Chairman David Porter
Commissioner Christi Craddick
Commissioner Ryan Sitton
May 2016

STAKEHOLDER MEETING

NPS GRANT PROJECT UPDATE

Wendkirk Oil Field Site

Robert Lee, Texas

May 25, 2016

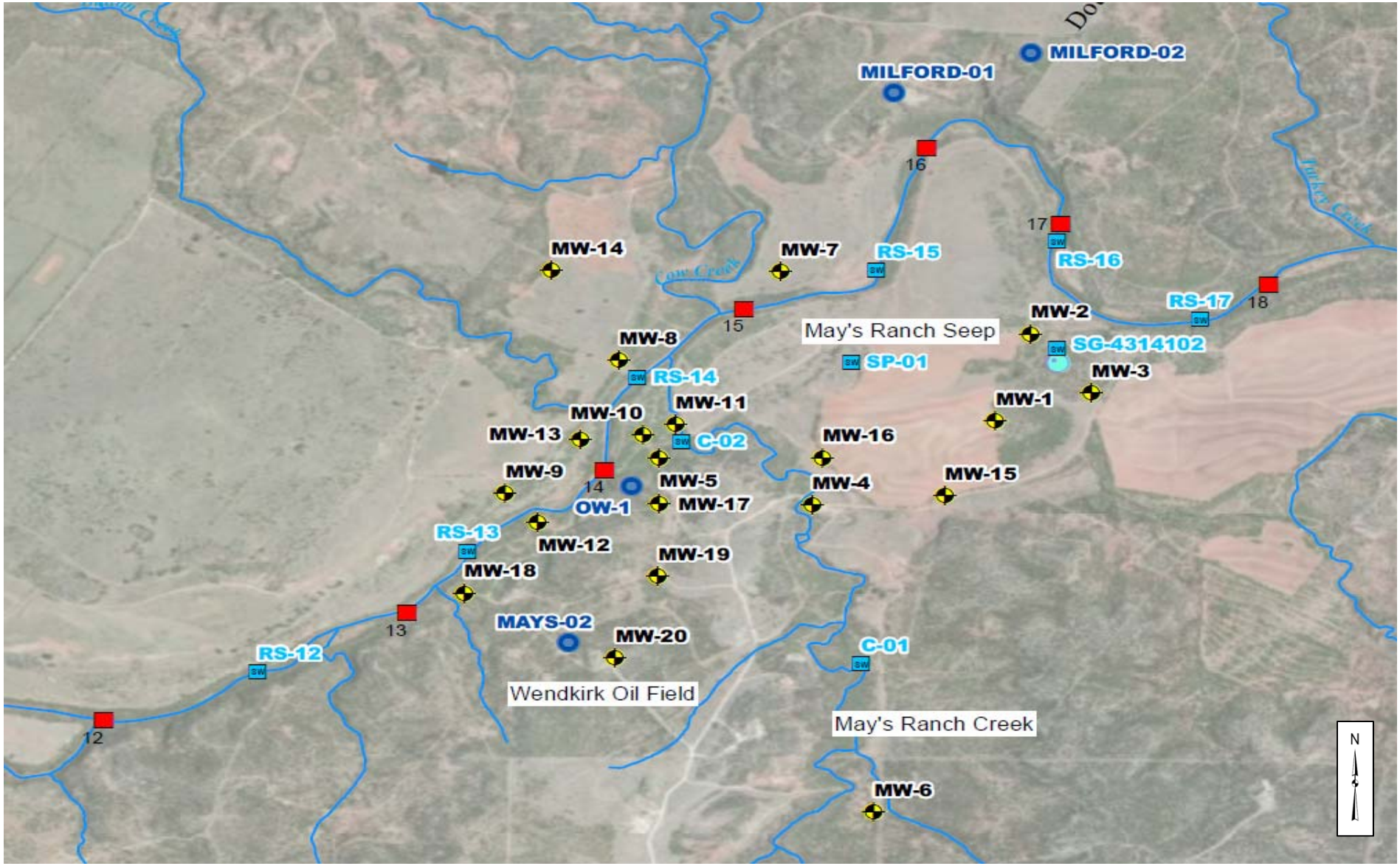
2013 NPS GRANT PROJECT OBJECTIVES

- Goal: Mitigate salinity loading to the Colorado River as a result of impacted groundwater beneath the site.
- Tasks:
  - Investigation of the optimum location for a Best Management Practice (BMP) system
  - Implementation of a BMP (i.e., saline groundwater recovery system)
  - Monitor BMP effectiveness

2013 NPS GRANT
ACTIVITIES PERFORMED TO DATE

- Monitoring and Modeling Quality Assurance Project Plans (QAPPs).
- Comprehensive groundwater/surface water monitoring event in 2014 for current site data.
- Additional surface water sampling in June and December 2015.
- Aquifer testing in 2015 for site-specific hydrogeologic characteristics.
- Groundwater flow modeling and BMP scenario evaluation in 2015.
- Initial BMP design finalized May 2016.

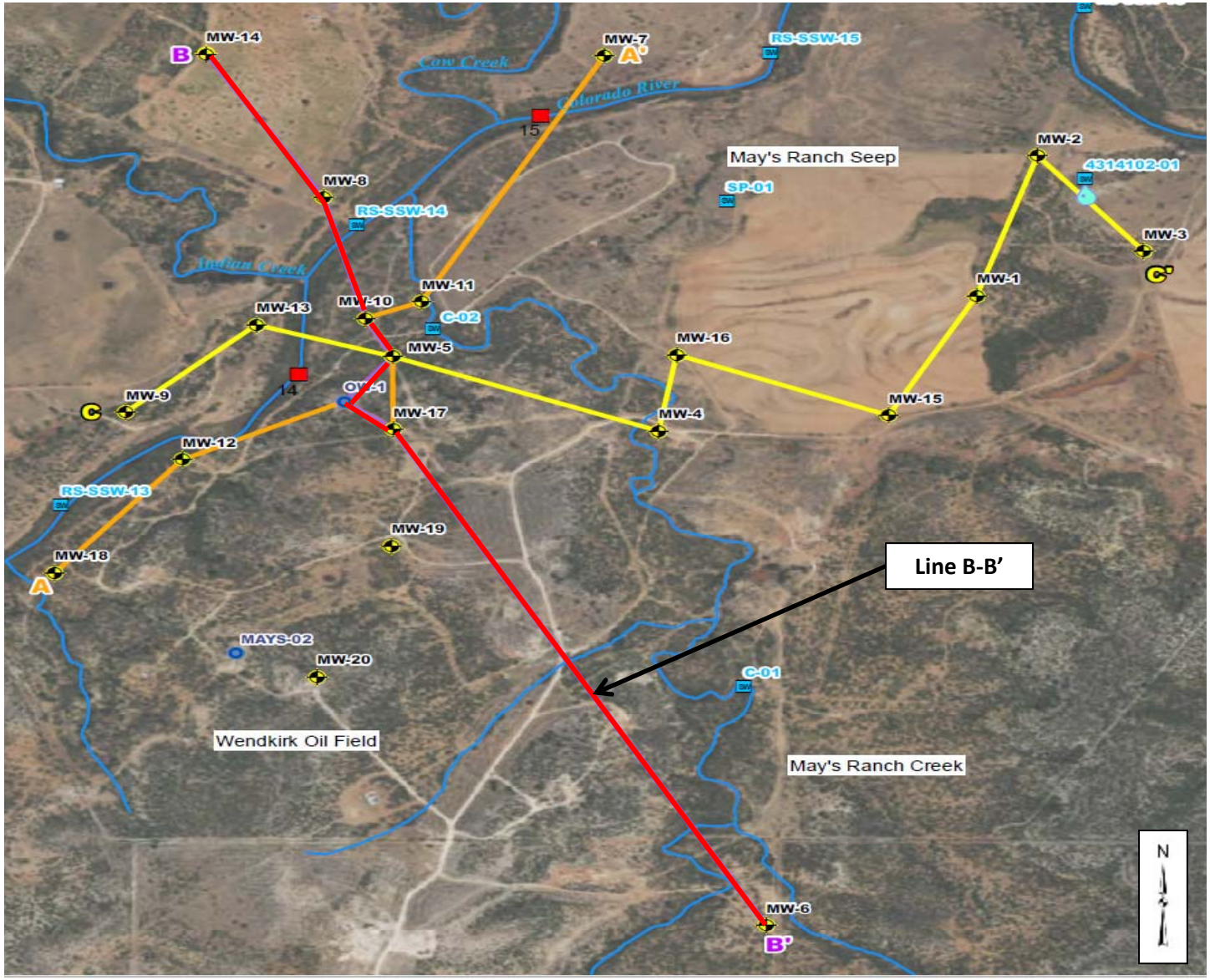
SITE LAYOUT


MILFORD-02
MILFORD-01
16
17
RS-16
RS-15
MW-14
MW-7
Cow Creek
RS-17
18
MW-2
15
May's Ranch Seep
SG-4314102
MW-8
SP-01
MW-3
RS-14
MW-1
MW-11
MW-10
MW-13
C-02
MW-16
MW-9
14
MW-5
MW-4
MW-15
OW-1
MW-17
RS-13
MW-12
MW-19
MW-18
13
MAYS-02
MW-20
C-01
RS-12
Wendkirk Oil Field
May's Ranch Creek
12
MW-6
N

CONCEPTUAL SITE MODEL

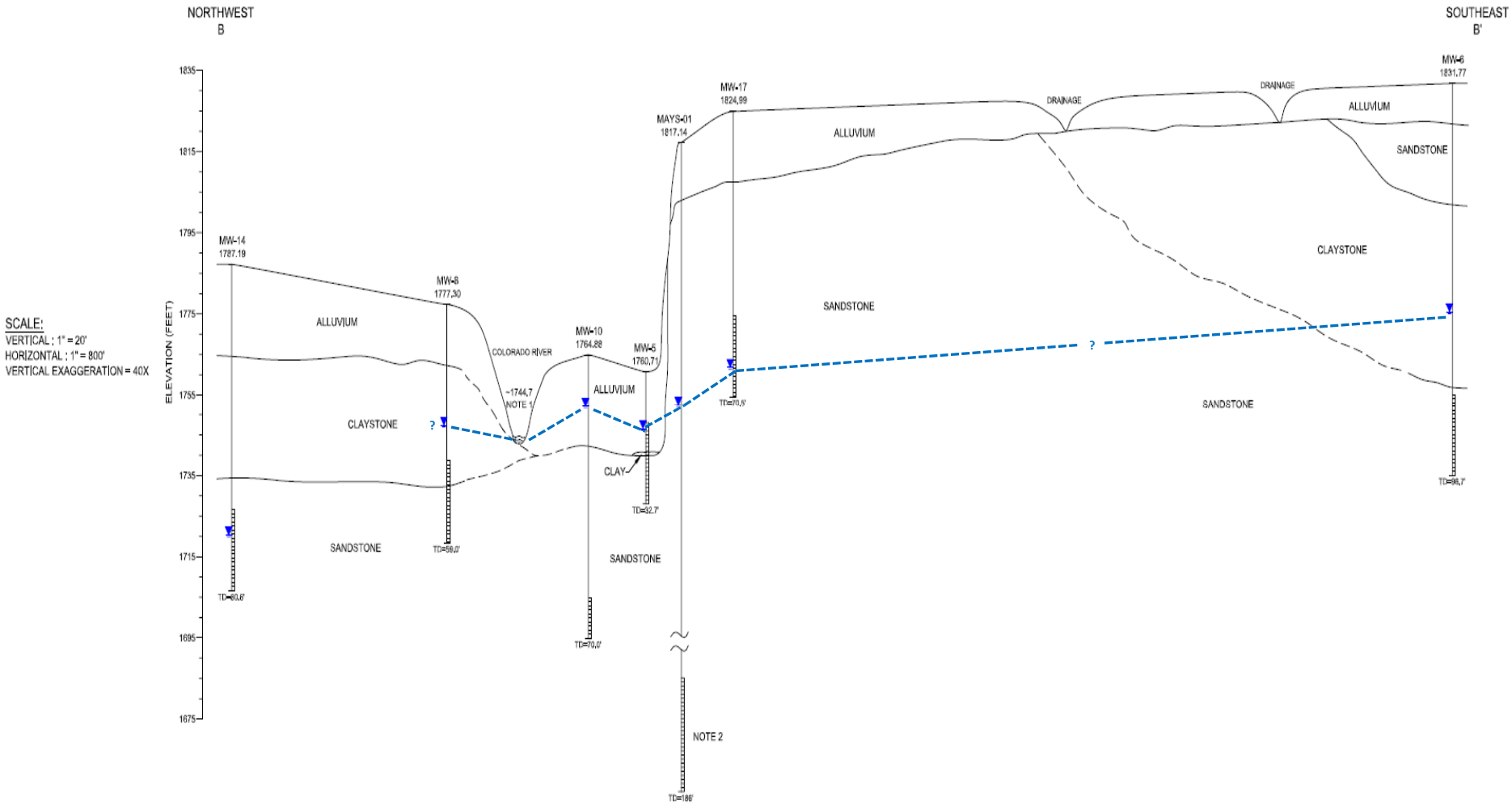
- Produced water from oil field activities is suspected source of high salinity groundwater.
- Lithology consists of San Angelo formation sandstone overlain by unconsolidated sand and discontinuous clay lenses (alluvium) and claystone units.
- Uppermost groundwater-bearing unit (GWBU) present in San Angelo formation; some saturation in alluvium in low land areas and along the river.

GEOLOGIC CROSS-SECTION



Line B – B': crosses oil field and Colorado River

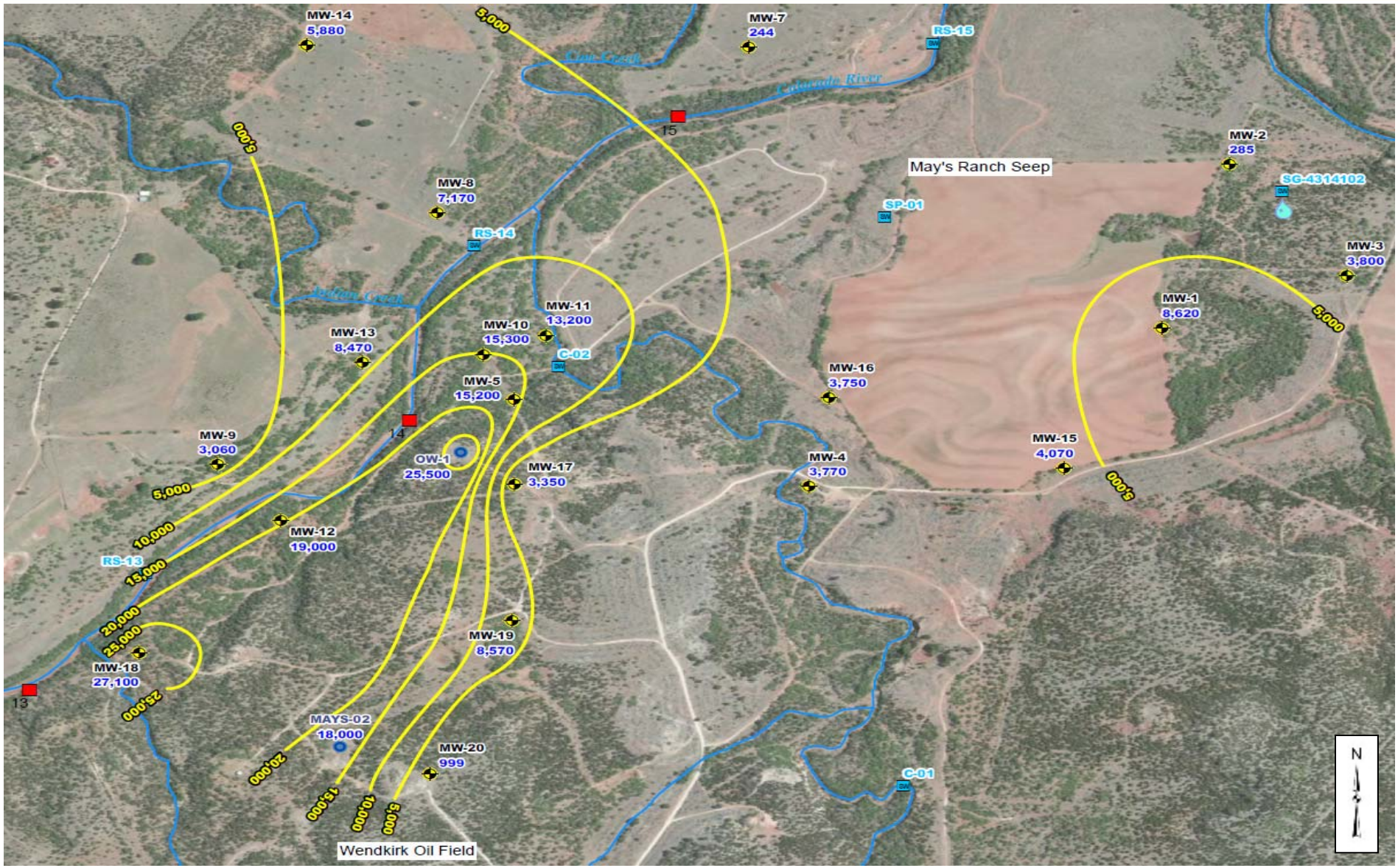
GEOLOGIC CROSS-SECTION



GROUNDWATER AND SURFACE WATER CONDITIONS – AUGUST 2014

- Groundwater flows toward the river.
- Maximum chloride concentrations in groundwater at MW-18 at 27,100 milligrams per liter (mg/L).
- Only one sampling station (RS-15) had surface water in August 2014.
  - Chloride concentration at 18,900 mg/L.
  - Likely represents base flow.
- No other surface water observed in river, May's Creek, or at May's Ranch Seep or Spring.

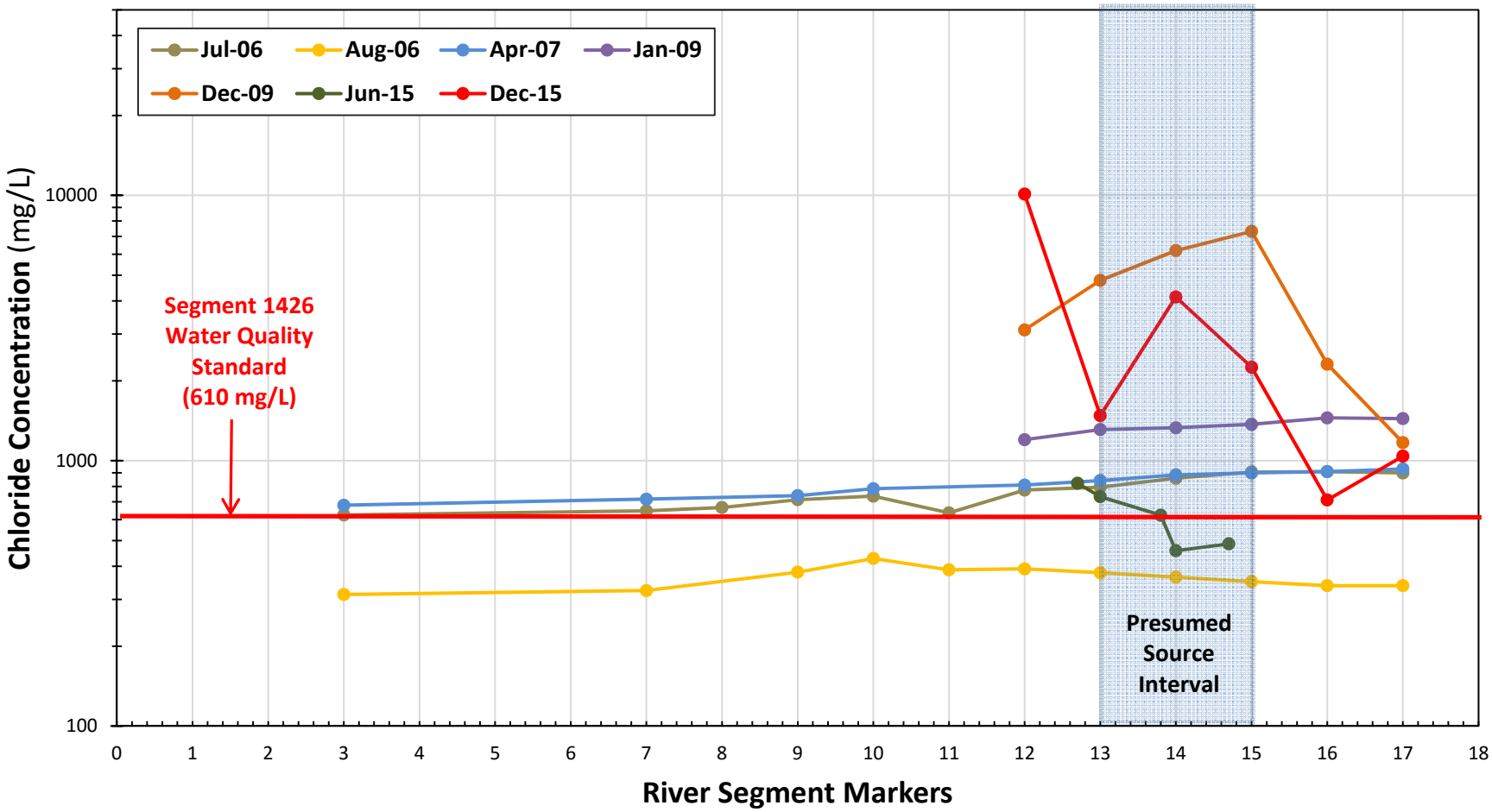
GROUNDWATER CONDITIONS
AUGUST 2014



SURFACE WATER CONDITIONS JUNE AND DECEMBER 2015

- **June 2015** – limited sampling of select stations to support groundwater modeling.
- **December 2015** – sampled all river stations but no access to May's Creek or May's Ranch Seep and Spring locations.
- **Maximum chloride concentration in June 2015** – 822 mg/L at most upstream location (Western Transect).
- **Maximum chloride concentration in December 2015** – 10,100 mg/L at most upstream location (RS-12). Other concentrations ranged from 711 mg/L to 4,140 mg/L.

SURFACE WATER QUALITY TRENDS 2007 – 2015



Note: River dry during 2011 and 2014 sampling events. December 2009 samples collected from pits excavated in river bed.

AQUIFER TESTING

- Slug testing on all monitoring wells (MW-1 through MW-20 and OW-1).
- Hydraulic conductivities (K) from slug testing – ~1E-3 to 2E-6 feet per second (ft/sec).
- Step-drawdown testing on three monitoring wells in likely BMP target area of highest salinity groundwater (MW-10, MW-11, and MW-18).
- K from step-drawdown testing – ~1E-1 to 1E-3 ft/sec.

AQUIFER TESTING

- Maximum pumping rates achieved during step-drawdown testing ranged from 0.5 to over 2 gallons per minute (gpm).
- Wells MW-11 and MW-18 pumped dry during step-drawdown testing at rates of 1.5 gpm and 0.5 gpm, respectively.
- Step-drawdown test at MW-10 indicated 2 gpm was likely sustainable maximum pumping rate.

GROUNDWATER MODELING

- MODFLOW for flow modeling and particle tracking.
- Model domain constructed of grid/layers to represent geologic and hydrogeologic characteristics of the site.
- Uppermost GWBU corresponds to upper saline zone identified in Bureau of Economic Geology (BEG) geophysical study.
- Calibrated model to historical groundwater elevation data.
- BMP scenarios evaluated consisted of recovery wells (RW) to intercept high salinity groundwater before discharging to the river.

GROUNDWATER MODELING

- Predicted optimum pumping rate per RW of 0.8 gpm.
- Optimum groundwater recovery configuration estimated with 10 RWs.
  - Recovery wells situated south of the river bank along the 20,000 mg/L chloride isoconcentration contour.
  - RWs screened through entire saturated thickness of upper saline zone identified in BEG study.

GROUNDWATER MODELING

- Groundwater / surface water is not well understood:
  - Variability in water quality from surface water samples may be related to gaining/losing river stage.
  - Available data spans years of exceptional drought conditions. Lack of surface water in river during drought years indicates that groundwater does not continuously discharge to the river.

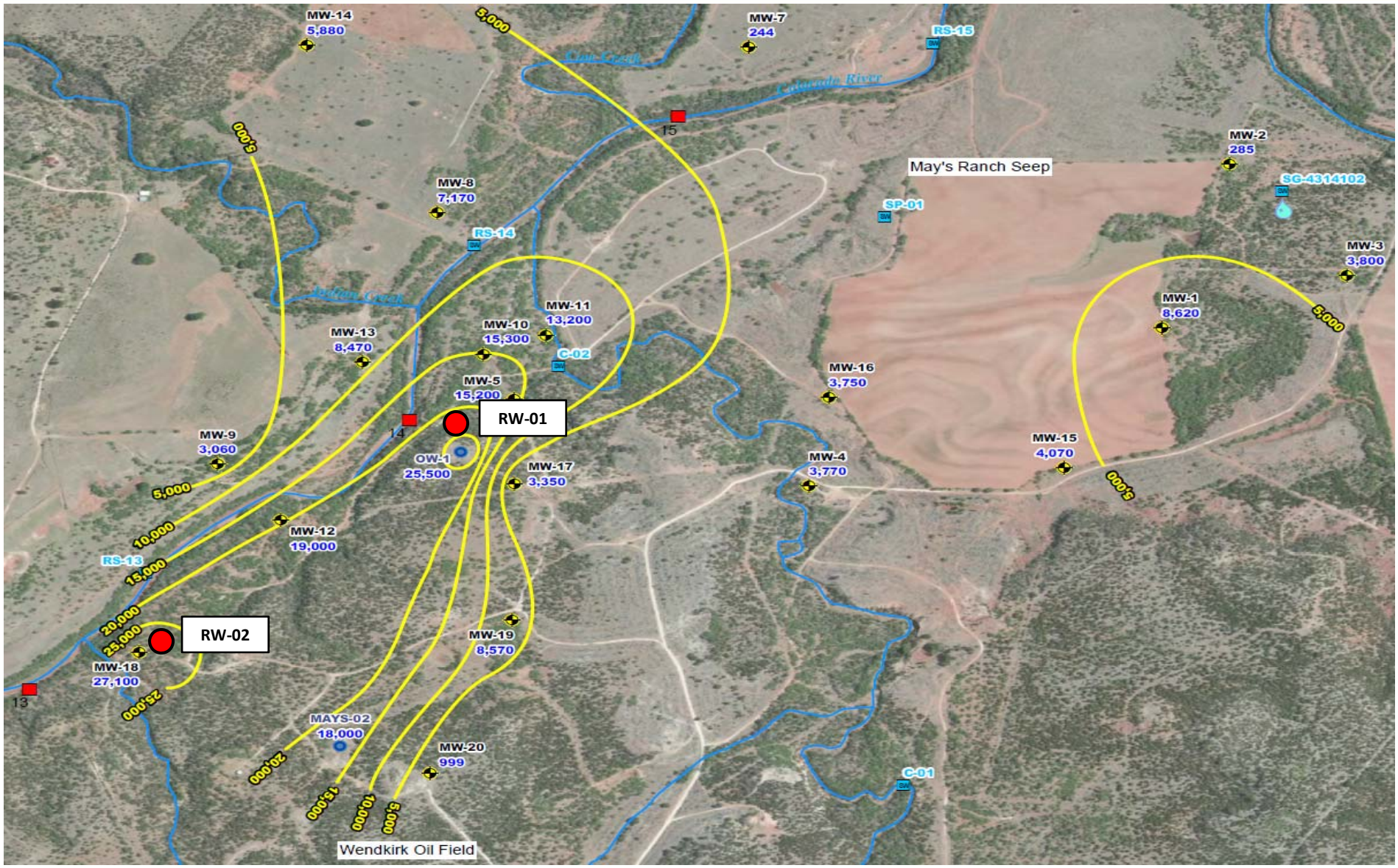
INITIAL BMP DESIGN

- Initial limited scale BMP recommended due to limited understanding of groundwater base flow to river.
- Limited scale BMP will still support salinity load reduction but allows for further assessment of actual aquifer response under continuous pumping conditions.
- Additional surface water and groundwater monitoring recommended to enhance understanding of the groundwater/surface water relationship.

INITIAL BMP DESIGN

- Design Concept
  - Pump groundwater from two RWs, one each near the monitoring wells with highest salinity groundwater (OW-1 and MW-18).
  - Discharge recovered groundwater via aboveground piping to an onsite RRC-permitted saltwater disposal well (Salmon #1 well).

INITIAL BMP DESIGN



Questions?

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