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Copper Flat Mine
Discharge Permit DP-1840 Application

Steven T. Finch, Jr., CPG, PG
Principal Hydrogeologist-Geochemist
John Shomaker & Associates, Inc.
WATER-RESOURCE AND ENVIRONMENTAL CONSULTANTS

September 2018

Outline

1. Site Experience and Qualifications
2. Key References
3. Hydrogeologic Setting for DP-1840
4. Copper Flat Open Pit
5. Waste Rock Stockpiles 2&3
6. Tailings Impoundment
7. Summary

Expertise

Education

- ✓ B.S. Geology from Sul Ross State University, 1985
- ✓ M.S. Geology from Northern Arizona University, 1991

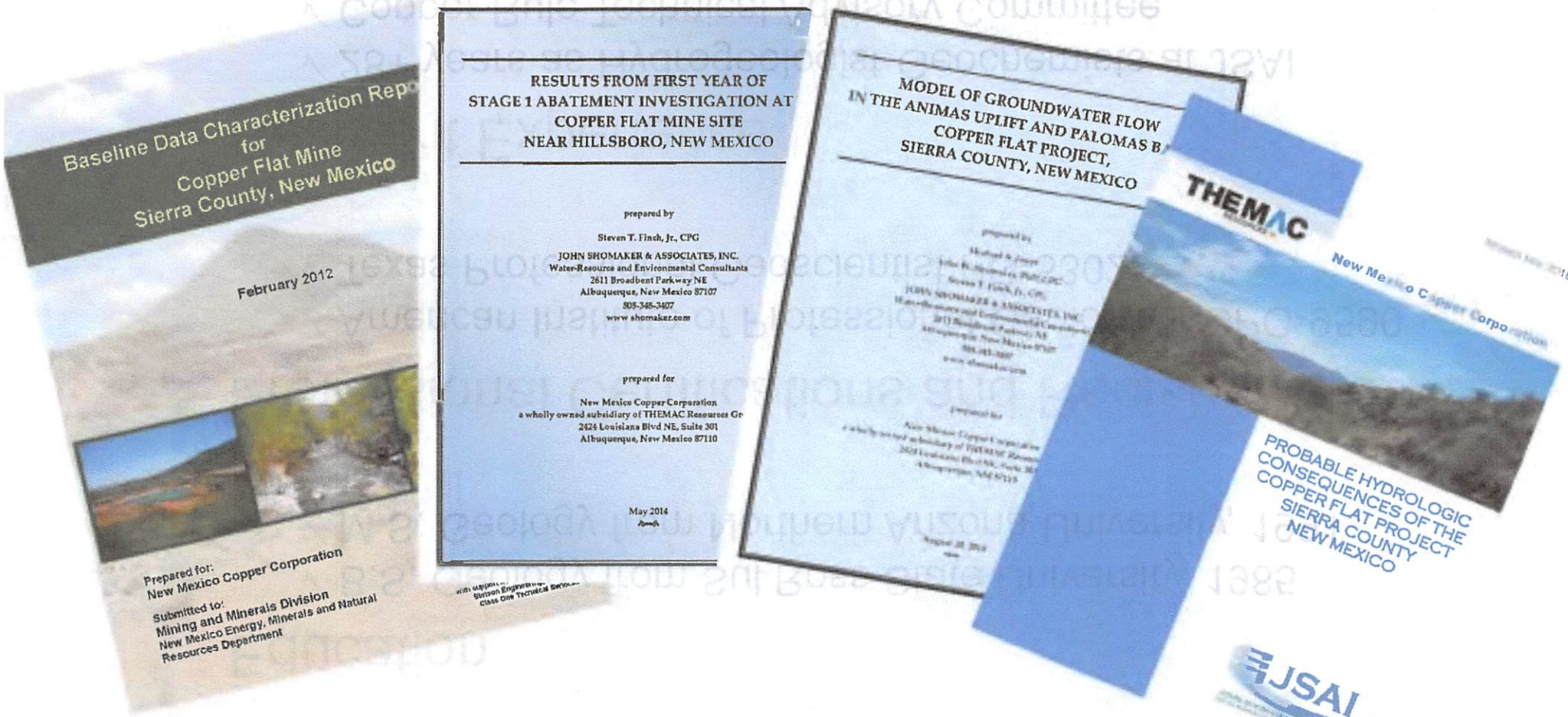
Professional Certifications and Registrations

- ✓ American Institute of Professional Geologists CPG-9590
- ✓ Texas Professional Geoscientist PG-5302

Relevant Experience

- ✓ 28+ years as Hydrogeologist-Geochemists at JSAI
- ✓ Copper Rule Technical Advisory Committee
- ✓ Experience with Copper Flat property – 1992 to current

Key References



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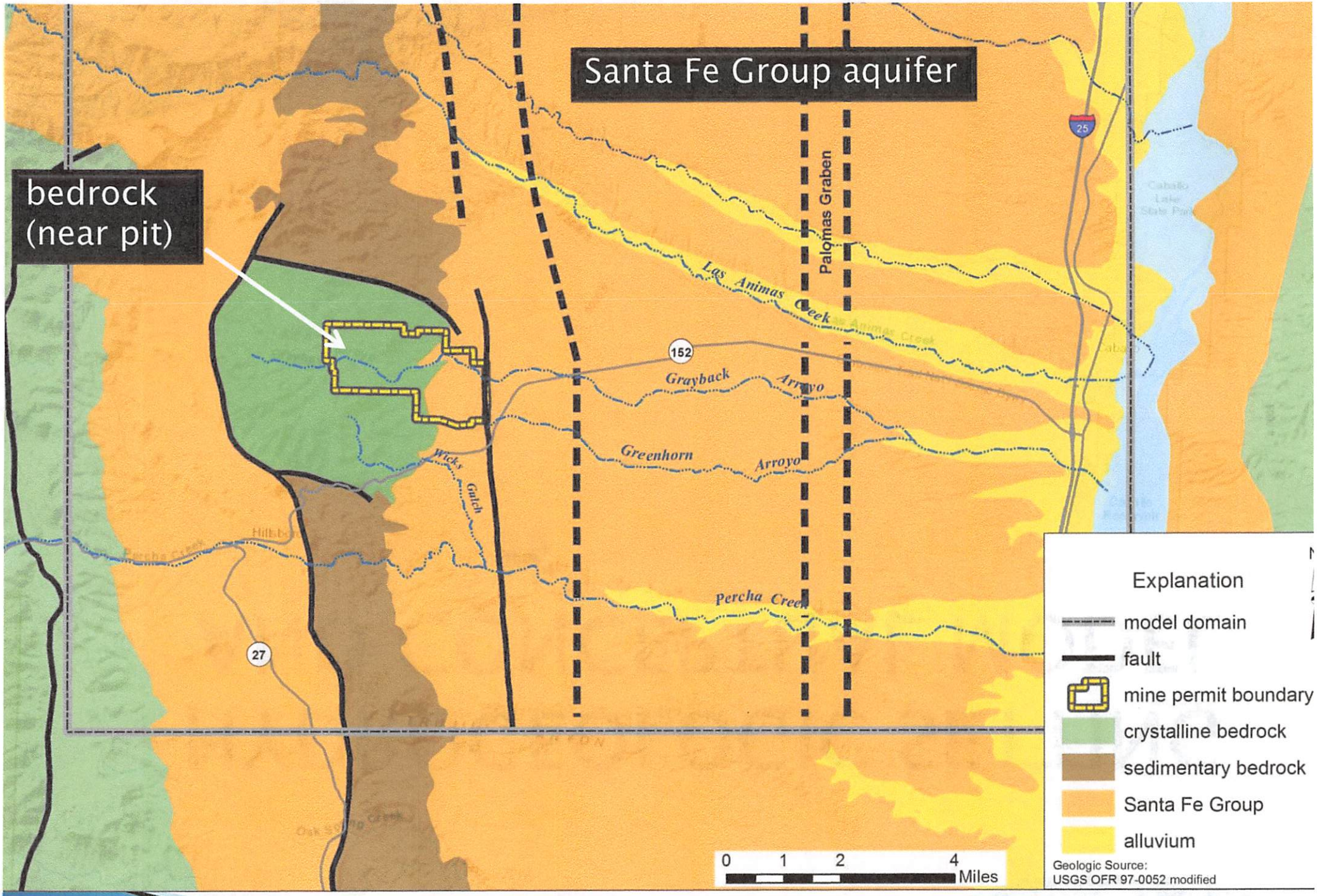
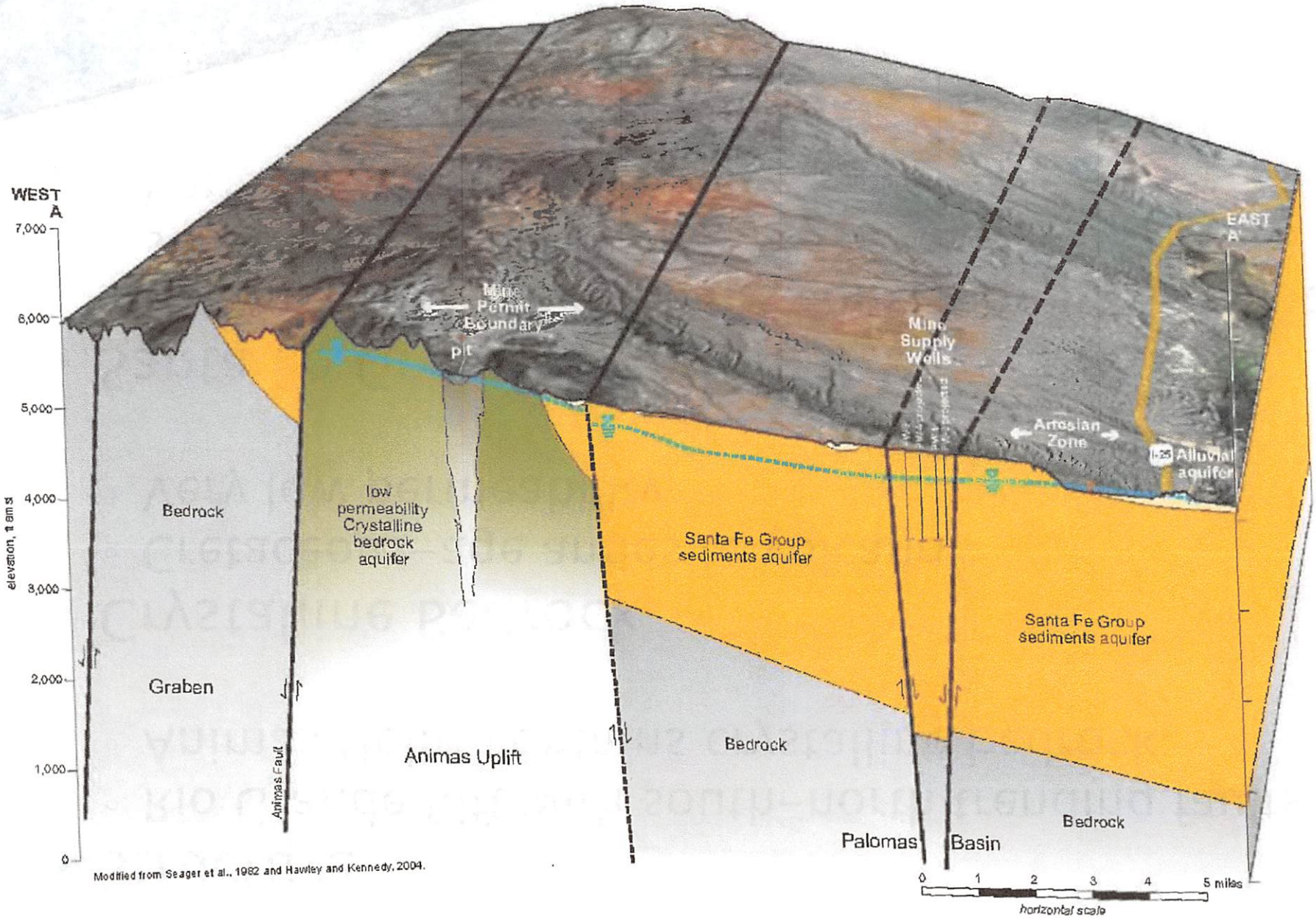
HYDROGEOLOGIC SETTING AND CONCEPTUAL MODEL



Regional Geologic Setting

20.6.7.11.P(2) NMAC

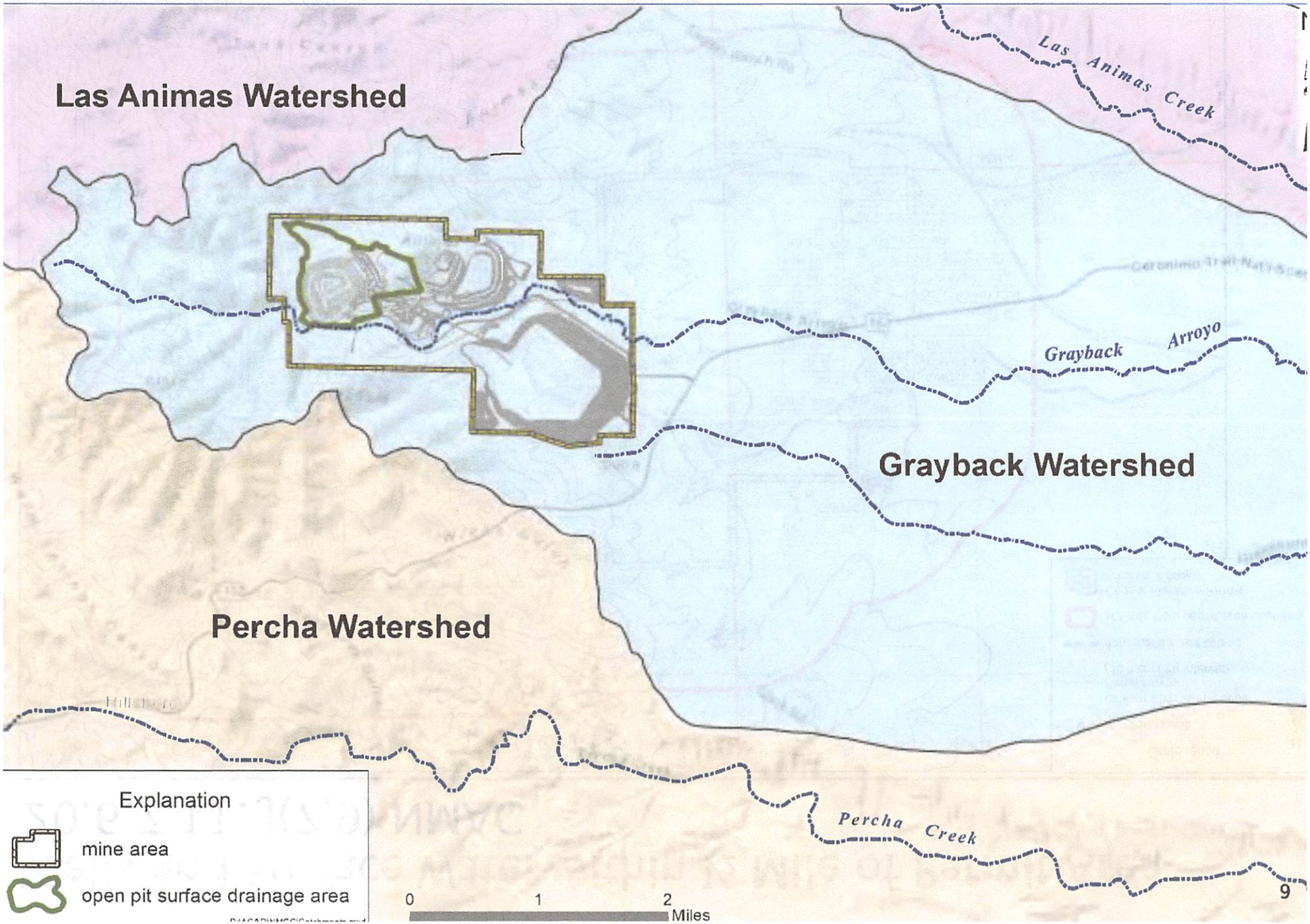


Regional Geologic Setting 20.6.7.11.P(2) NMAC

Regional Geology

- Structure
  - Rio Grande Rift with south-north trending faults
  - Animas Uplift contains crystalline bedrock
- Crystalline Bedrock
  - Cretaceous-age andesite volcano
  - Very low permeability
- Santa Fe Group Sediments
  - Unconsolidated sediments consisting of clay, silt, sand, and gravel
  - Variable permeability

Regional Hydrologic Setting 20.6.7.11.K&P NMAC



Wells and Surface Water within ½ Mile of Permit Area

20.6.7.11. J(7,9) NMAC

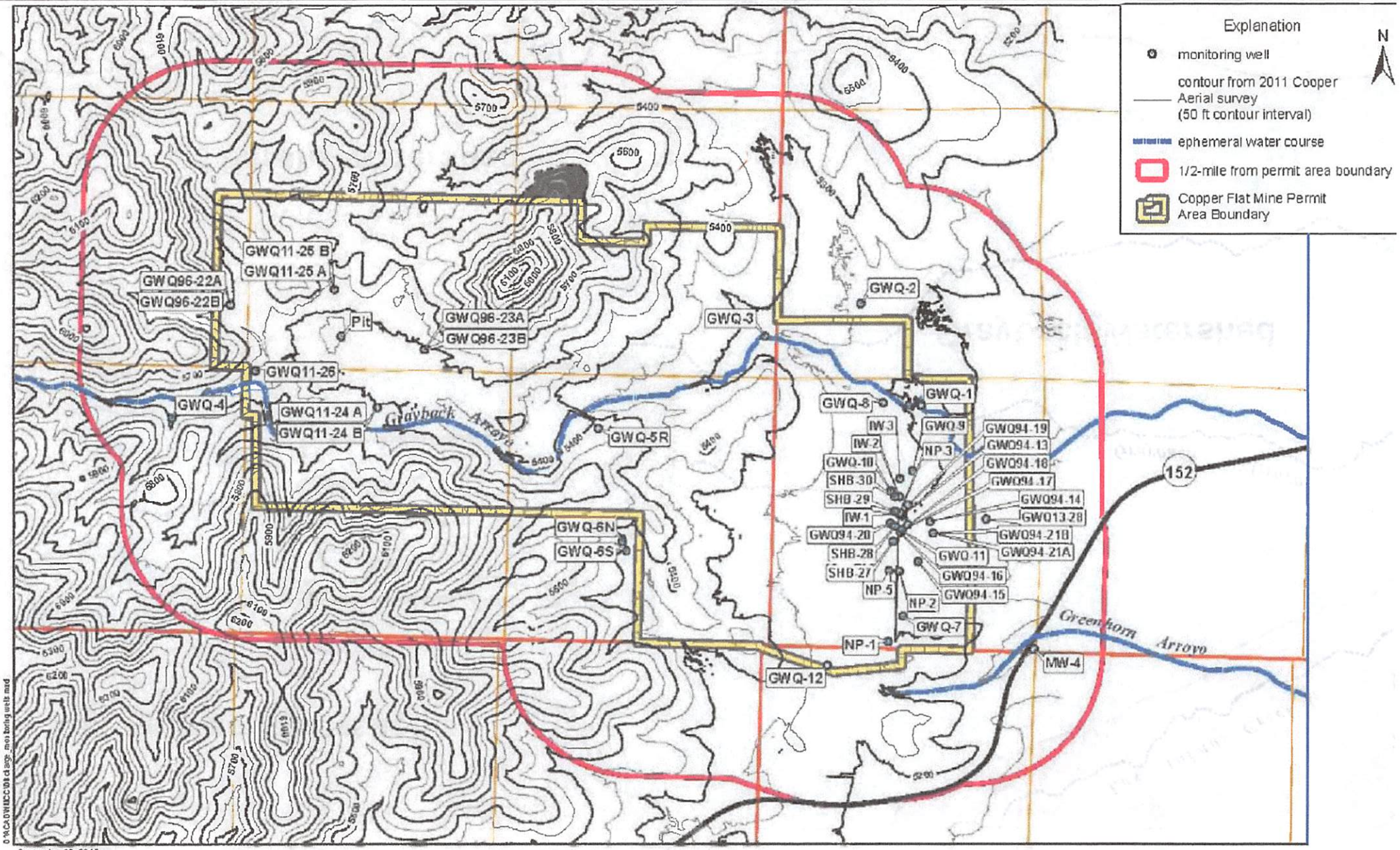


Figure 11K-8. Surface water within 1/2-mile from Copper Flat Mine Permit Area Boundary.

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Site Hydrogeologic Characterization

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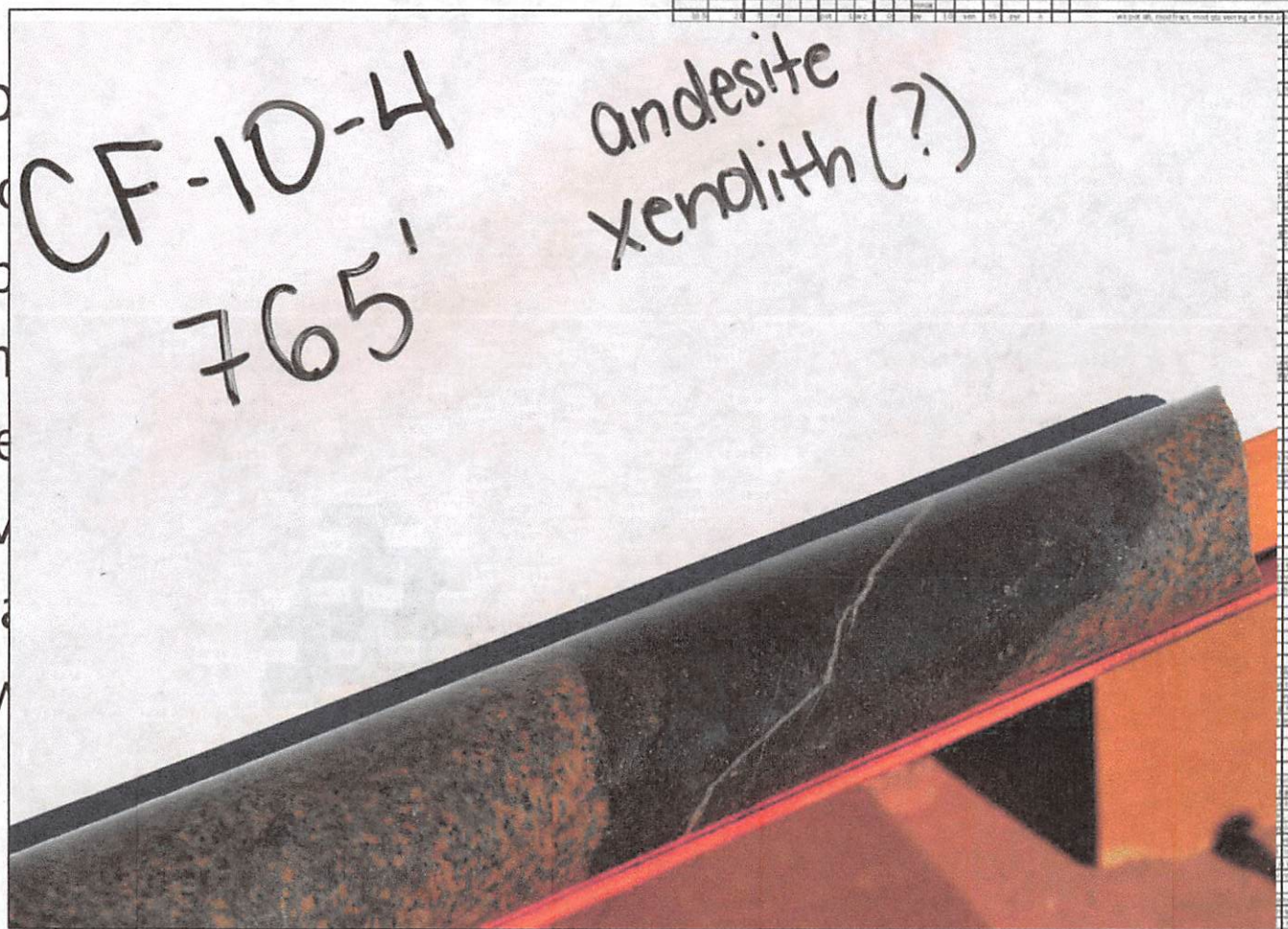
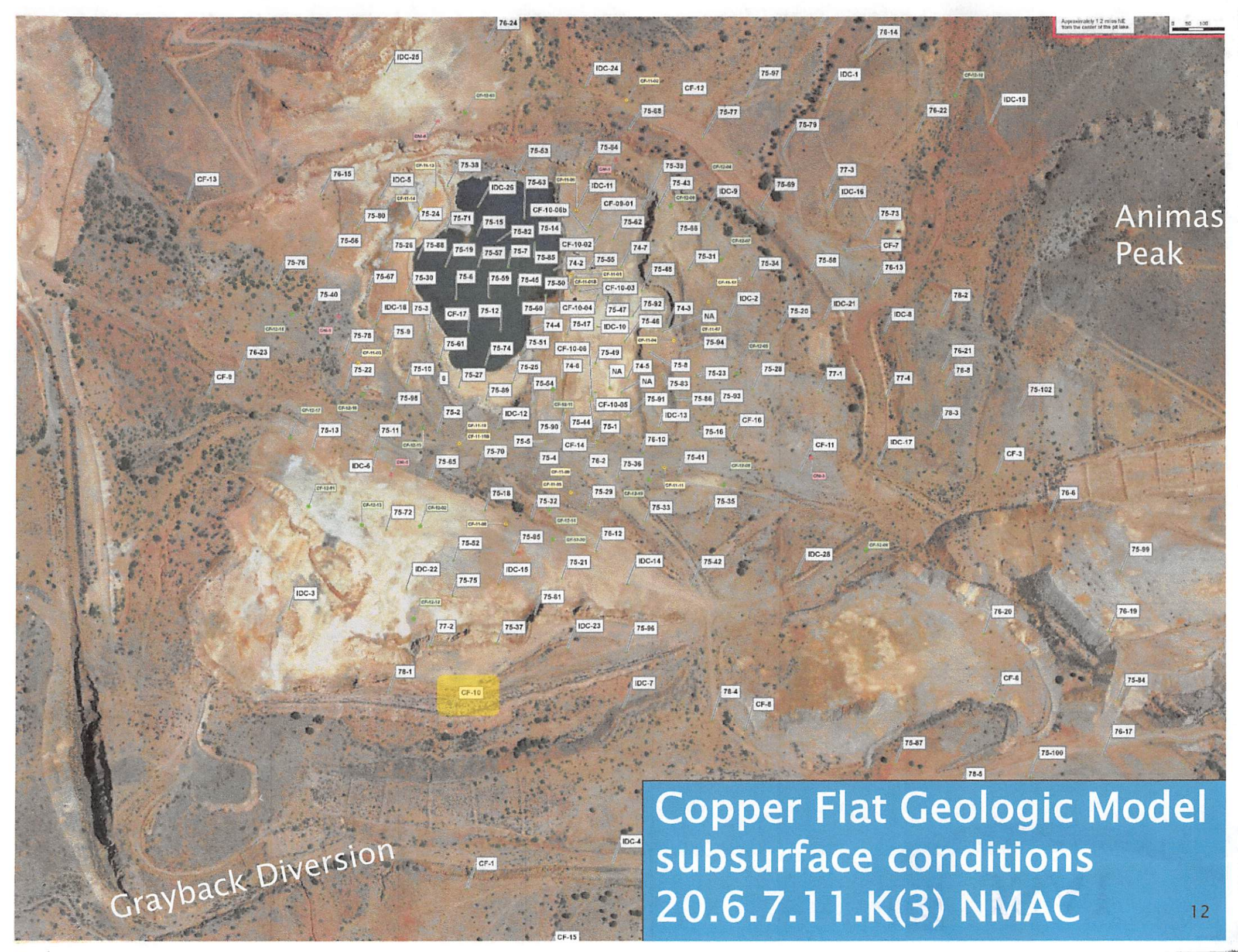
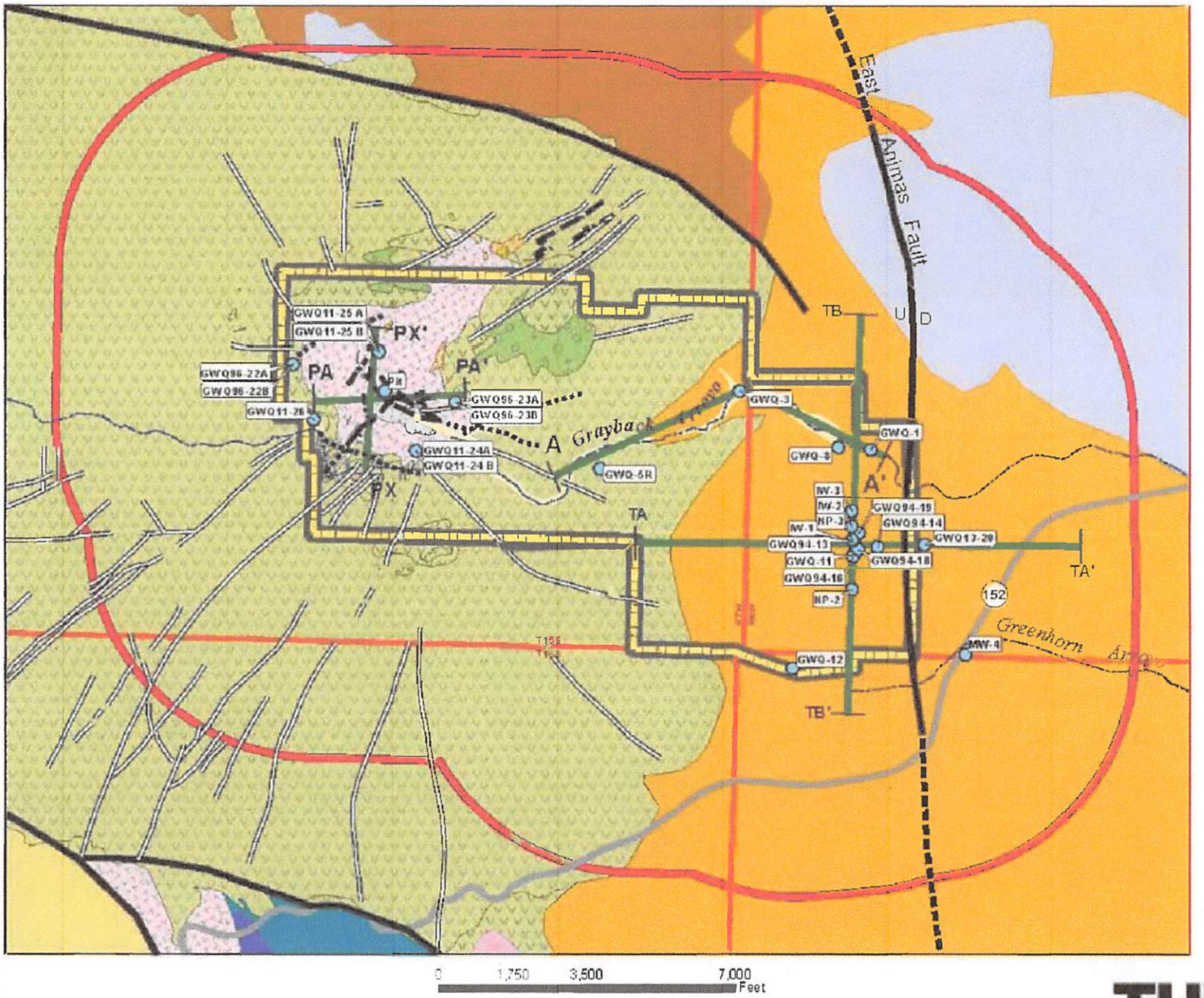
40 years o

- ✓ Explorati
- ✓ Field map
- ✓ Monitorin
- ✓ Aquifer te
- ✓ Water-lev
- ✓ Groundwa
- ✓ Surface-v




Animas Peak
Grayback Diversion
Copper Flat Geologic Model
subsurface conditions
20.6.7.11.K(3) NMAC



Explanation

- monitoring well used
- geologic cross-sectio
- line of section
- dike (Dunn)
- fault
- fault
- approximately l
- inferred location
- ephemeral water cou
- 1-mile from mine per area boundary
- Copper Flat Mine Per Area Boundary
- alluvium
- Diabase
- Silicified Breccia
- Latite
- Quartz Monzonite Br
- Ki Quartz Monzonite
- Ka Andesite Breccia
- Ka Fine-Grained An
- Ka Coarse-Grained
- QTs Upper Santa Fe
- QTb basalt and ande volcanics
- Tsf Lower and Midd Santa Fe Group
- Tv Middle Tertiary volcanic rocks
- Pz Paleozoic rocks
- SO-C Silurian through Cambrian rocks
- M-C Mississippian th Cambrian rocks

Dece

Geologic Source: modified from USGS NMCC, 2013 Dunn, 1982

Figure 11K-2a. Geologic map within 1-mile of the Copper Flat Mine Area permit boundary, Sierra County, New Mexico.

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JOHN SHOMAKER & ASSOCIATES,

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drologic Information
6.7.11.K(3) NMAC

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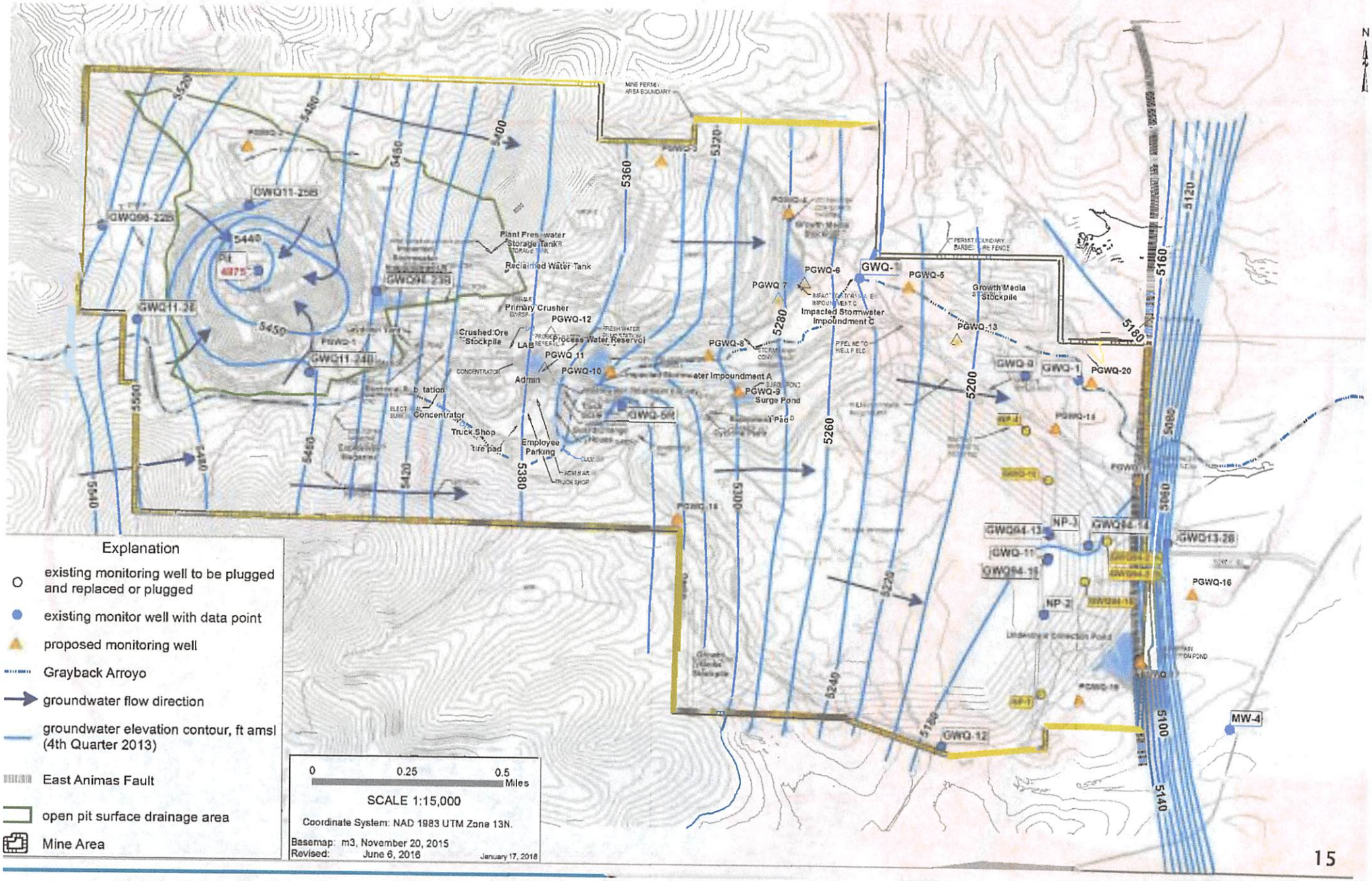
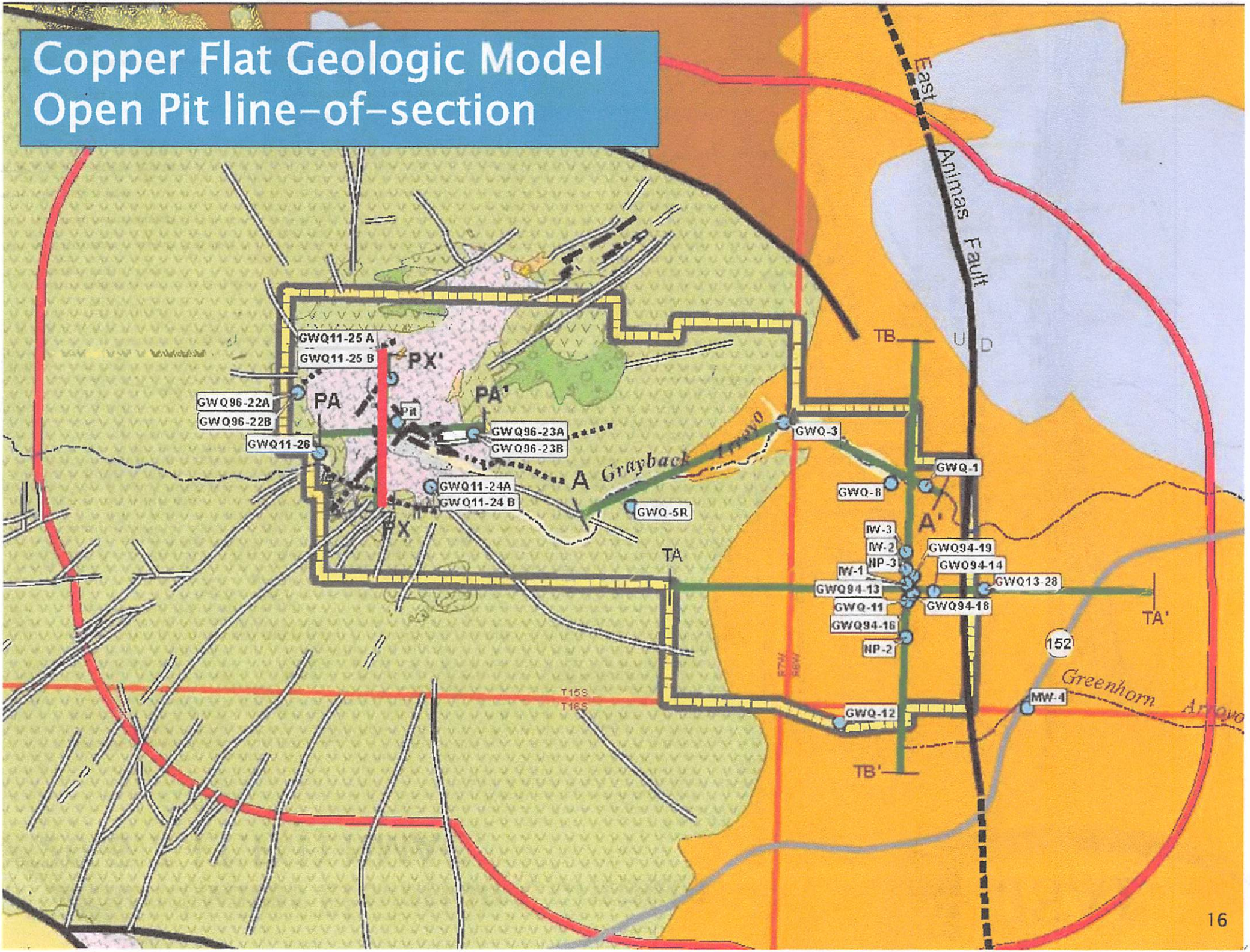
Hydraulic Conductivity Properties of Water Bearing Units Beneath the Copper Flat Mine Permit Area

vater bearing zone	Range of Hydraulic Conductivity (ft/day)	Range of Hydraulic Conductivity (cm/s)	wells included in test range	model input hydraulic conductivity (ft/day)	source of information
/stalline drock Aquifer ndesite)	0 to 0.0027	0 to 9.5×10^{-7}	GWQ96-22 GWQ96-23 GWQ-5R	0.002 L2 0.001 L3 0.001 L4	JSAI May 2014 JSAI August 2014
/stalline drock Aquifer uartz nzonite)	0.02 to 0.14	7.1×10^{-6} to 4.9×10^{-5}	GWQ11-24 GWQ11-25	0.002 L2 0.001 L3 0.001 L4	JSAI May 2014 JSAI August 2014
nta Fe Group	1.0 to 4.7	3.5×10^{-4} to 1.7×10^{-3}	GWQ-1 GWQ-7 GWQ-9 GWQ94-17 GWQ94-28	0.20 to 10.0 L2 0.20 L3 0.05 L4	JSAI May 2014 JSAI August 2014
aternary uvial Aquifer	3.8	1.3×10^{-3}	GWQ94-16	24.00 L1	JSAI May 2014 JSAI August 2014

Groundwater Elevation Contours
20.6.7.11.P(1) NMAC



Copper Flat Geologic Model
Open Pit line-of-section



Copper Flat Open Pit Hydrogeologic Cross-Section

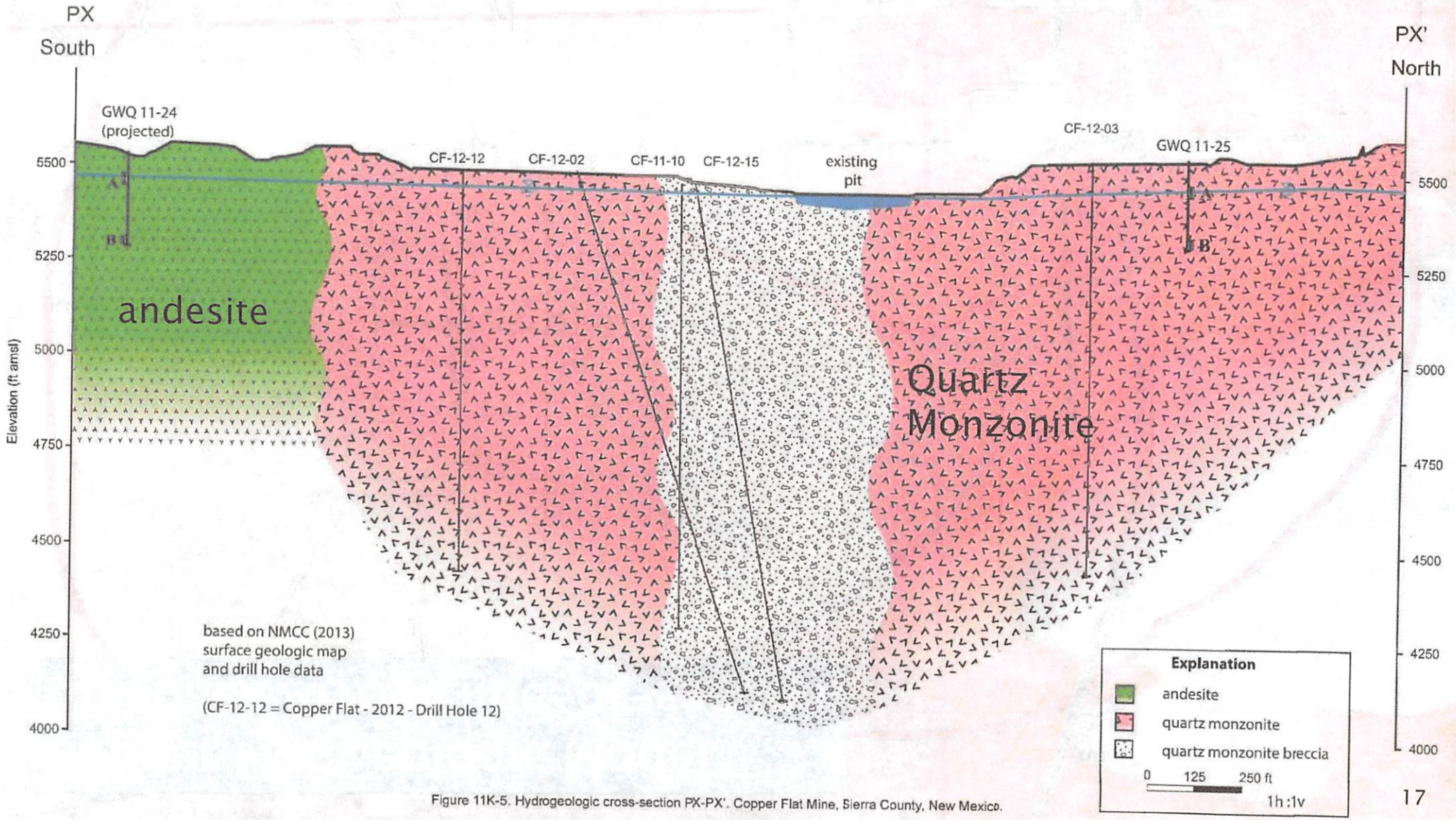
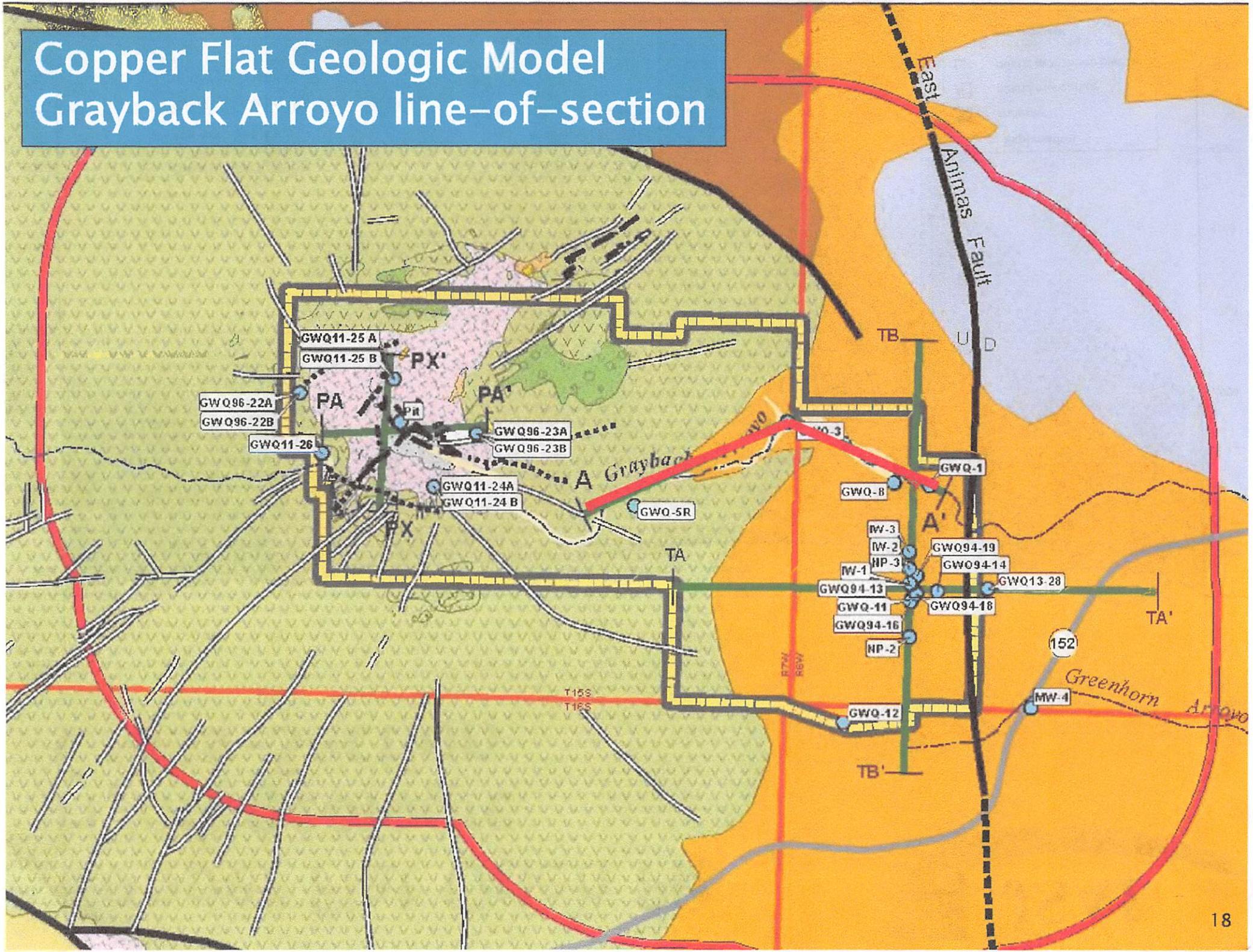
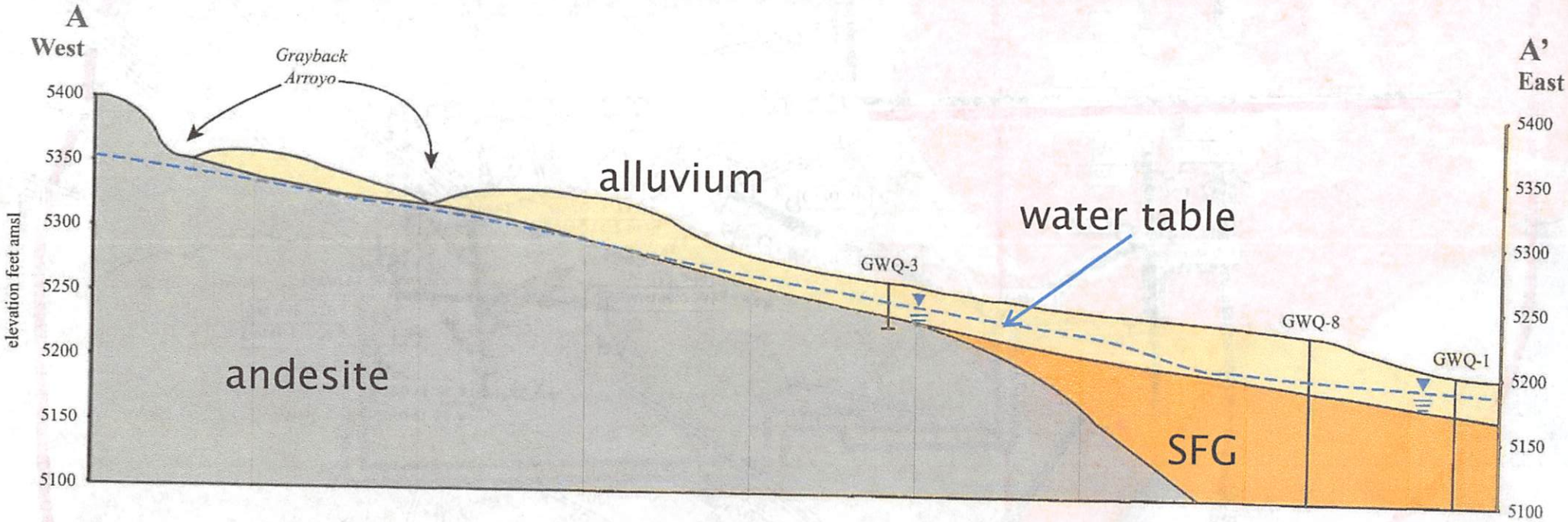


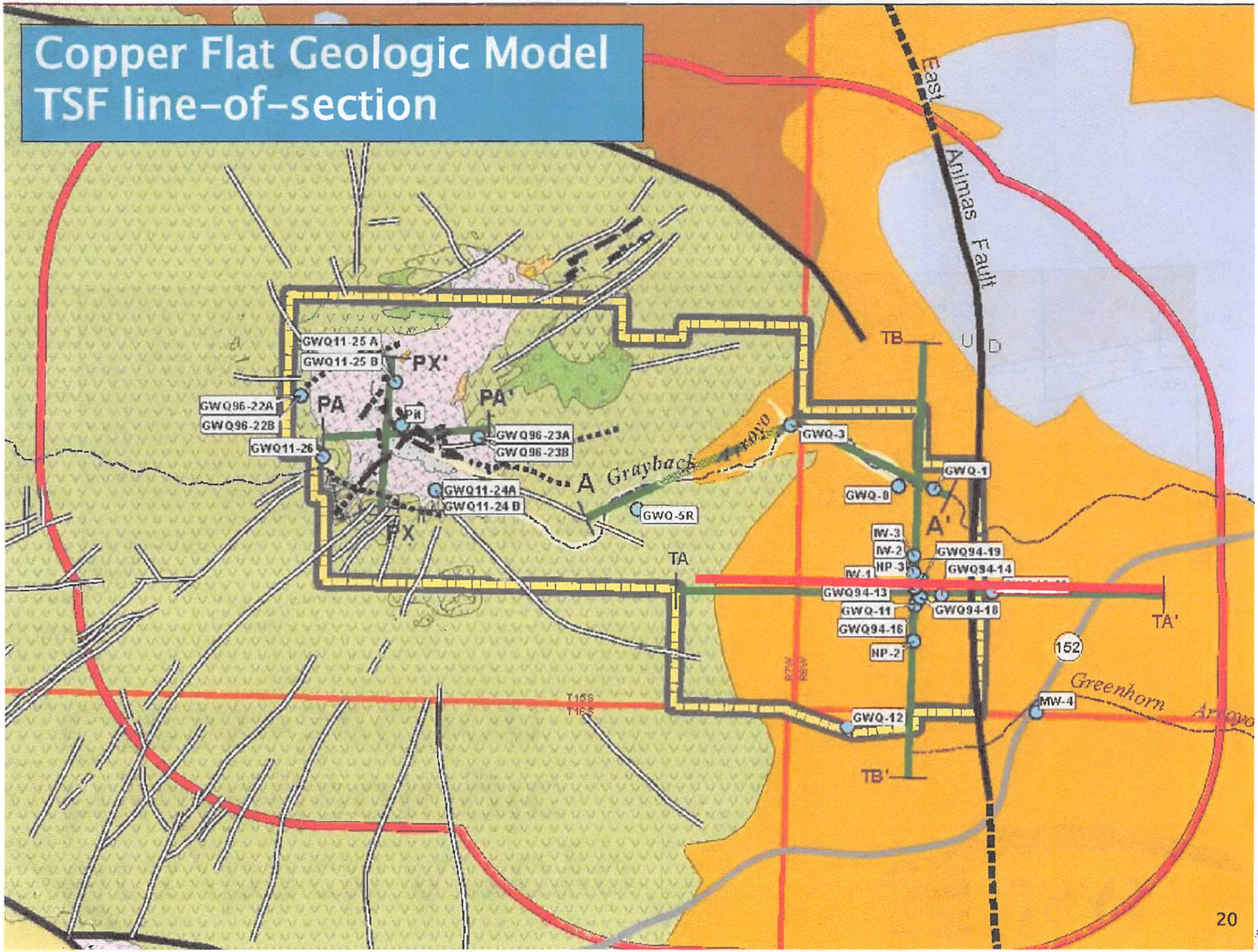
Figure 11K-5. Hydrogeologic cross-section PX-PX'. Copper Flat Mine, Sierra County, New Mexico.

Copper Flat Geologic Model
Grayback Arroyo line-of-section

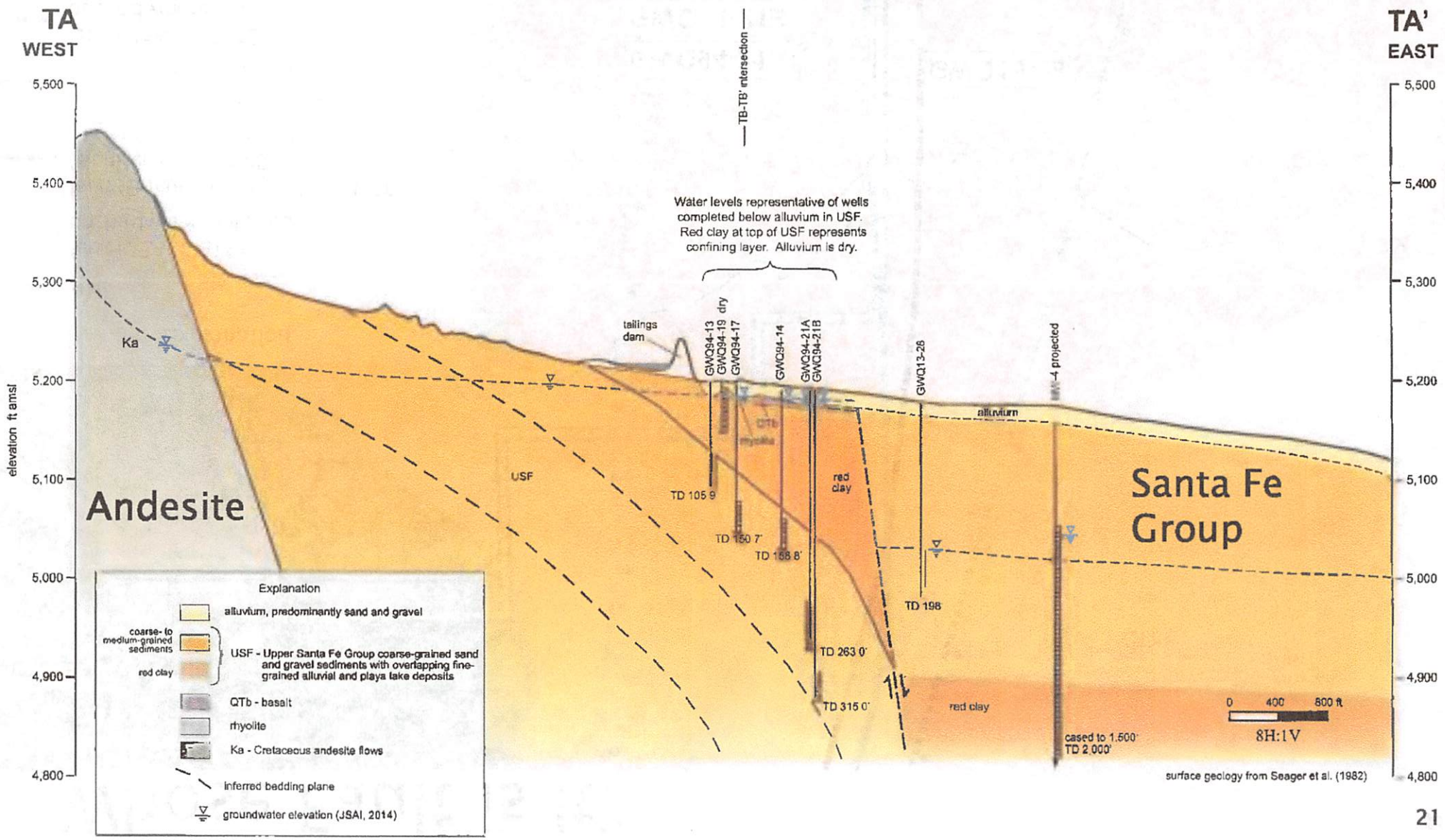


Grayback Arroyo Hydrogeologic Cross-Section

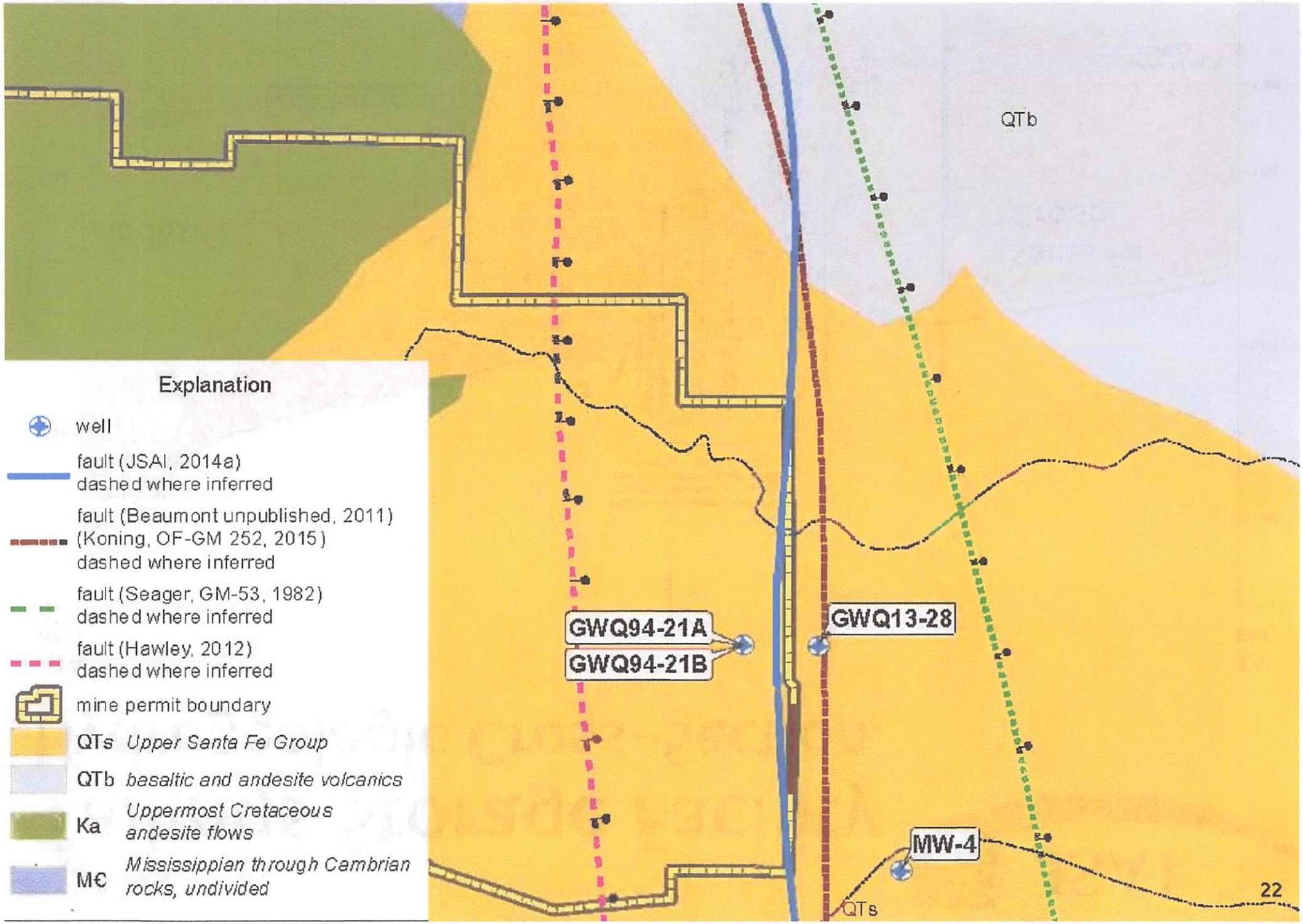



Copper Flat Geologic Model
TSF line-of-section
East Animas Fault
GWQ11-25 A
GWQ11-25 B
PX'
PA
PA'
GWQ96-22A
GWQ96-22B
GWQ11-26
Pit
GWQ96-23A
GWQ96-23B
A
Grayback Arroyo
GWQ11-24A
GWQ11-24 B
GWQ-5R
PX
TB
U
D
GWQ-3
GWQ-1
GWQ-0
A'
IW-3
IW-2
HP-3
IW-1
GWQ94-19
GWQ94-14
GWQ94-13
GWQ-11
GWQ94-18
GWQ94-16
NP-2
TA
TA'
152
Greenhorn Arroyo
MW-4
GWQ-12
TB'
T16S
T16S
20

Tailings Storage Facility
Hydrogeologic Cross-Section



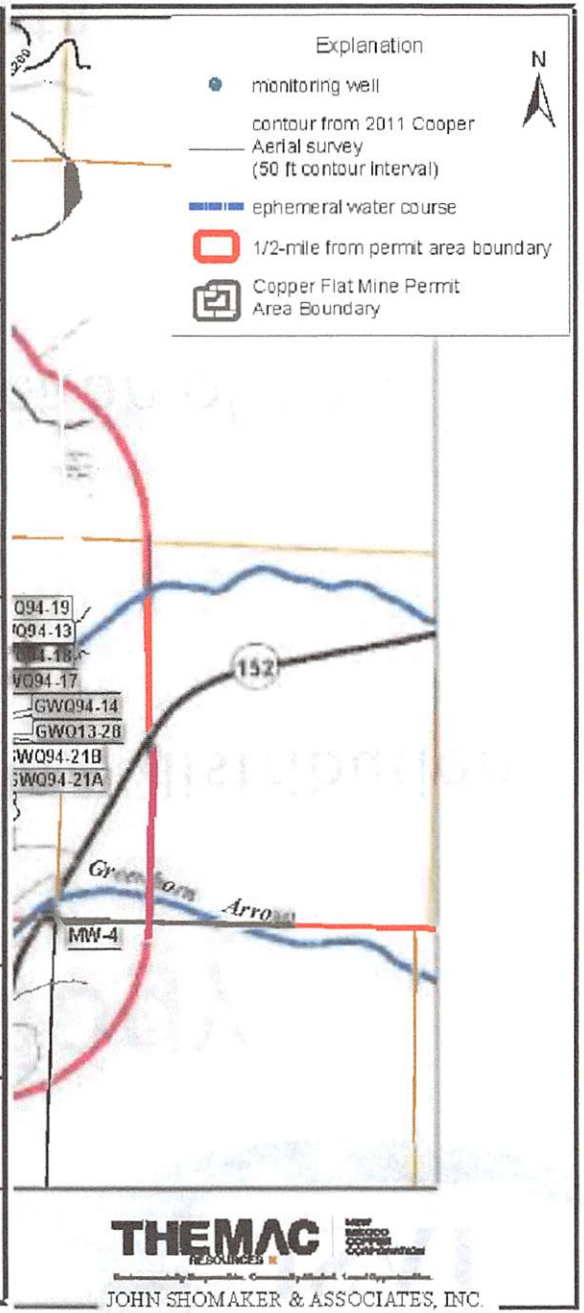
Whose Fault is it?



Pre-Discharge TDS 20.6.7.11.G NMAC

TABLE 11G-2
Pre-Discharge TDS Concentrations

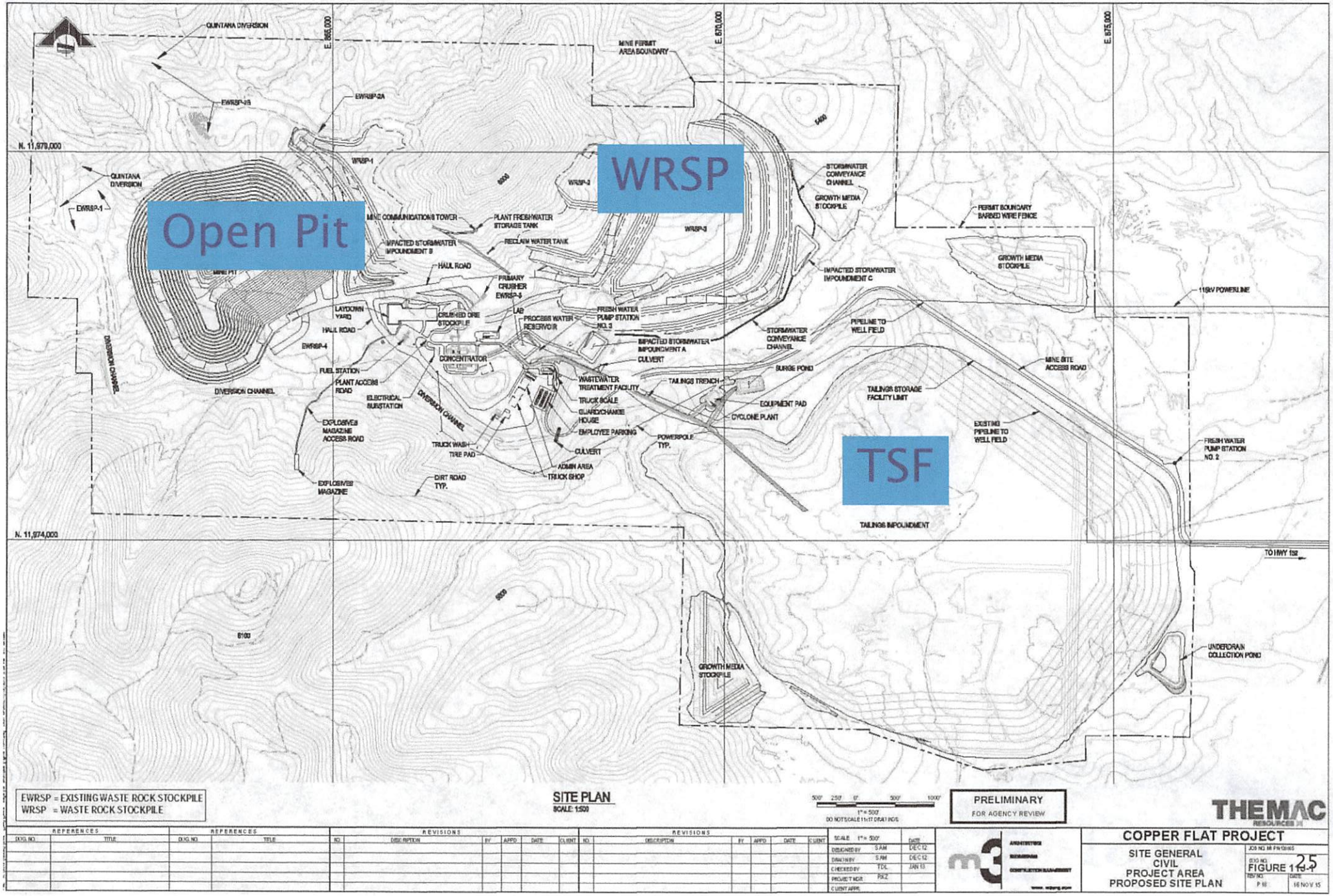
Aquifer	Sub-Aquifer	Pre-Discharge Concentration (mg/l)	Wells Sampled	Sample Date (m/yr)	Well Locations
Quaternary Alluvial	Grayback Alluvial Up-gradient of Ore	317-905	GWQ11-26	4/2013-10/2013	Up-gradient of the ore body
	Grayback Alluvial Down-gradient of Ore	868-1,260	GWQ-3[1] GWQ-5[2]	9/1976-2/1982	Down-Gradient of the ore body
	Alluvial Fan and Fluvial deposits in the Upper Santa Fe Group	354-840	SHB-27[3] SHB-28[3] SHB-29[3] SHB-30[3] NP-5	9/1976-2/1982	In the vicinity of the current TSF
Santa Fe Group	NA	350-650	GWQ-1 GWQ-2 GWQ-7 GWQ-8 GWQ-9 GWQ-10 GWQ-11 NP-1 NP-2 NP-3	6/1976-2/1982	In the vicinity of the current TSF down-gradient of the ore body
Crystalline Bedrock	Andesite	500-798	GWQ96-22A GWQ96-22B GWQ-4	6/1981-1/2013	Up-gradient of the ore body;
	Andesite	496-920	GWQ-5R GWQ96-23A GWQ96-23B	7/1996-10/2013[6]	Down-gradient of ore body
	Quartz Monzonite[4,5]	2,280-4,400	GWQ11-24A GWQ11-24B GWQ11-25B	1/2010-10/2013[6]	



Permit Area Hydrogeology

- Geologic Model
  - Detailed understanding of rock type distribution
  - Mapped faults and structures
- Aquifer Characteristics
  - Groundwater elevations and direction of flow
  - Permeability of rock units
- Baseline Water Quality
  - Over 40 years of water-quality data

Site Map of Proposed Facilities 20.6.7.11. J(1) NMAC



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Copper Flat Open Pit

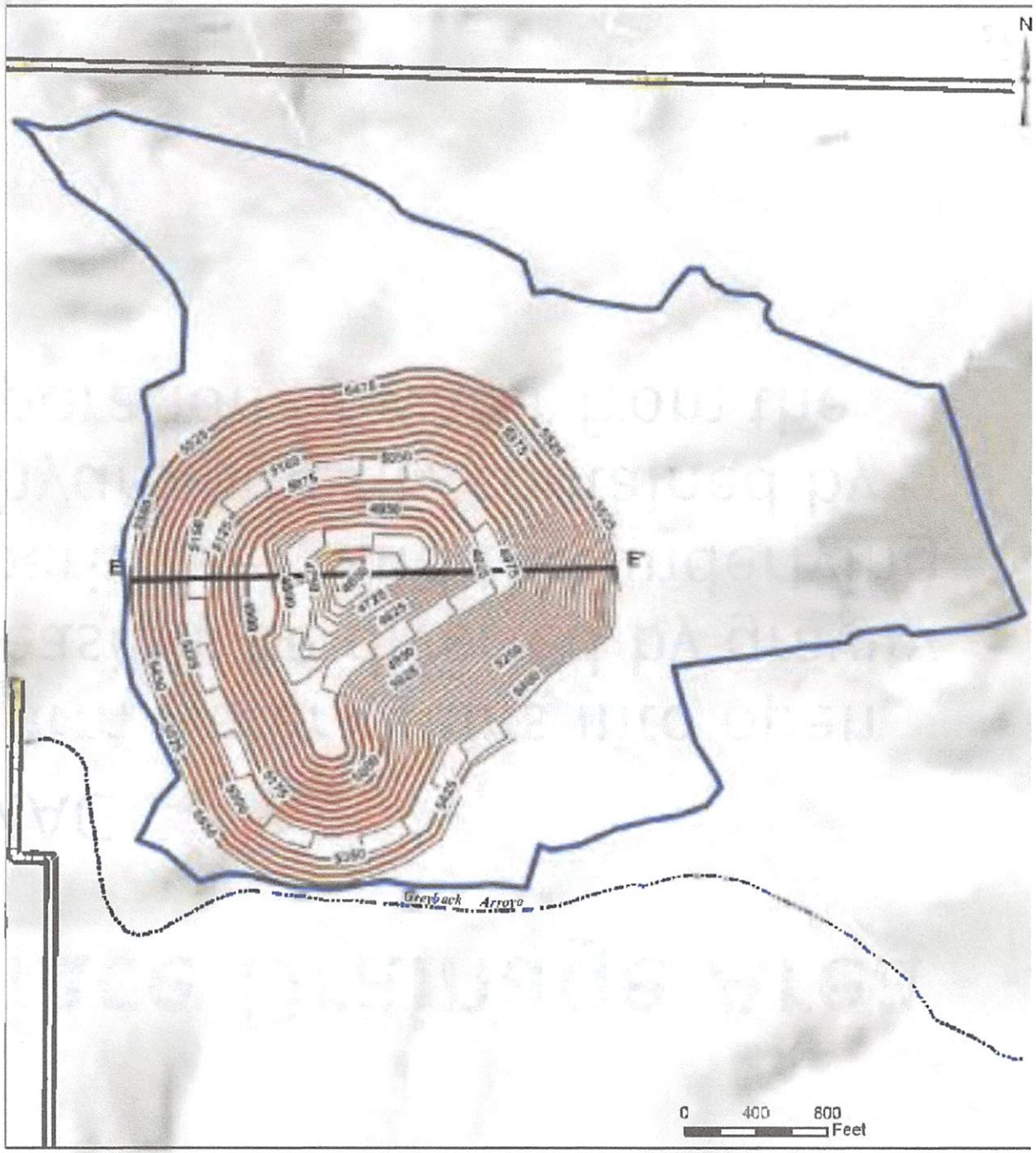
- Monitoring 20.6.7.28 NMAC
- Closure 20.6.7.33 NMAC
- Post Closure 20.6.7.35 NMAC

Open Pit Surface Drainage Area

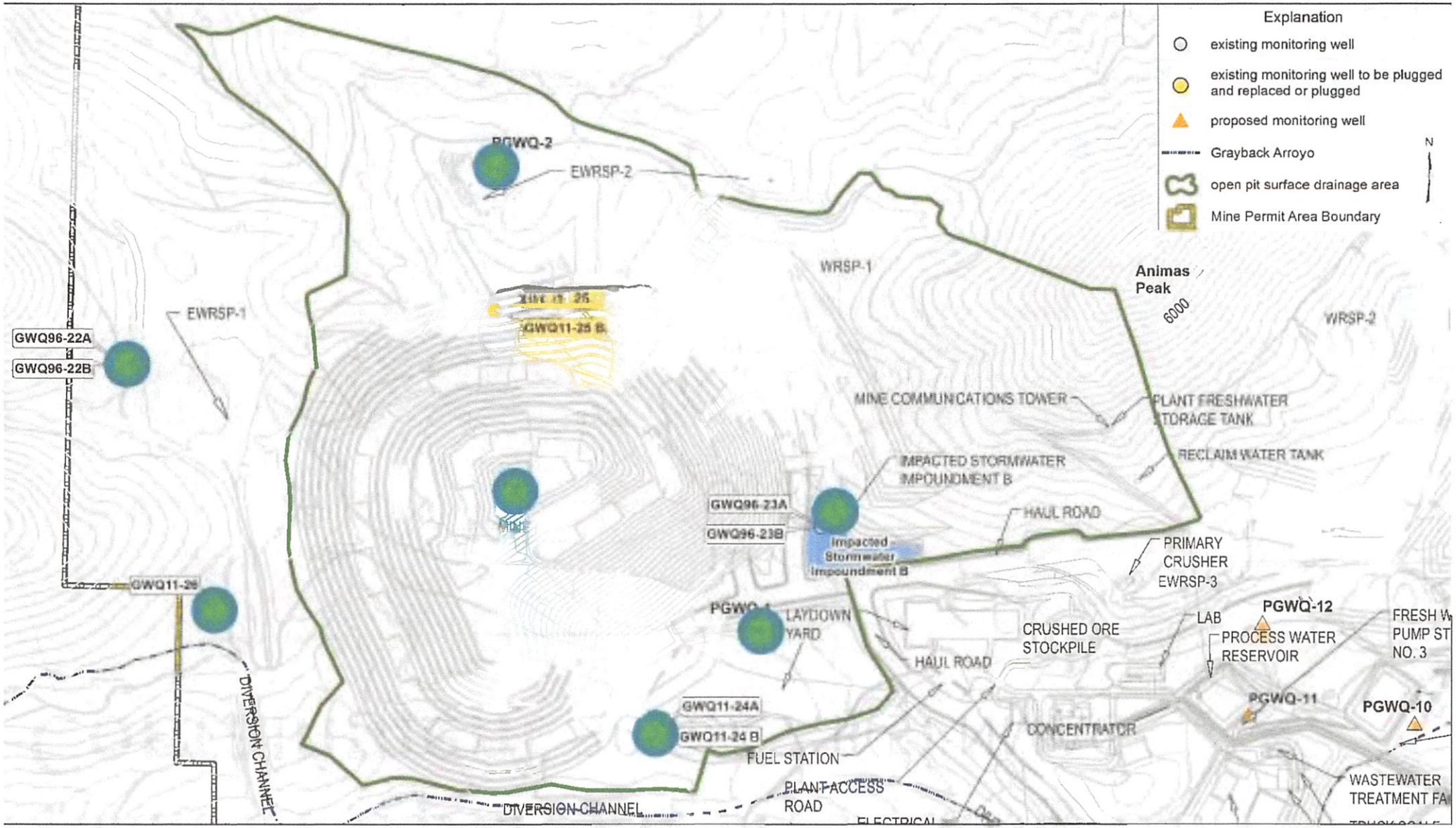
20.6.7.7.B(42) NMAC

- Area in which storm water drains into open pit and cannot feasibly be diverted by gravity outside the pit perimeter, and the underlying groundwater is hydrologically contained by pumping or evaporation of water from the open pit.

Copper Flat Open Pit Surface Drainage Area

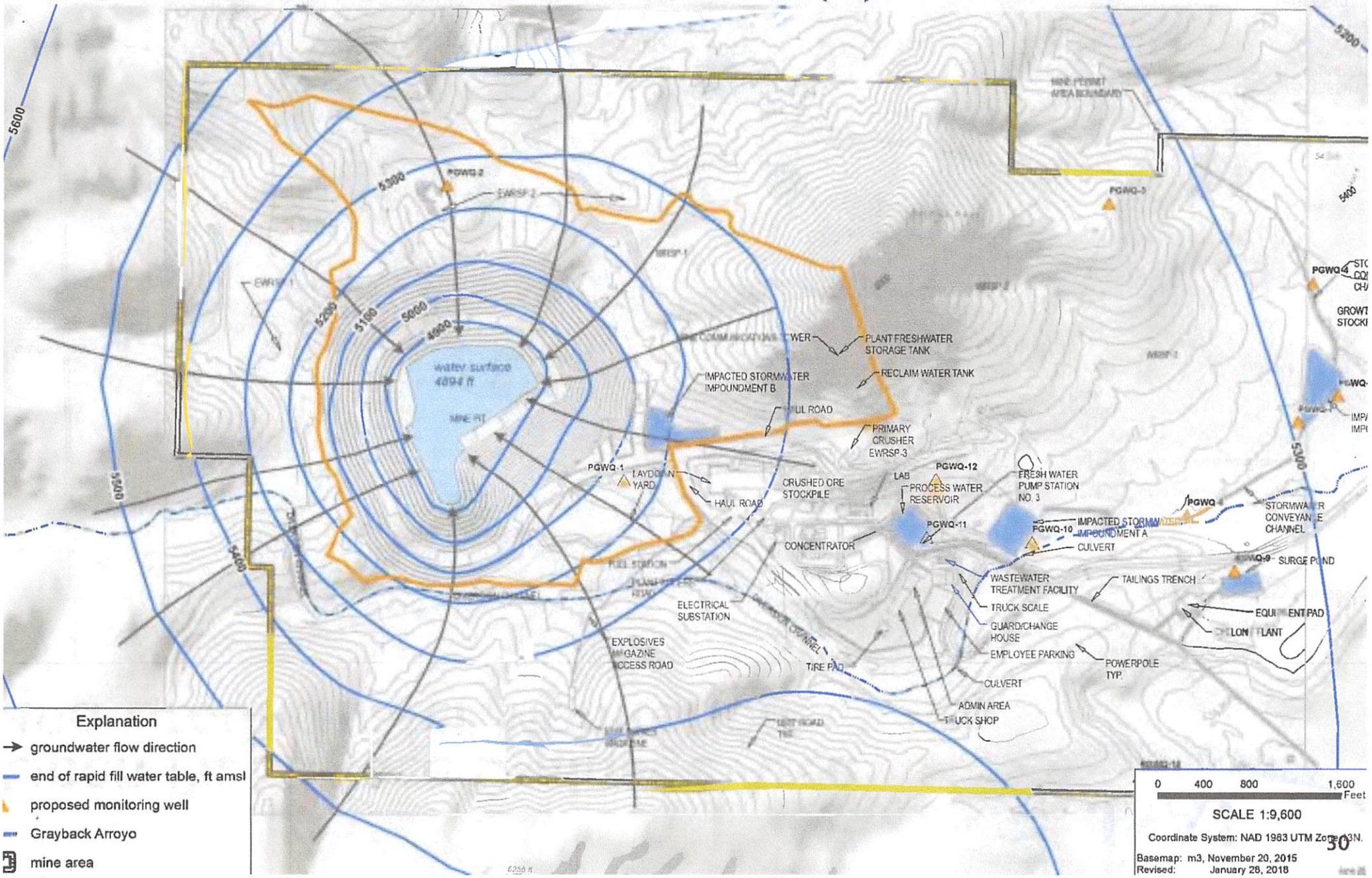


Open Pit Surface Drainage Area and Groundwater Monitoring

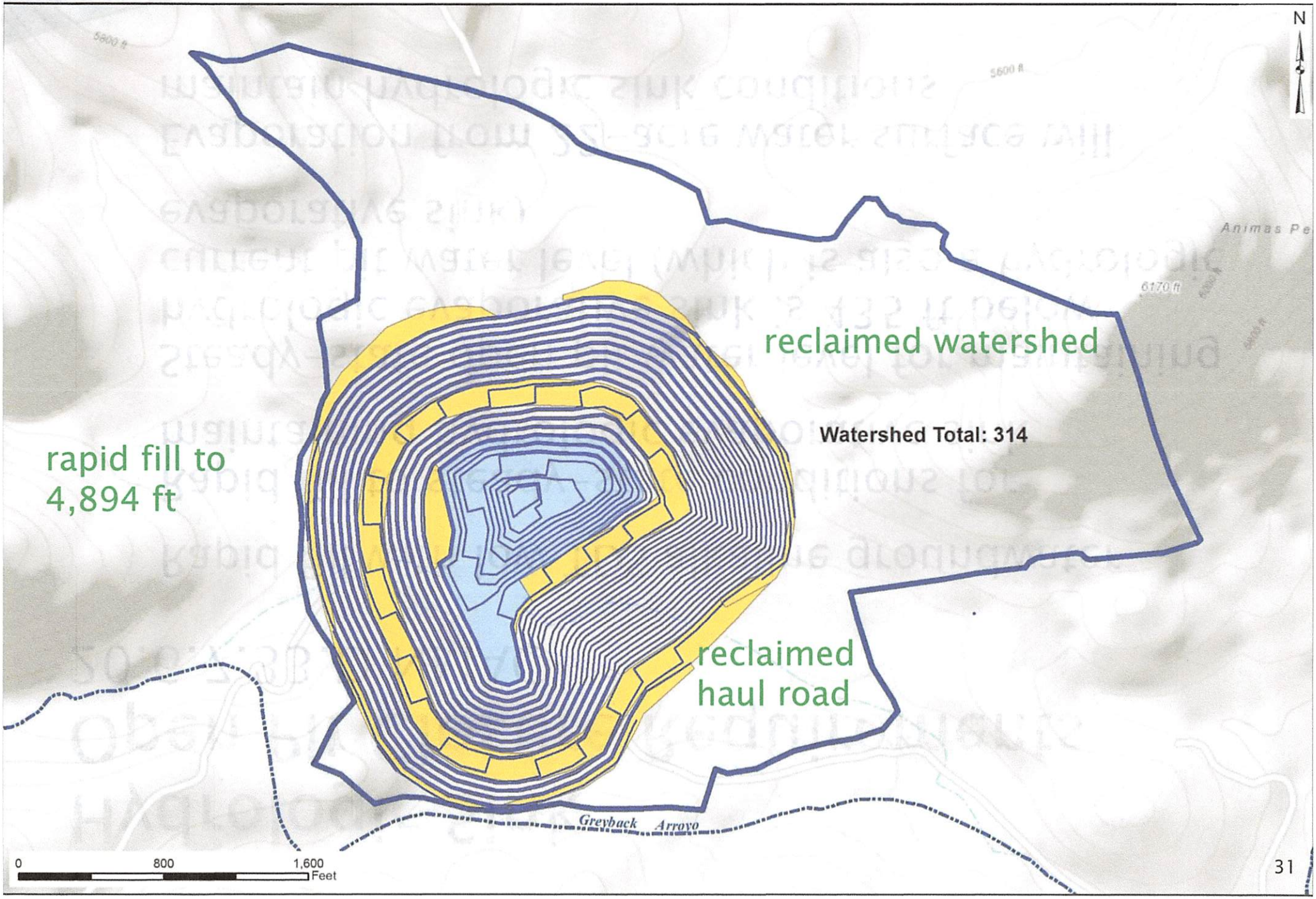


3/2018 Basemap: m3, November 20, 2015
Revised: October 27, 2016

Area of Open Pit Hydrologic Containment 20.6.7.7.B(5) NMAC



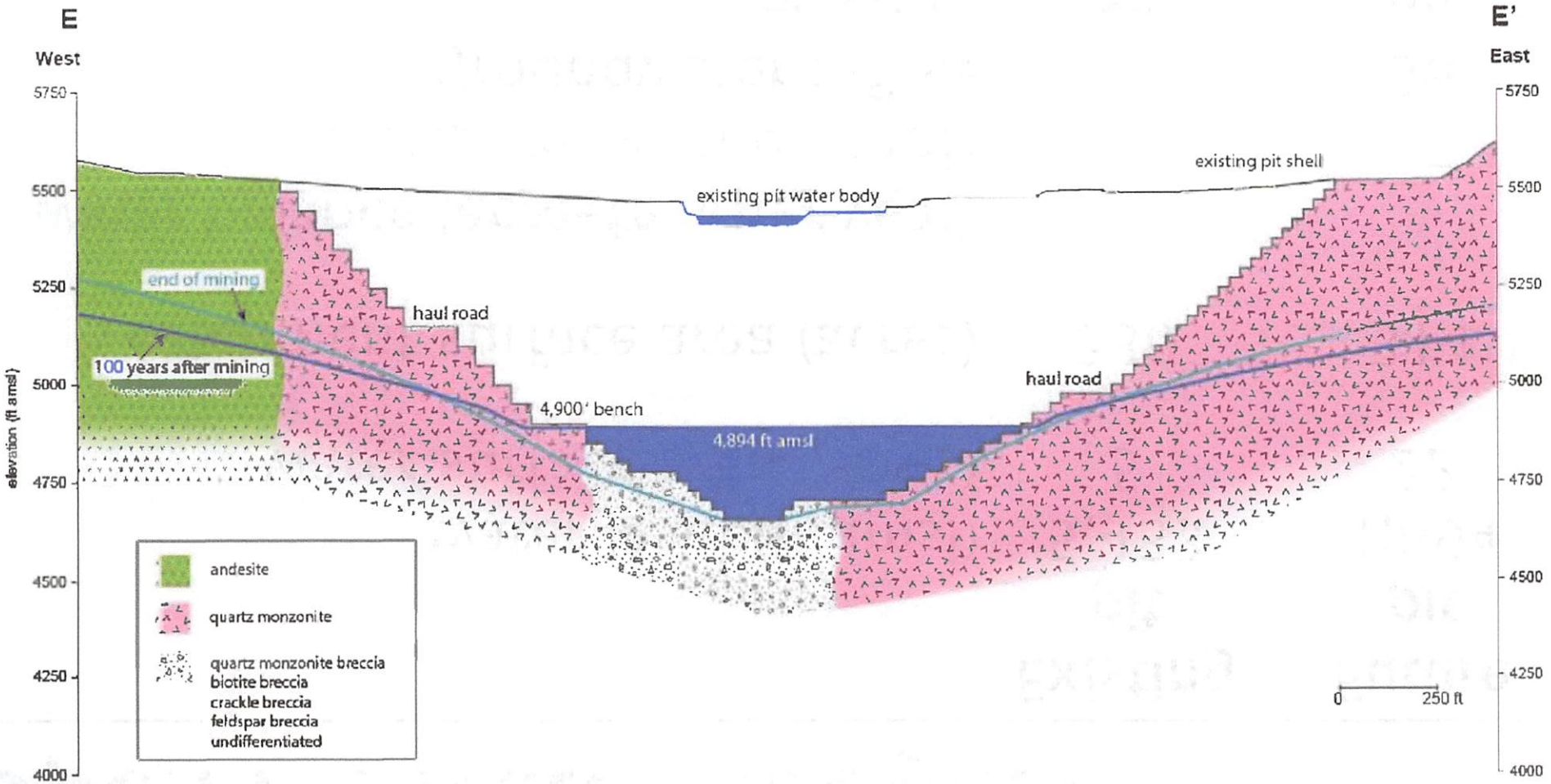
Open Pit Rapid Fill Reclamation



Hydrologic Sink
Open Pit Closure Requirements
20.6.7.33.D NMAC

- Rapid fill with low TDS alkaline groundwater
- Rapid fill to steady-state conditions for maintaining hydrologic evaporative sink
- Steady-state open pit water level for maintaining hydrologic evaporative sink is 435 ft below current pit water level (which is also a hydrologic evaporative sink)
- Evaporation from 22-acre water surface will maintain hydrologic sink conditions

Open Pit Dewatering and Rapid Fill Reclamation



Open Pit Water Budgets

	Existing pit	Future pit
water level (ft amsl)	5,433	4,894
water surface area (acres)	5	22
catchment surface area (acres)	230	314
water balance (acre-feet per year)		
precipitation and runoff	18	57
groundwater inflow	7	36
Total In	**25**	**93**
Evaporation Out	**25**	**93**

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WASTE ROCK STOCKPILES 2&3

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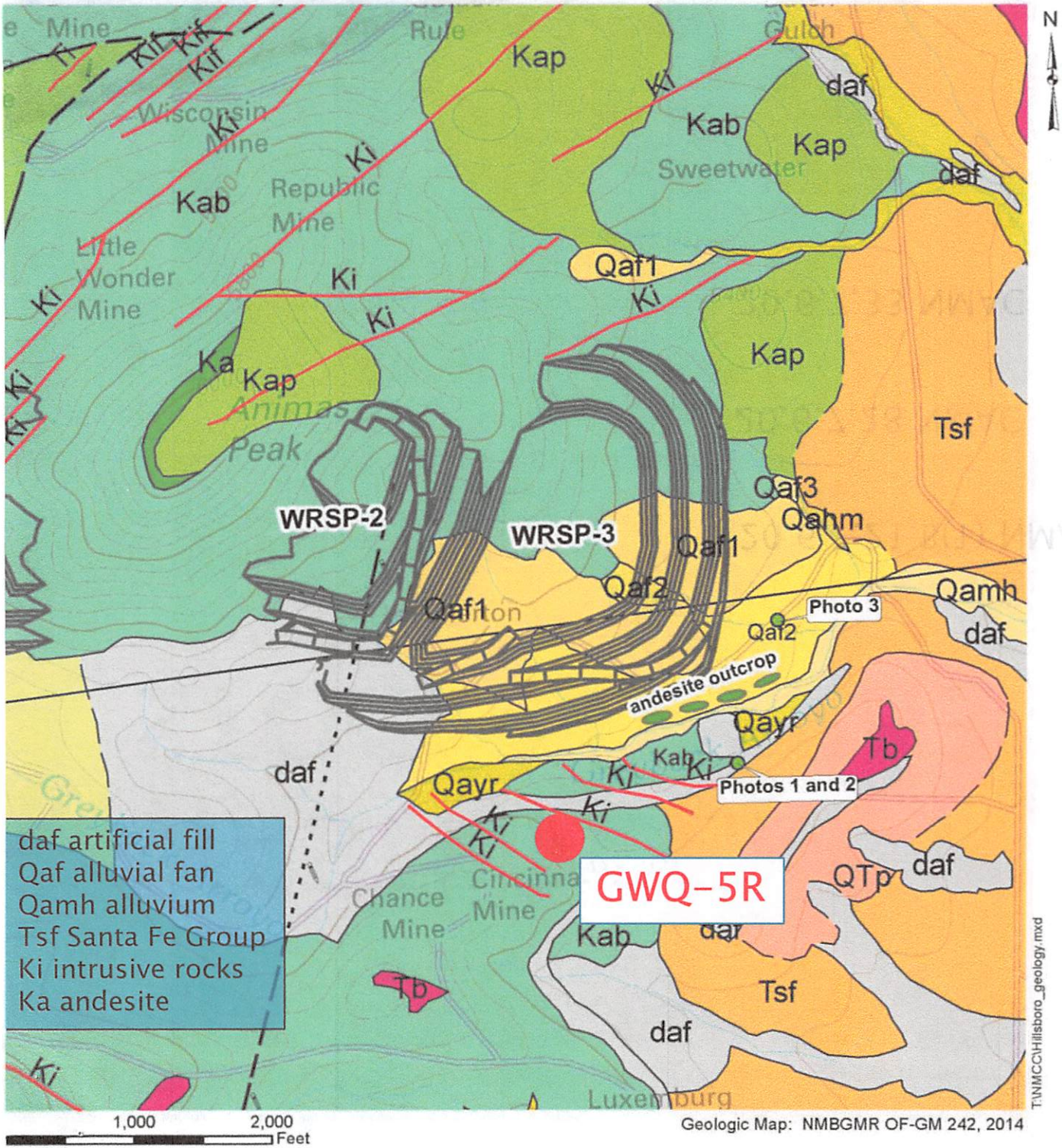
20.6.7.21.B(1) NMAC

20.6.7.28 NMAC

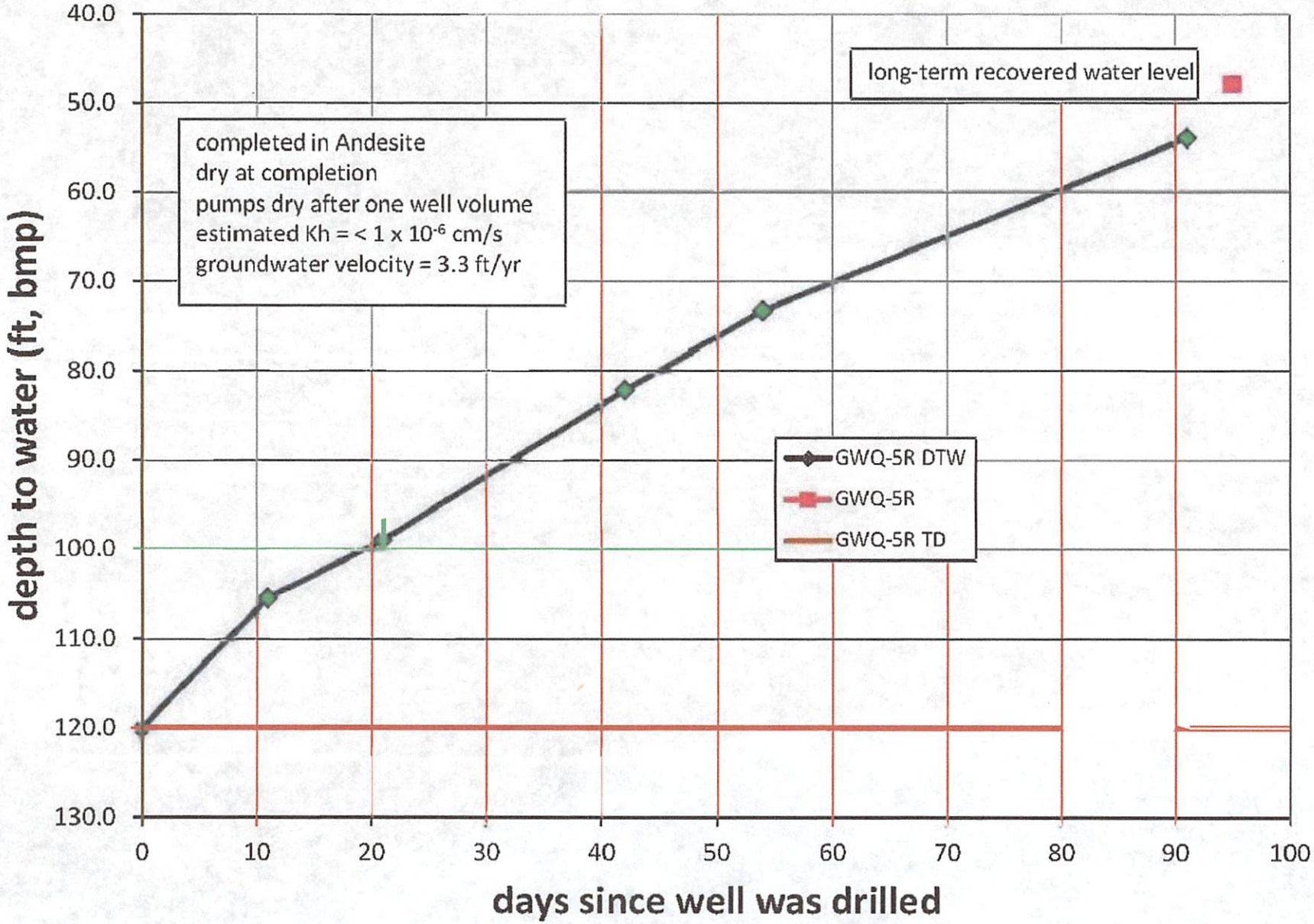
20.6.7.33 NMAC

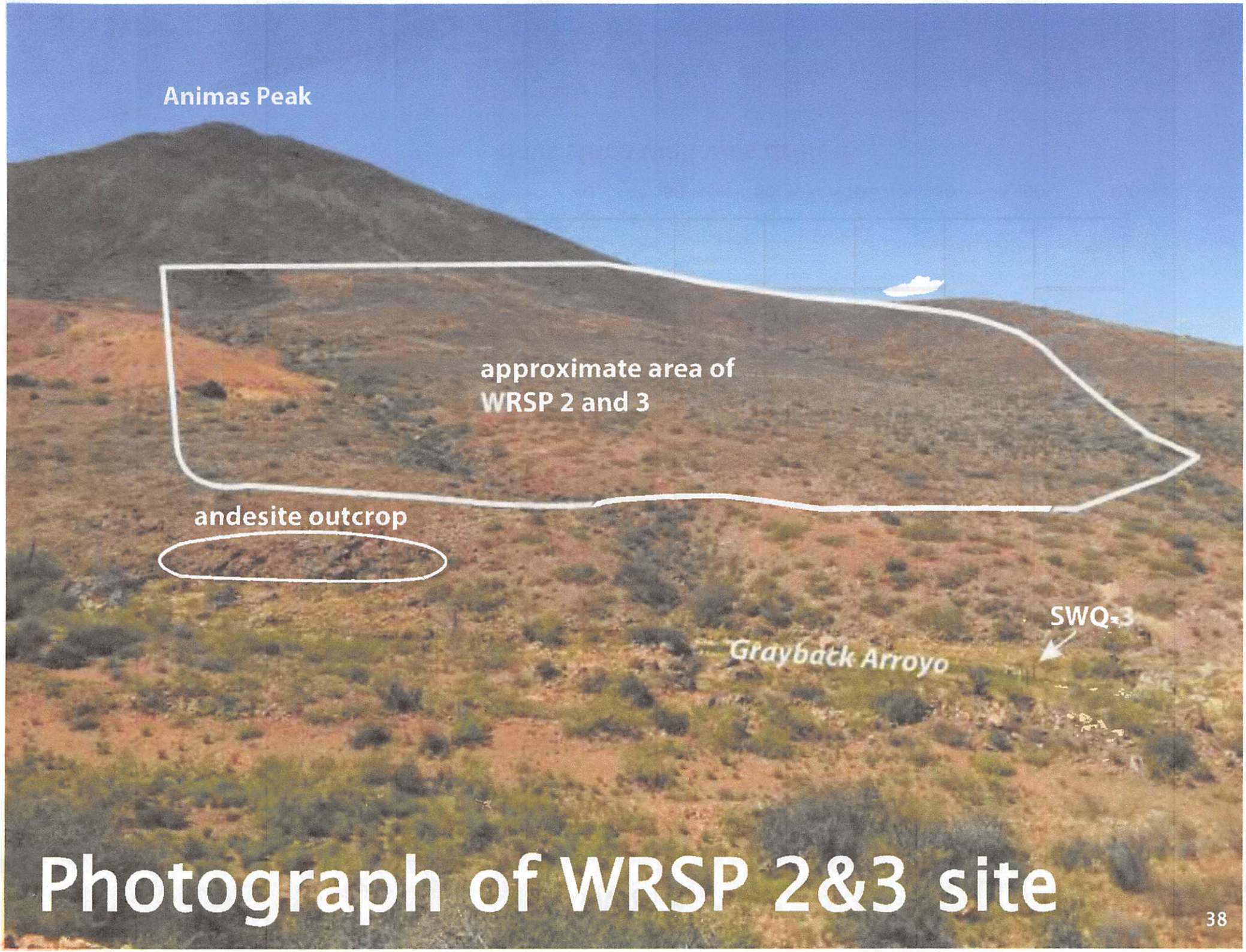


Aquifer Evaluation

Aquifer characteristics and the hydrogeologic controls on the movement of leachate from waste rock stockpiles and groundwater impacted by the waste rock stockpiles based on actual field data 20.6.7.21.B(1)(d)(vi)

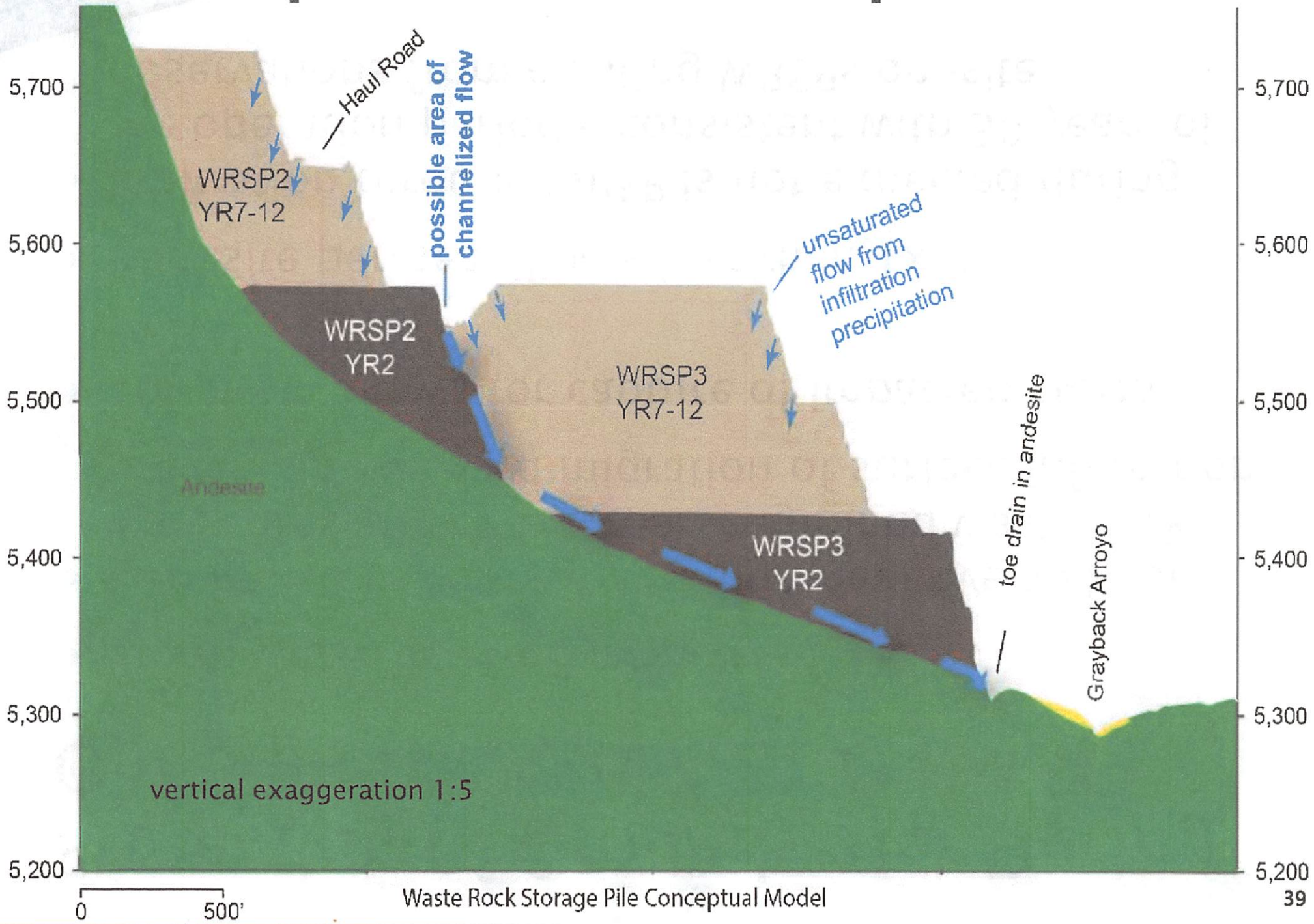
GWQ-5R


40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0
depth to water (ft, bmp)
0
10
20
30
40
50
60
70
80
90
100
days since well was drilled
long-term recovered water level
completed in Andesite
dry at completion
pumps dry after one well volume
estimated Kh = < 1 x 10-6 cm/s
groundwater velocity = 3.3 ft/yr
GWQ-5R DTW
GWQ-5R
GWQ-5R TD



Photograph of WRSP 2&3 site

WRSP Operational Conceptual Model



Protection of Groundwater During Operations (20.6.7.21.D NMAC)

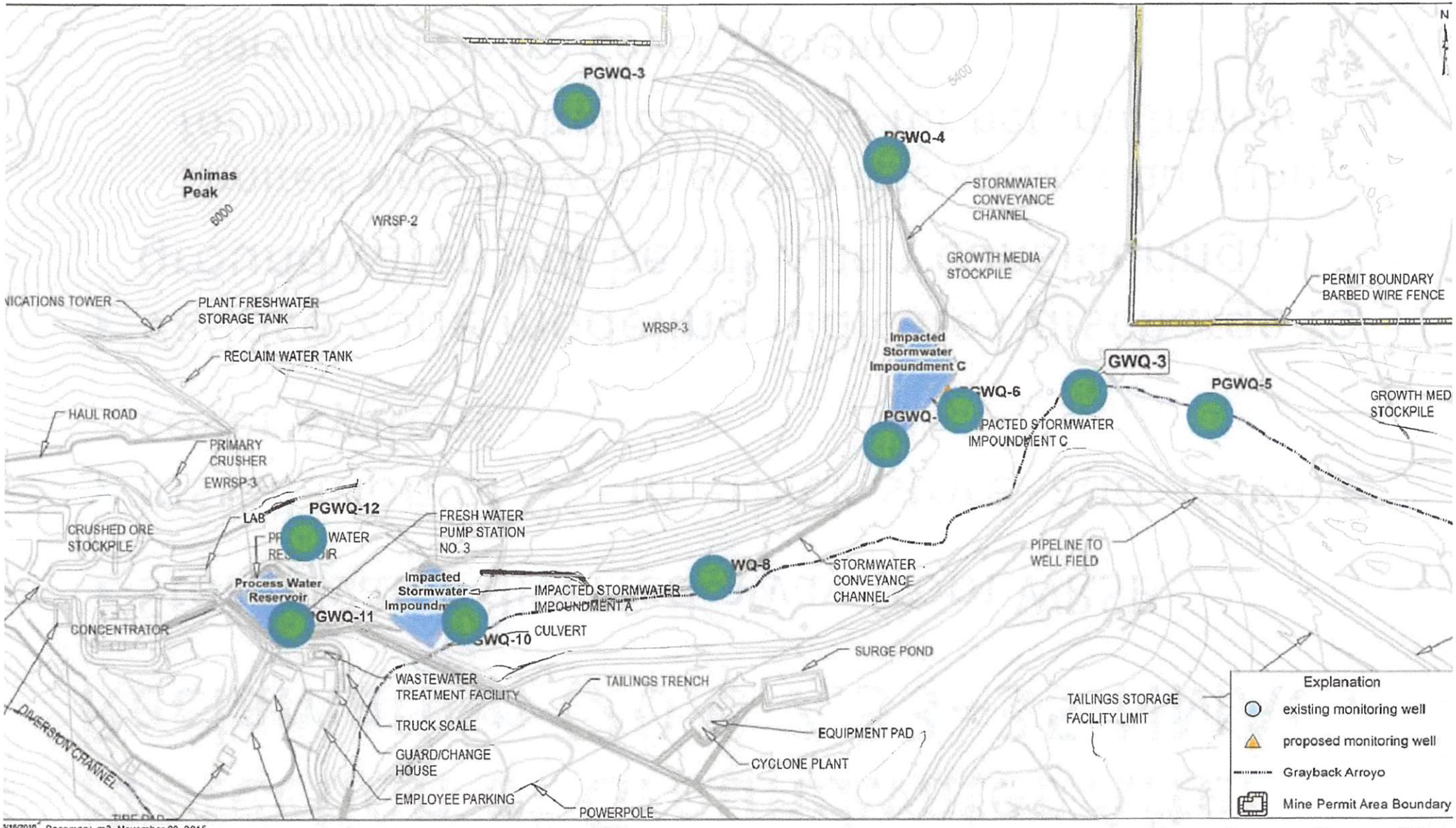
- Storm water diverted away from WRSP
- Low moisture content and high negative soil pore-water pressure of the coarse-grained waste rock prevents downward migration of surface infiltration
- Toe drain allows for capture of impacted storm water
- Andesite permeability is less than $1x10^{-6}$ cm/s
- Infiltration through WRSP is not expected during the operation period - consistent with 30 years of observations from existing WRSPs on-site

Protection of Groundwater After Reclamation (20.6.7.33-35 NMAC)

- Storm water diverted away from WRSP
- Installation of 36-in.-thick store-and-release cover system
- Vadose zone modeling indicates discharge to groundwater will be nil when considering:
  - Limited time between operations and reclamation for development of conditions for net infiltration
  - Store and release cover system
  - Low permeability of andesite

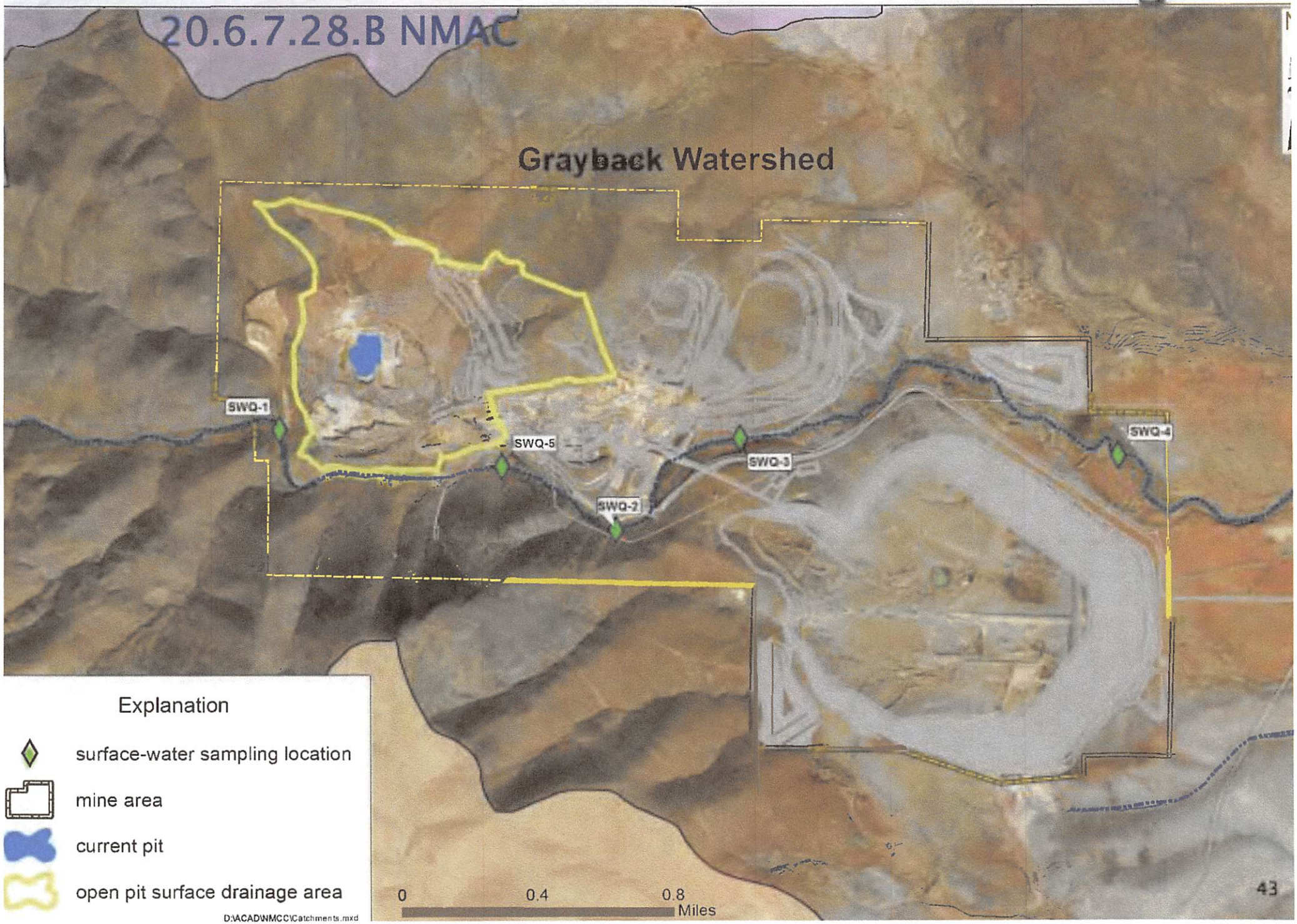
WRSP 2&3 Groundwater Monitoring

20.6.7.28.B NMAC



WRSP 2&3 Surface-Water Monitoring

20.6.7.28.B NMAC



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Tailings Storage Facility

20.6.7.22(4)(d)(vi) NMAC

20.6.7.28 NMAC

TSF Aquifer Evaluation

20.6.7.22.B(4)(vii) NMAC

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TSF aquifer evaluation considered potential liner leak, water quality of seepage, and groundwater mixing and transport calculations

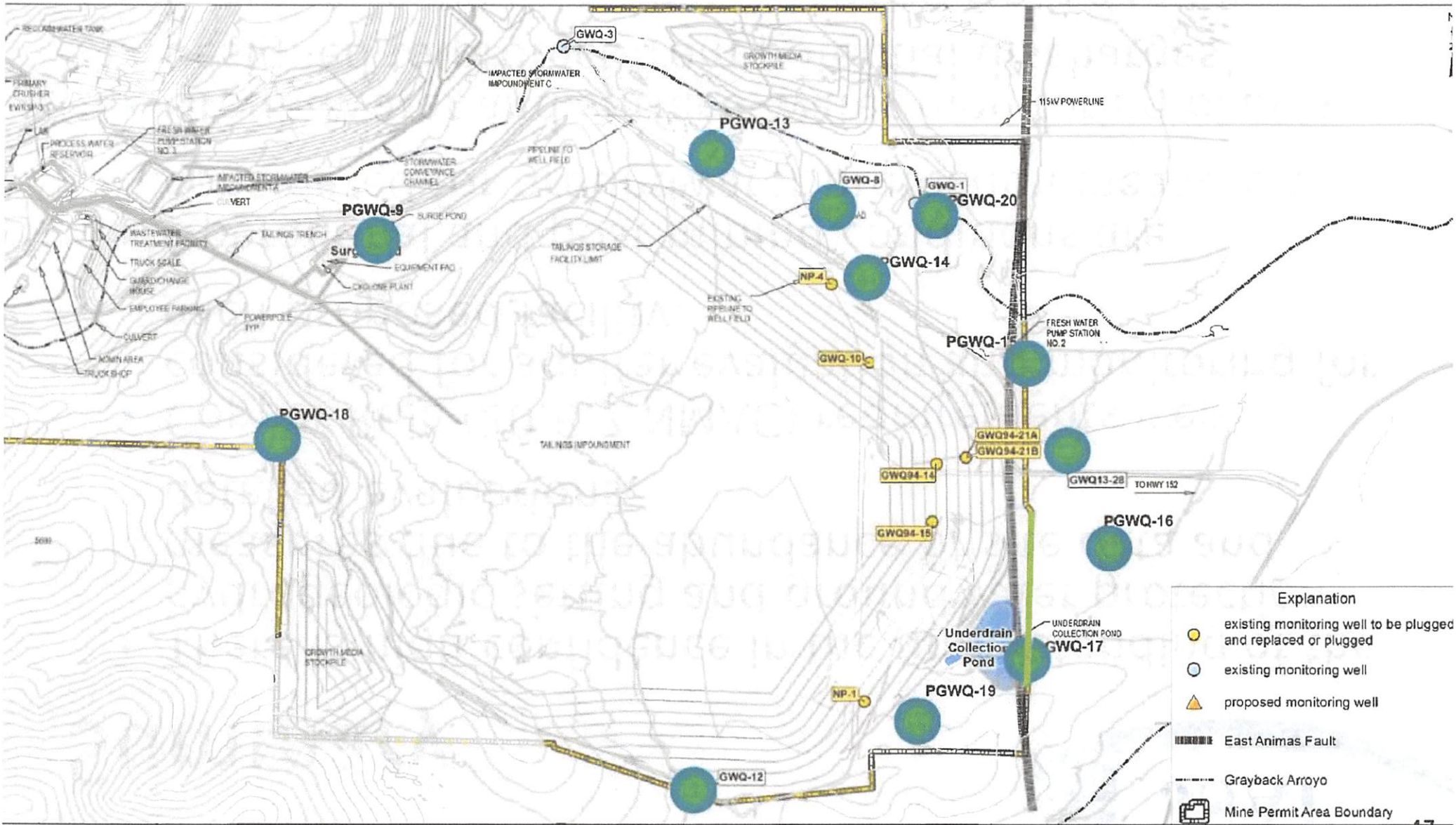
Table 3.6. Potential tailings liner leakage

B_c	0.21
h_w	1.5 ft
L_s	1 ft
a_d	1.0 cm^2
K_s	$1x10^{-6}$ cm/s
q	0.0009 gpm/acre
total flow	0.5 gpm

TSF Aquifer Evaluation

- The projected rate of potential leakage from the liner is insignificant (0.5 gpm).
- The hydraulic gradient will be reduced as a result of the reduced recharge from the liner in the TSF footprint.
- Groundwater beneath the TSF will have a low travel velocity.
- Potential leakage, if percolates to groundwater, will blend or remain beneath the TSF for hundreds of years.

TSF Groundwater Monitoring



6/16/2016 Basemap: m3, November 20, 2015
Revised: June 6, 2016

Summary

- There is high confidence in the understanding of the hydrogeologic setting and groundwater protection measures due to the abundance of site data and detailed evaluations.
- Copper Rule (20.6.7 NMAC) requirements were considered for aquifer evaluation and monitoring for each proposed facility.
- Operational and post mining conditions are considered for groundwater protection measures.
- Groundwater and surface-water monitoring plan is designed to protect from potential discharges.
- In my professional opinion, NMCC DP-1840 is compliant with the Copper Rule 20.6.7 NMAC.