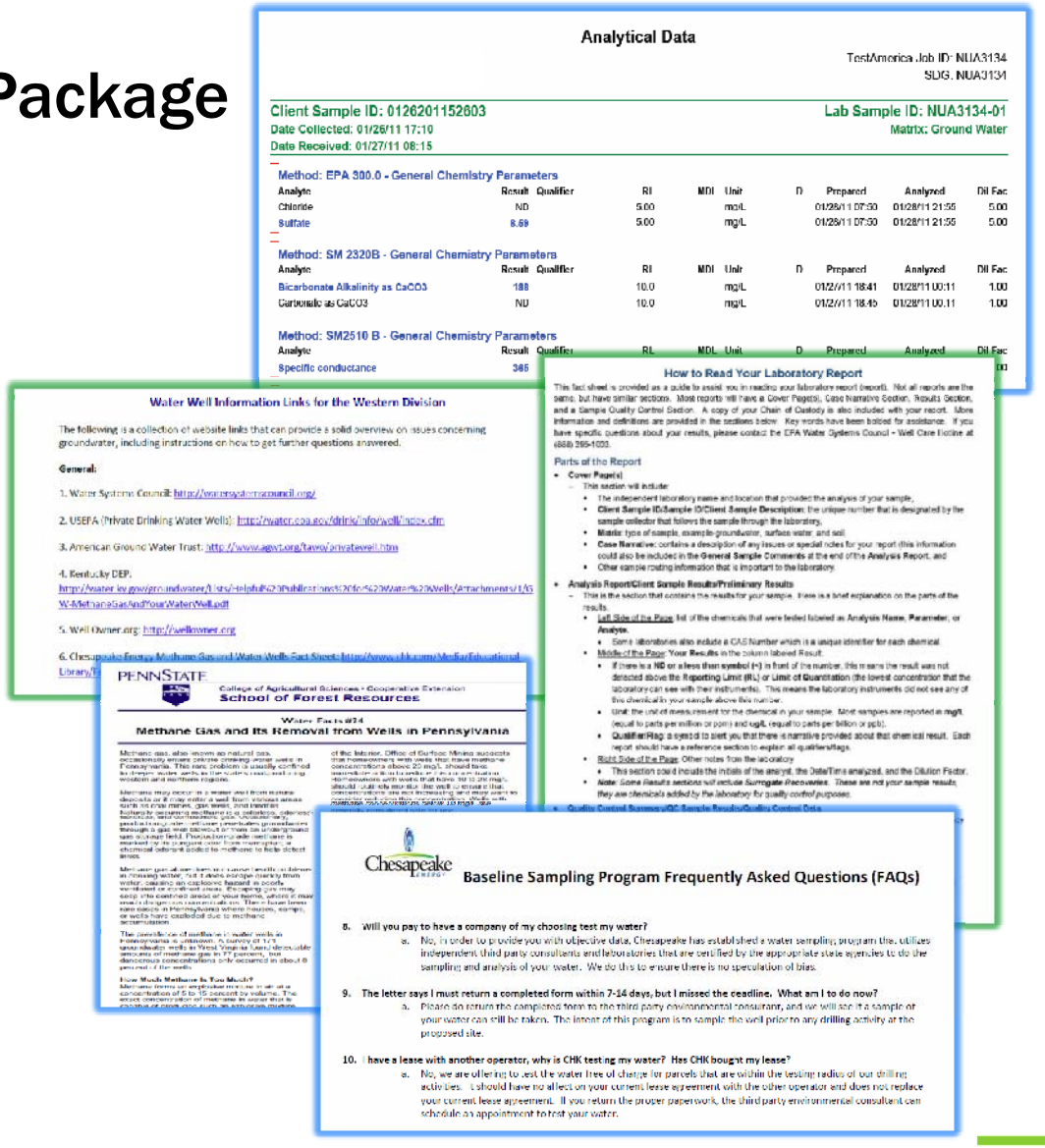
- **Independent Analytical Laboratories**
  - Analyze for specific indicator parameters to establish general water quality
  - Use scientifically validated methods for testing groundwater and surface water
- **Data Internally Stored in EQuIS Format**
  - Able to utilize data for statistical reports
  - Readily access data for complaints or other uses

WATER TESTING PARAMETERS AND LANDOWNER REPORTS

- **Chesapeake Standard Baseline Parameters**
  - **Field Screening:** pH, Temperature, Specific Conductivity, DO, Turbidity, GE/GC/FID/PID and LEL readings, Eh, and Hydrogen Sulfide
  - **General Chemistry:** pH, Specific Conductance, Turbidity, Chloride, Sulfate, Bromide, Carbonate Alkalinity, Bicarbonate Alkalinity, MBAS, TDS, and TSS
  - **Total Metals:** Ag, As, Ba, Ca, Cd, Cr, Fe, Hg, Li, K, Mg, Mn, Na, Pb, S, Se, and Sr
    - Dissolved Metals: Fe and Mn, if field turbidity exceeds 10 NTU
  - **Organics:** BTEX, O&G (HEM), and Dissolved Light Gases (C_1-C_3)
    - Rush dissolved light gas results if field LEL reading is greater than 10% or sample is effervescent
  - **Isotopic Methane:** if dissolved methane exceeds 20 mg/L
    - Some states have a lower threshold of 1 to 2 mg/L

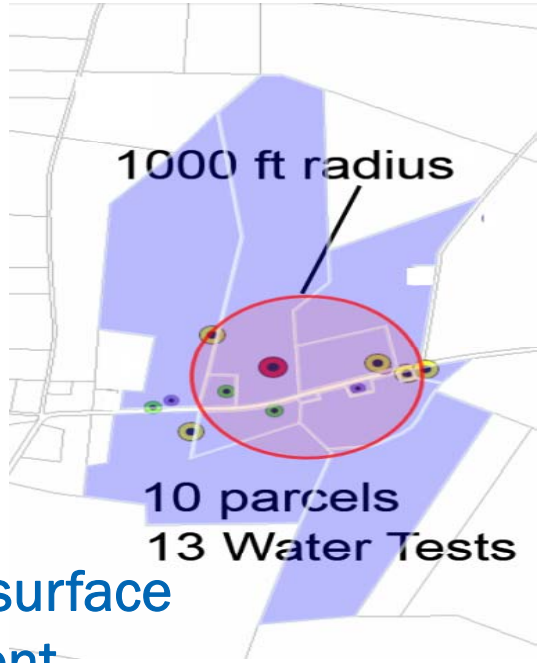
WATER TESTING PARAMETERS & LANDOWNER REPORTS

- **Chesapeake Resident Package**
  - Full Copy of Analytical Laboratory Report
    - How to Read Your Laboratory Report Fact Sheet
  - Frequently Asked Questions (FAQs)
  - Methane Fact Sheets (when dissolved methane is detected)



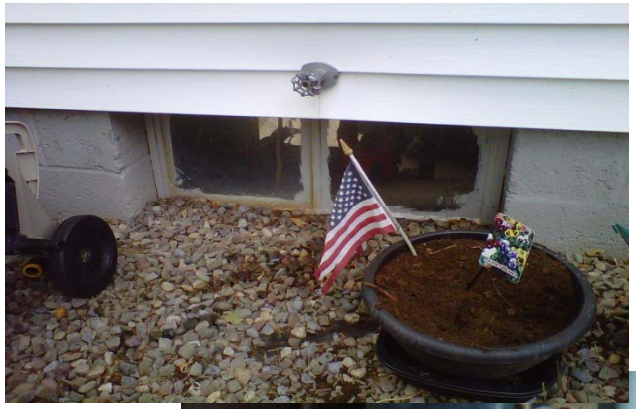
WATER SOURCES & SAMPLING RADIUS

- **Water Sources utilized for household purposes:**
  - Bathing and Washing
  - Drinking and Cooking
  - Other household uses
- **Sampling Radius:**
  - One Thousand feet (1000') from well pad (surface hole) location or state regulatory requirement, whichever is greater
  - Some areas radius is extended (4,000') based on location and available water sources



BASELINE WATER SAMPLING POINT

- **Sample Collection Point:**
  - Non-invasive sampling
    - Dissolved gases should be collected under water head
  - Water Line from Water Well or Spring:
    - Sample point/spigot at well head or prior to treatment/pressure tank
    - Base of pressure tank
    - Sink tap
  - Springs: end of the pipe, outlet, or from cistern/water collection system
  - Surface water: mid-depth from center of water source, if possible



BENEFITS OF PRE-DRILL SAMPLING & TESTING

- **Better understanding of general water quality in immediate area**
  - Water well records obtained during baseline sampling surveys may be incomplete in counties where records are poorly kept
  - Landowner knowledge of water quality is documented in Water Sampling Survey
  - Help identify areas with pre-existing dissolved methane sources

BENEFITS OF PRE-DRILL SAMPLING & TESTING

- **Help establish a baseline of water quality if complaint is made**
  - Use in addition to a timeline for events prior to the complaint
  - Additional data can be gleaned from mud logger data, area data compilations, and evaluation of other possible sources (e.g., legacy wells, etc.)

BENEFITS OF PRE-DRILL SAMPLING & TESTING

- **Water testing in the area demonstrates the operator's commitment to protection of water source(s)**
- **Landowners receive a full analytical report documenting their water quality**
  - › Provide educational fact sheets to assist landowners in understanding their resident package
  - › Many landowners do not know the depth of their well
- **Help educate the general public in localized town hall meetings**
  - › Helps to overcome public perceptions
  - › Presents baseline data findings for the general area
  - › One-on-one sessions are made available

LESSONS LEARNED

- **Operator's program document must be written**
- **Photo documentation is critical**
  - › Consultants must act as the eyes for the operator at each site being sampled
  - › Photos of wellhead, sample point and any special or unusual conditions noted
- **Document all attempts to provide testing**
  - › Consultant must document all written and oral contact with well owner to offer water sampling in order to establish due diligence
  - › All refusals must be clearly documented

LESSONS LEARNED

- **Laboratories should be prepared to be flexible**
  - Numbers of samples are not guaranteed
  - Participation in baseline sampling programs may lead to additional work
    - Example: 26 baseline samples lead to an additional 750 samples in a subsequent investigation

LESSONS LEARNED

- **Laboratories need rigorous electronic data delivery systems and robust QA/QC for data reporting**
  - Correct reporting of data, units, etc.
  - Use of consistent analyte nomenclature
    - 1,2-xylene versus o-xylene
    - Dibromochloromethane versus chlorodibromomethane
  - Use of multiple methods for the sample analyte
    - Appears as two different compounds
  - Electronic data delivery (EDD) must be consistent with written analytical report
    - Multiple confirmation runs reported in the EDD

LESSONS LEARNED

- **Laboratories need to invest in excellent analytical capabilities for general water quality parameters**
  - Need to be robust and provide irrefutable analytical data
  - Example: Sulfate data for 30 wells collected on the same day
    - Results reported on one day were 4 times higher than actual concentration due to manual calculation error at the bench level
    - Data had not been internally reviewed by the laboratory for consistency with other general water quality parameters reported for the samples and for the project
    - Investments need to be made in upgrading capacity and capabilities in the general chemistry laboratory

LESSONS LEARNED

- **Laboratories need to provide consistently accurate sample results**
  - Baseline sampling programs for a single O&G operator may involve multiple laboratories
  - O&G operators are beginning to share data collected in the sample area
  - It is critical that data from each laboratory be comparable

LESSONS LEARNED

- **Laboratories need to improve laboratory reports**
  - Many are difficult to read and understand
  - Example: Well owner indicated he was concerned about the 100% acetylene in his well
    - Misinterpreting the surrogate data for light gases reported in the midst of the analytical data for his well
  - Surrogates and other quality assurance information is necessary but confusing for the non-professional
  - Laboratory reports should contain a summary of detected results at the beginning of the laboratory report

LESSONS LEARNED

- **Laboratories need to improve case narratives**
  - Laboratories are using data qualifiers instead of extensive case narratives
  - The case narrative is often critical to the correct interpretation of the data
  - Example: Total metals results for a domestic water well sample were highly elevated compared to three prior samples
    - Inquiry to the laboratory revealed the sample analyzed for metals contained substantial amounts of sediment
    - This was not noted in the case narrative
  - Example: Set of 10 air samples analyzed by EPA Method TO-15
    - Case narratives on 9 of 10 samples indicated issues with analysis of samples in Tedlar bags
    - The one sample with significant results did not have the statement in the case narrative
  - Laboratories need to prepare well written and completely descriptive case narratives

LESSONS LEARNED

- **Laboratories need to have in place mechanism to rapidly notify the client of analytical results which exceed an established threshold**
  - Baseline samples with dissolved method 20 mg/L or above requires notification so that the well owner can be immediately notified and appropriate education and mitigation can begin

CONCLUSIONS

- Laboratories need to be prepared to be an active partner with the oil and gas operator client
- Laboratories need to have robust systems to support accurate delivery of data into electronic database systems
- Laboratories need to invest in excellent analytical capabilities for general water quality parameters

CONCLUSIONS

- Laboratories need to update laboratory report formats so they are more easily read and understood
- Laboratories need to improve case narratives
- Laboratories need to have a rapid notification system in place for results which exceed established thresholds

QUESTIONS?

debby.mcelreath@chk.com