DEPARTMENT OF THE AIR FORCE
377TH AIR BASE WING (AFGSC)

ENTERED

Colonel Dawn A. Nickell
Installation Vice Commander
377 ABW/CV
2000 Wyoming Blvd SE
Kirtland AFB NM 87117

MAR 2 9 2018

Mr. John Kieling, Bureau Chief
Hazardous Waste Bureau (HWB)
New Mexico Environment Department (NMED)
2905 Rodeo Park Drive East, Building 1
Santa Fe NM 87505-6303

Dear Mr. Kieling

In accordance with the Notice of Deficiency dated 16 November 2017 and pursuant to the response issued by the Air Force (AF) on 29 December 2017, the AF committed to submitting preliminary groundwater modeling results to the New Mexico Environment Department (NMED) no later than 31 March 2018. Please find attached the preliminary groundwater modeling results for your review. Comprised within the attachment is the proof of concept of the FEFLOW modeling performed which contains a synopsis of the completed initial model design, model calibration, and hydraulic capture results of the groundwater interim measure at the Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS-111 at Kirtland Air Force Base, New Mexico.

The AF is prepared to present the preliminary groundwater modeling results at the modeling Technical Working Group (TWG) meeting scheduled for 12 April 18. It is our understanding that once the TWG has selected a model or models, NMED will direct the AF regarding the timeline for development of the six step capture zone analysis.

If you have any questions or concerns, please contact Mr. Scott Clark at (505) 846-9017 or at scott.clark@us.af.mil.

Sincerely

DAWN A. NICKELL, Colonel, USAF
Vice Commander

Attachment:
Preliminary Groundwater Modeling Results

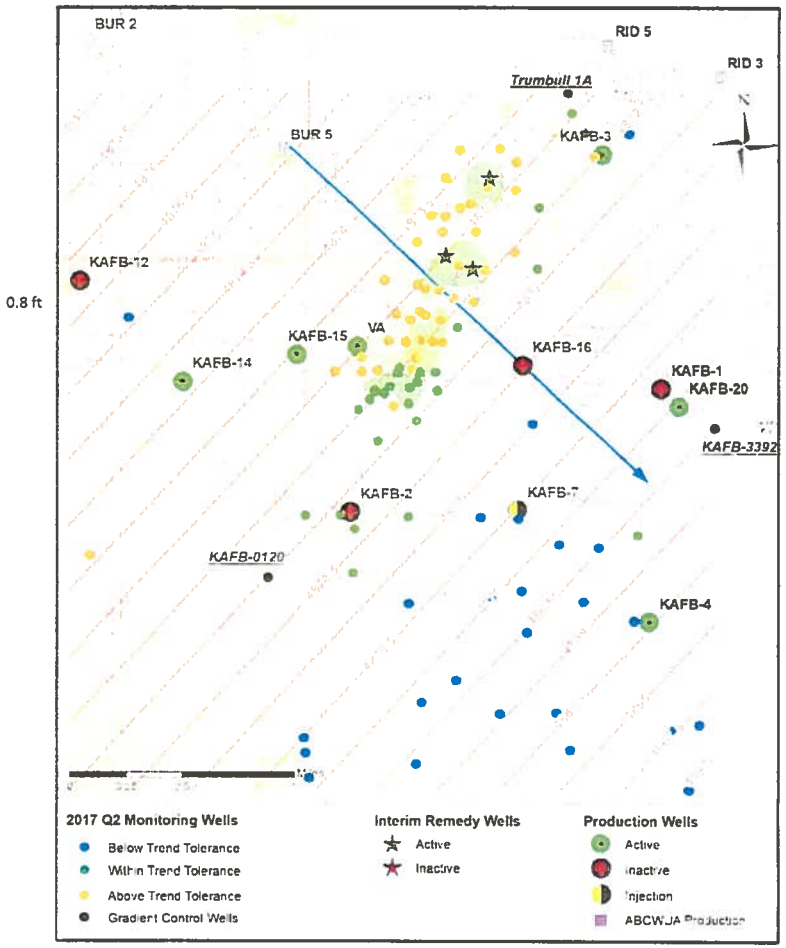
cc:
NMED (Borrego) letter only
NMED-OOTS (McQuillan)
NMED-GWQB (Hunter, Pullen)
SAF-IEE (Lynnes) electronic only
AFCEC/CZ (Renaghan, Segura, O'Grady) electronic only
USACE-ABQ District Office (Simpler, Phaneuf, Dreeland; Cordova; Salazar) electronic only
Public Info Repository, AR/IR, and File

KAFB4652

ATTACHMENT
PRELIMINARY GROUNDWATER MODELING RESULTS

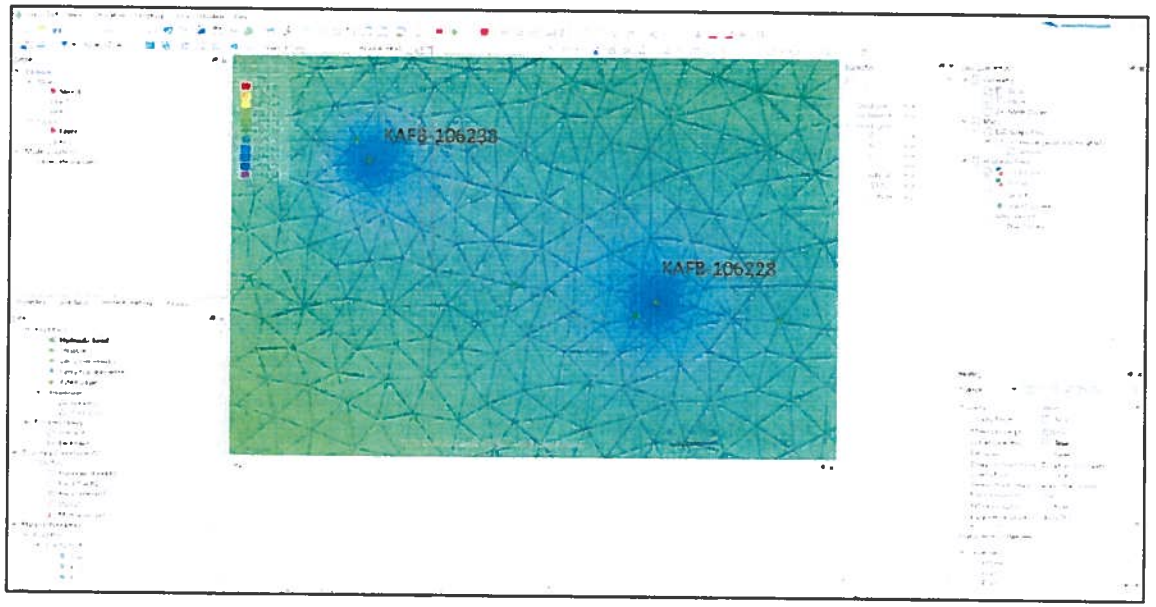
2017 Q2 Gradient Input to Model

- Extraction from KAFB and interim remedy water-table aquifer wells has equaled or exceeded extraction from Ridgecrest wells resulting in a shift in flow direction across the AOI
- Only when Ridgecrest extraction greatly exceeds KAFB extraction does flow at Trumbull 1A shift towards Ridgecrest wells
  - Periodic shift
- Combined drawdown associated with KAFB-3, 4, and 20 extraction has become the controlling factor for AOI gradient
- Linear Gradient Model
  - Gradient = 0.00047
  - Flow Direction = S47^{o}E (317^{o})
  - Goodness of Fit
    - Measure head range (difference)
      - 4,869.3 to 4,875.9 NAVD88 (6.7 ft)
      - Trend fit = residual -0.67 to 0.67 ft
    - NRMSE = 21%
      - The poor fit of the linear trend model to measured head data across the AOI is due to interim remedy extraction.
      - Poor model fit in south of AOI due to gradient across this area is towards the east and the combined KAFB-4 / KAFB-20 drawdown.



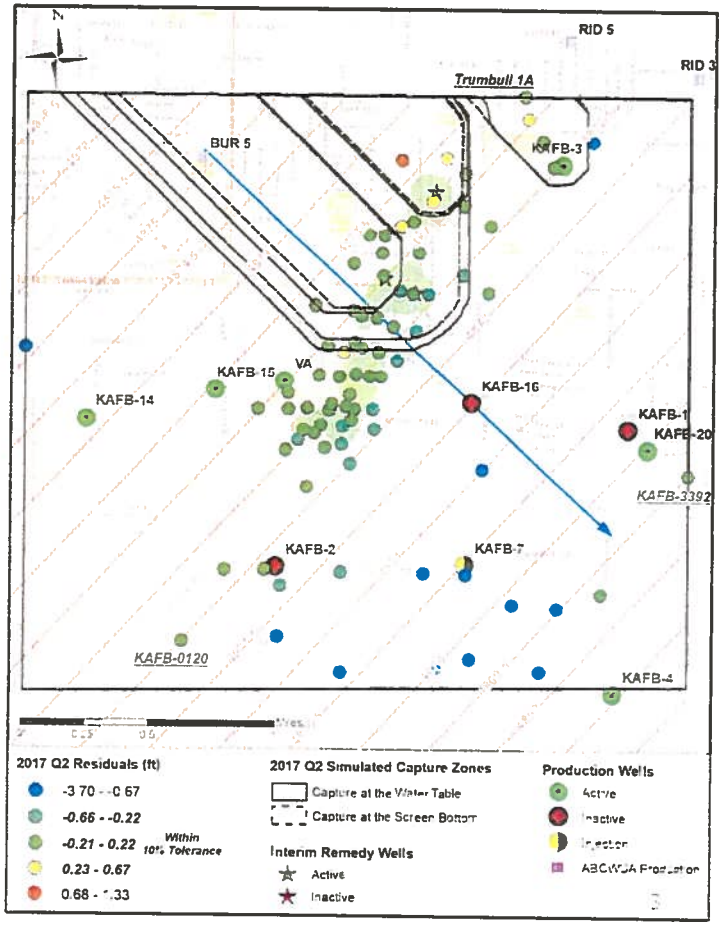
Gradient Flow Model Design

- Purpose: supporting line of evidence for Interim Remedy Capture Analysis
- Incorporates:
  - Aquifer properties:
    - Horizontal hydraulic conductivity
    - Vertical anisotropy
  - Magnitude and direction of the local gradient
  - Interim Remedy extraction rates
- Design:
  - Finite element numerical flow simulation using FEFLOW
  - 3D, 2-layer, phreatic, steady-state model
    - Top of model elevation set at 4,885 ft amsl
      - Top of KAFB-3 screen
    - Top of layer two set at bottom of Interim Remedy extraction well screen elevations
      - Assures extraction wells are fully penetrating with respect to layer one
    - Bottom of model equals top of A2 confining unit elevation
      - Extracted from CB&I flow model
  - Mesh refined down to less than 3 feet at three Interim Remedy extraction wells and KAFB-3
  - Well screen casing radius assigned to well boundary
  - Approximate node spacing equals 50 ft
    - 74,530 nodes per layer (223,590 total)
    - 148,034 elements per layer (296,068 total)



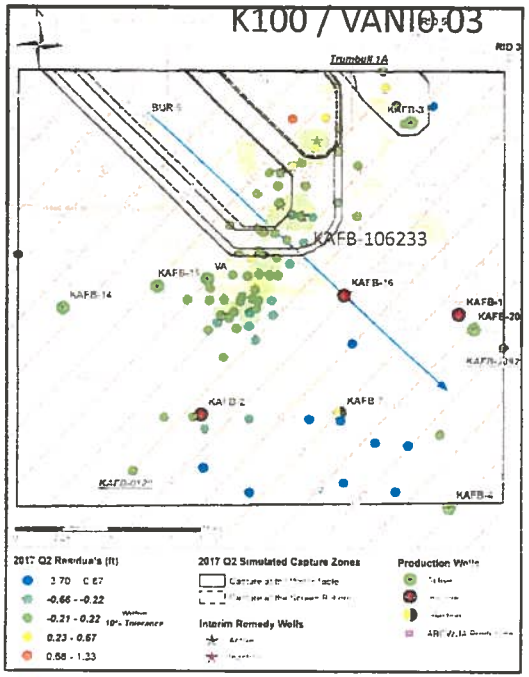
Gradient Flow Model Calibration

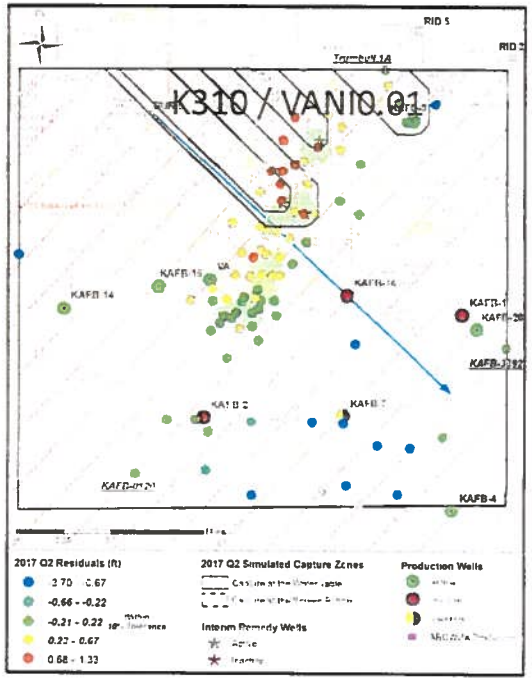
- Five KAFB-106228 aquifer test scenarios simulated to determine aquifer parameters resulting in best-fit to measured head data
  - Homogeneous hydraulic conductivity (K)
  - Homogeneous vertical anisotropy (VANI)
  - Model boundary assigned as constant head
    - Boundary head extracted from 2017 Q2 linear gradient model
  - Starting heads assigned by extracting the heads from the gradient model at each flow model node
- Scenario Assignments:
  - KAFB-106035 (shallow obs. well)
    - K = 170 ft/day; VANI = 0.003; KAFB-3 = 400 gpm
    - K = 180 ft/day; VANI = 0.001; KAFB-3 = 450 gpm
  - KAFB-106022 (shallow obs. well)
    - K = 310 ft/day; VANI = 0.01; KAFB-3 = 650 gpm
  - KAFB-106036 (intermediate obs. well)
    - K = 150 ft/day; VANI = 0.04; KAFB-3 = 375 gpm
  - **KAFB-106037 (deep obs. well)**
    - **K = 100 ft/day; VANI = 0.03; KAFB-3 = 225 gpm**
- Scenario Calibration
  - KAFB-106228 = 145 gpm (fixed)
  - KAFB-106233 = 177 gpm (fixed)
  - KAFB-106234 = 161 gpm (fixed)
  - KAFB-3 extraction rate was modified to give a best-fit to monitoring well KAFB-106201 for each scenario (see above)
    - All scenarios but K=310 simulated measured head at 201 within 0.05 ft
    - Simulated head at 201 off by +0.14 ft using max KAFB-3 pump rate



Scenarios Simulations VS Measured

- Goodness-of-fit was analyzed using standard Normalized Root-Mean-Squared Deviation (NRMSD) method
  - Generally acceptable NRMSD is <10%
  - NRMSD was calculated for the 60 REI 4857 dissolved EDB plume monitoring wells
- Scenario NRMSD
  - K310/VANI0.01 = 26%
  - K180/VANI0.001 = 16%
  - K170/VANI0.003 = 16%
  - K150/VANI0.04 = 17%
  - **K100/VANI0.03 = 13% (Includes southern wells [blue] outside of AOI**
    - Best Fit
    - Most Reasonable KAFB-3 extraction rate
      - Since the beginning of 2015
      - Average monthly KAFB-3 extraction rate - 14 to 361 gpm
      - Three-year mean – 213 gpm
      - Three-year median – 204 gpm





Gradient Flow Model Results

- The K 100; VANI 0.03 Scenario best fits the measured head data
- The K 100; VANI 0.03 Scenario produces the most reasonable KAFB-3 extraction rate
- The K 100; VANI 0.03 compares well with the horizontal capture analysis based on only measured head data