Modern Data Management for Large Scale Dewatering Tests

Ben Radtke, SRK Consulting (U.S.), Inc. – Presenter
Stephanie Douglas, Newmont Mining Corporation
Larry Cope, SRK Consulting (U.S.), Inc.

Smart Mining Annual Conference and Expo
Society for Mining, Metallurgy and Exploration
February 25, 2019

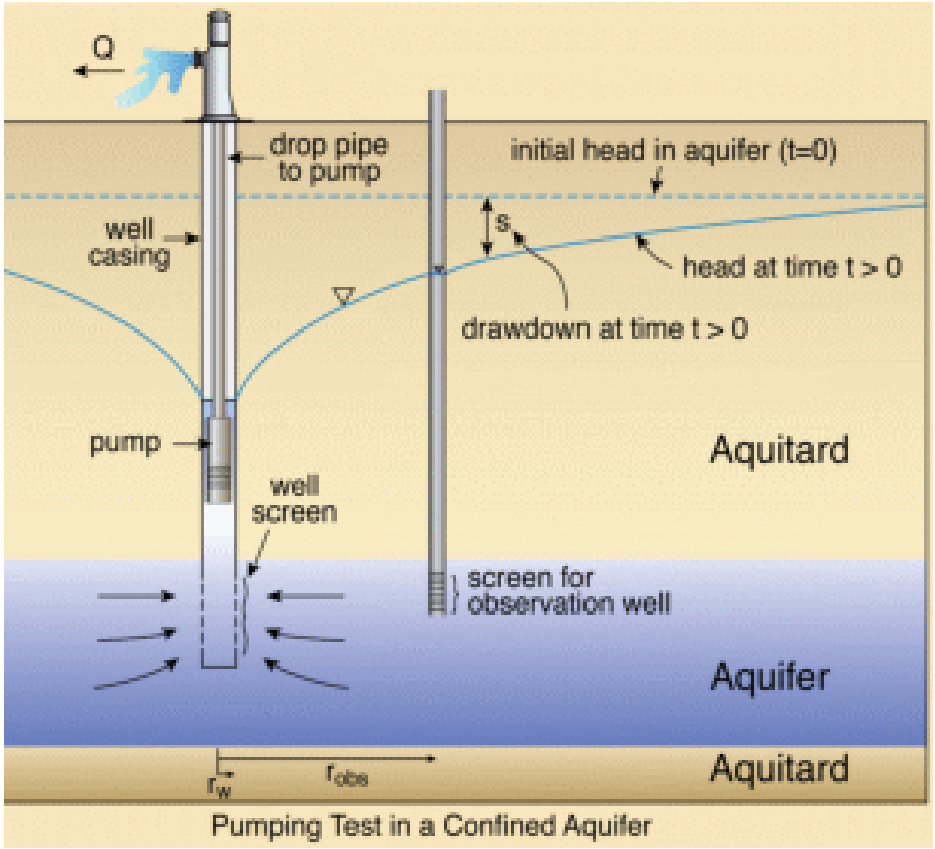
NEWMONT
NORTH AMERICA

srk consulting

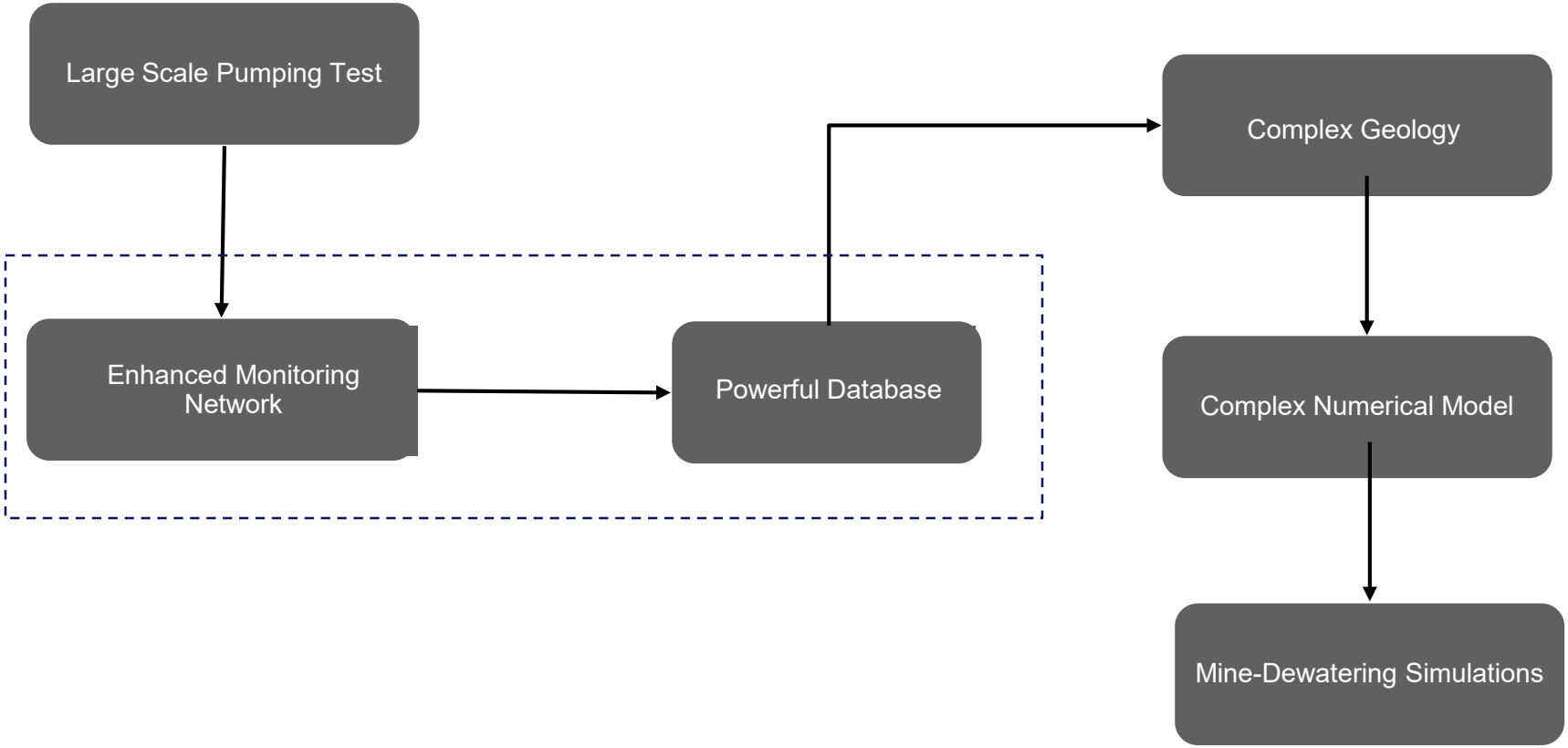
Dewatering Tests

What is a dewatering test?

- A pumping test to evaluate well production and dewatering feasibility.
- Induce large drawdown stress to aquifer to support a numerical groundwater model.
- Model needed for permitting and mine planning.



Large Scale Pumping Test



The Scale

Newmonts Long Canyon Mine

Pumping Setup:

- Three pumping wells (2 discharge 1 supplemental)
  - Intermittent pumping interference from 10 other pumping wells
- Maximum combined pumping rate of 5,700 gpm
- 74 day stress period
- Subsequent recovery period

Monitoring Network:

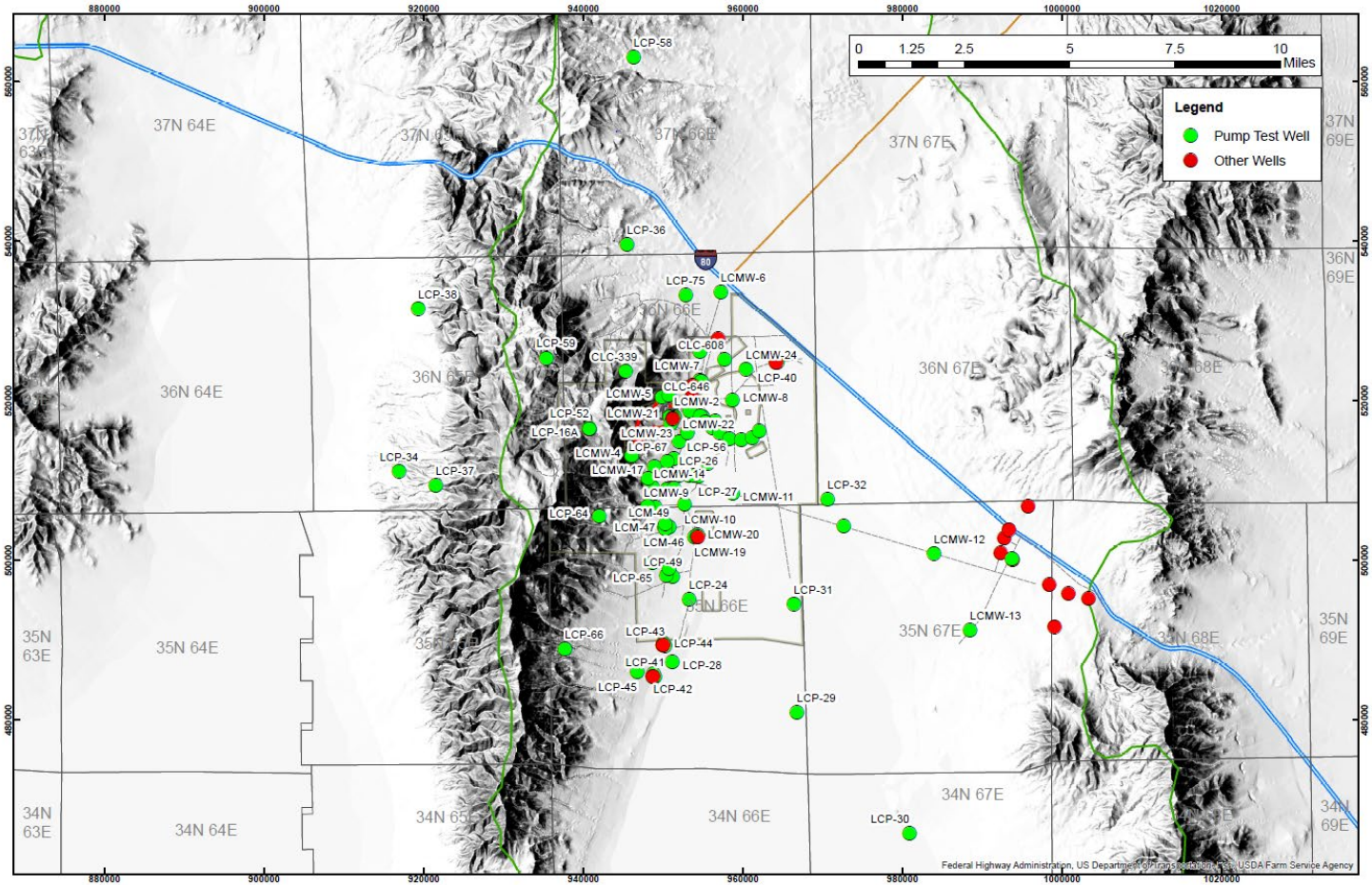
- 185 groundwater monitoring points in 89 locations (Open Standpipe or Vibrating Wire Piezometer)
- 31 surface water monitoring points (Flume, Weir, Staff Gauge)
- Monitoring frequencies of 1 to 15 minutes

The Scale

Type	Number of Monitoring Points	Number of Pairs per Point	Reading Frequency (per day)	Sum of Data Pairs
Open Standpipe	47	3	96	2,030,400
VWP	122	3	96	5,270,400
Pumping	15	2	24	108,000
Flume	6	2	96	172,800
Weir	8	2	96	230,400
Staff Gauge	31	1	2	9,300
Stilling Well	10	2	96	288,000
Water Quality	2	5	24	36,000
SUM				8,145,300

The Scale

Groundwater Monitoring Network



The Data

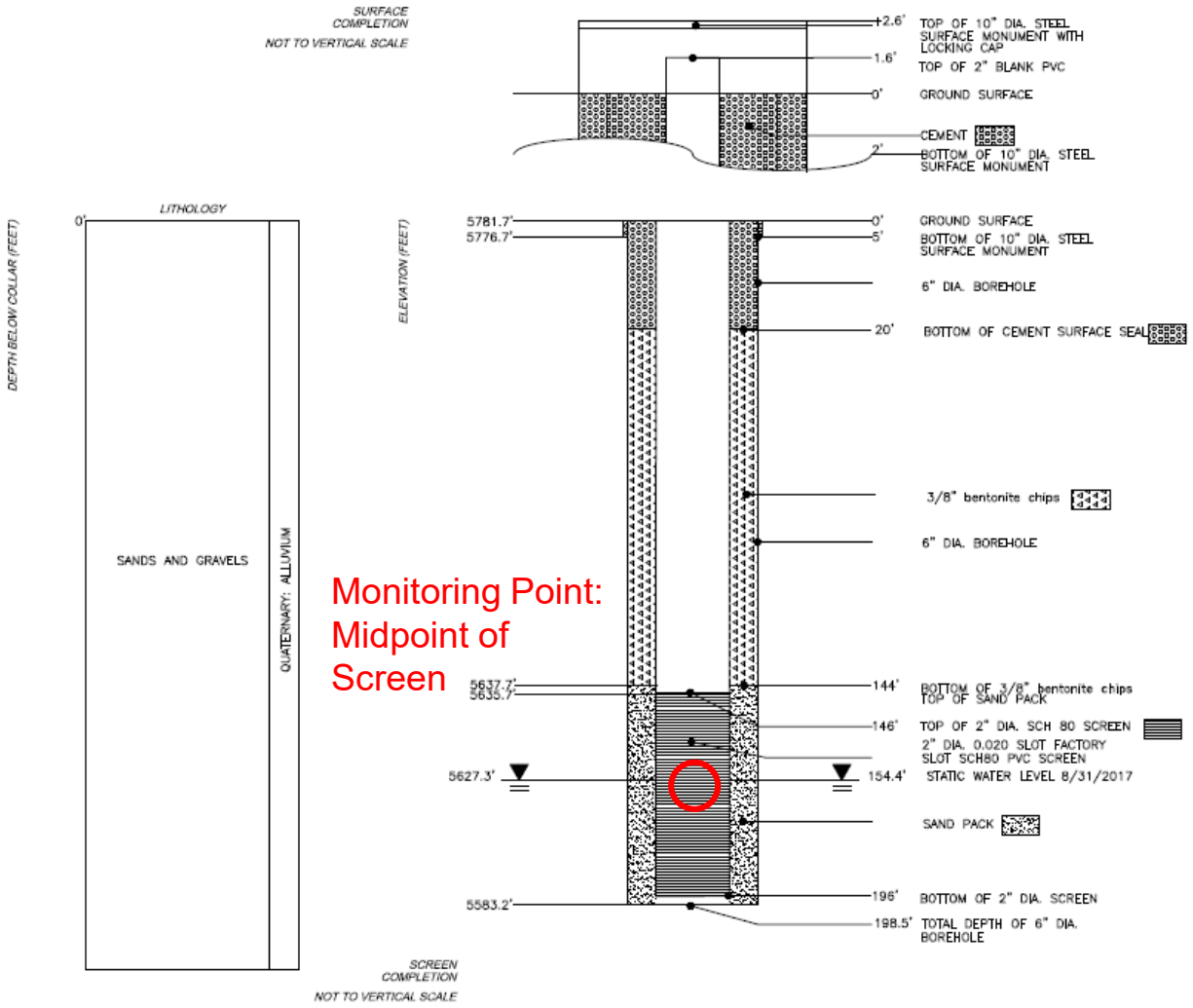
What Was Monitored?

- Water Quantity
  - Groundwater potentiometric surface
  - Groundwater discharge
  - Surface water stage
  - Surface water flow
  - Time and Temperature, “pressure”, etc. for every point
- Water Quality
  - Dissolved oxygen
  - Total dissolved gas
  - pH
  - Conductivity

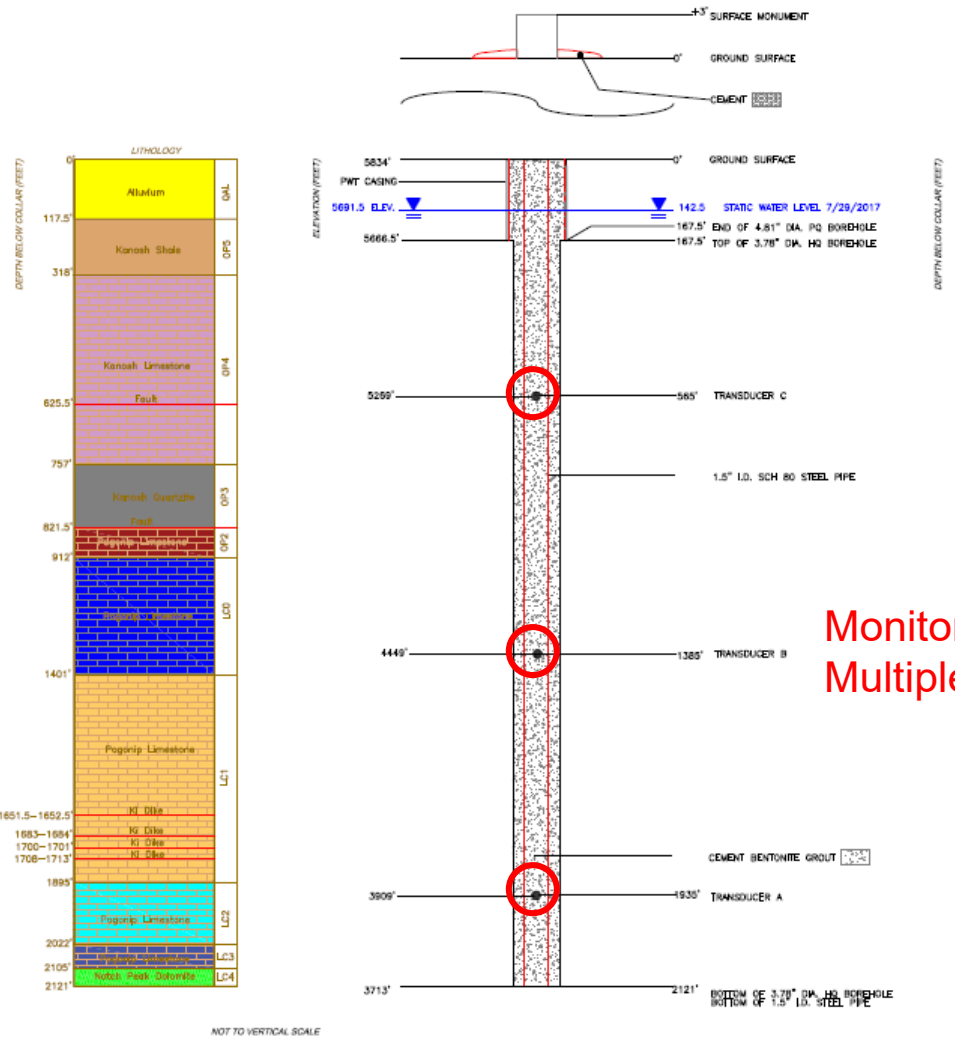
What are we measuring?

- Drawdown – for hydraulic parameter estimates and model calibration
- Changes in spring discharge and quality – for model calibration and to evaluate environmental impacts

Groundwater Monitoring



Groundwater Monitoring



Monitoring Point:
Multiple Grouted in VWPs

Surface Water Monitoring

Stilling Well and Staff Gauge – Standing Water or Obstructed Flow

Transducer installed inside stilling well

Surface Water Monitoring

Weir – Low Flow Setting

Surface Water Monitoring

Flume – High Flow Setting

Data Acquisition

Groundwater measurements collected and stored in a Loadsensing™ datalogger at the wellhead and Telemetered to an online database

Data Acquisition

Surface water measurements collected and stored using transducers and either telemetered to an online database or manually downloaded

Data Acquisition

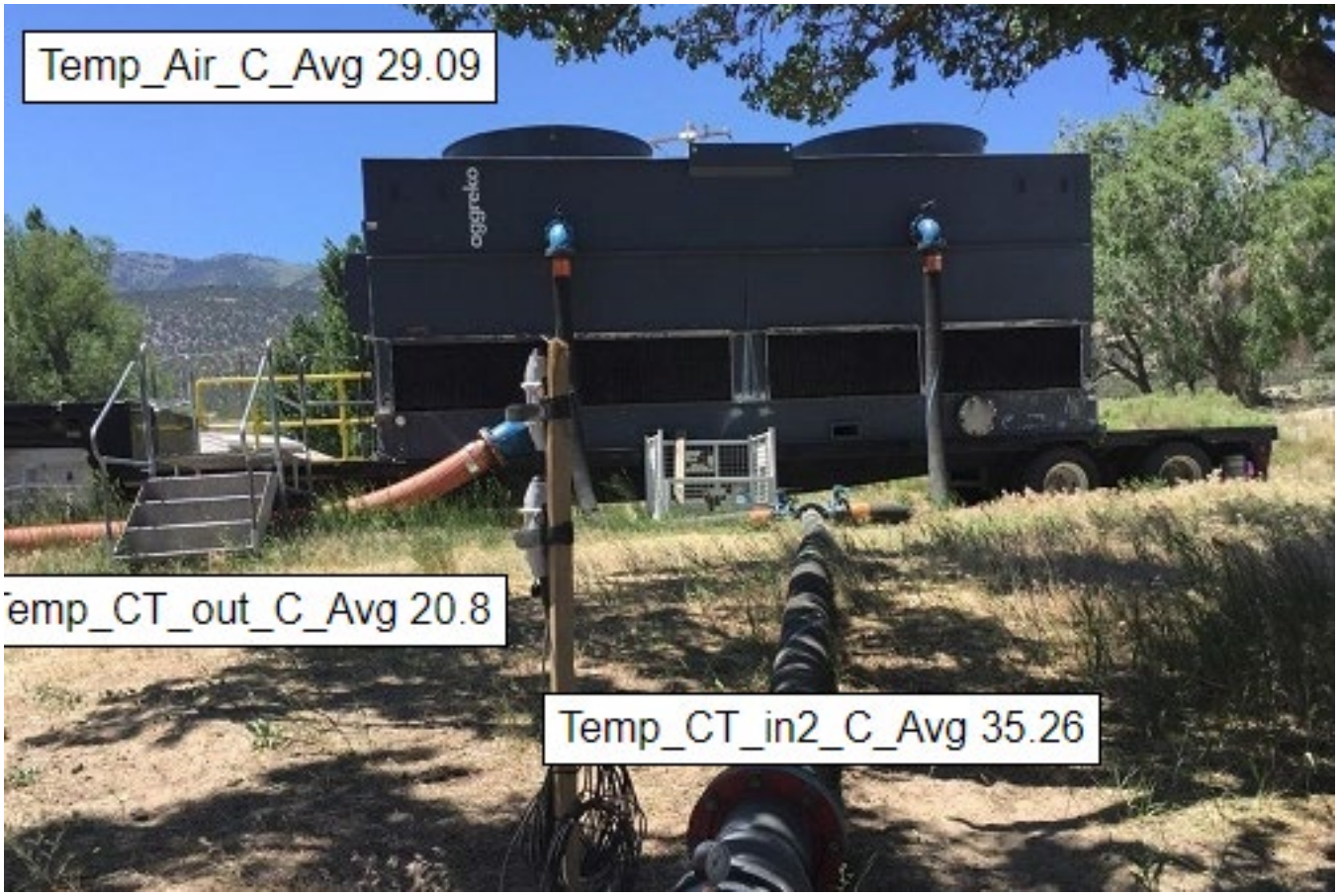
Non-instrumented staff gauge readings taken twice per day to monitor stage levels

Data Acquisition

Water quality data collected using automated multiparameter dataloggers

Data Acquisition

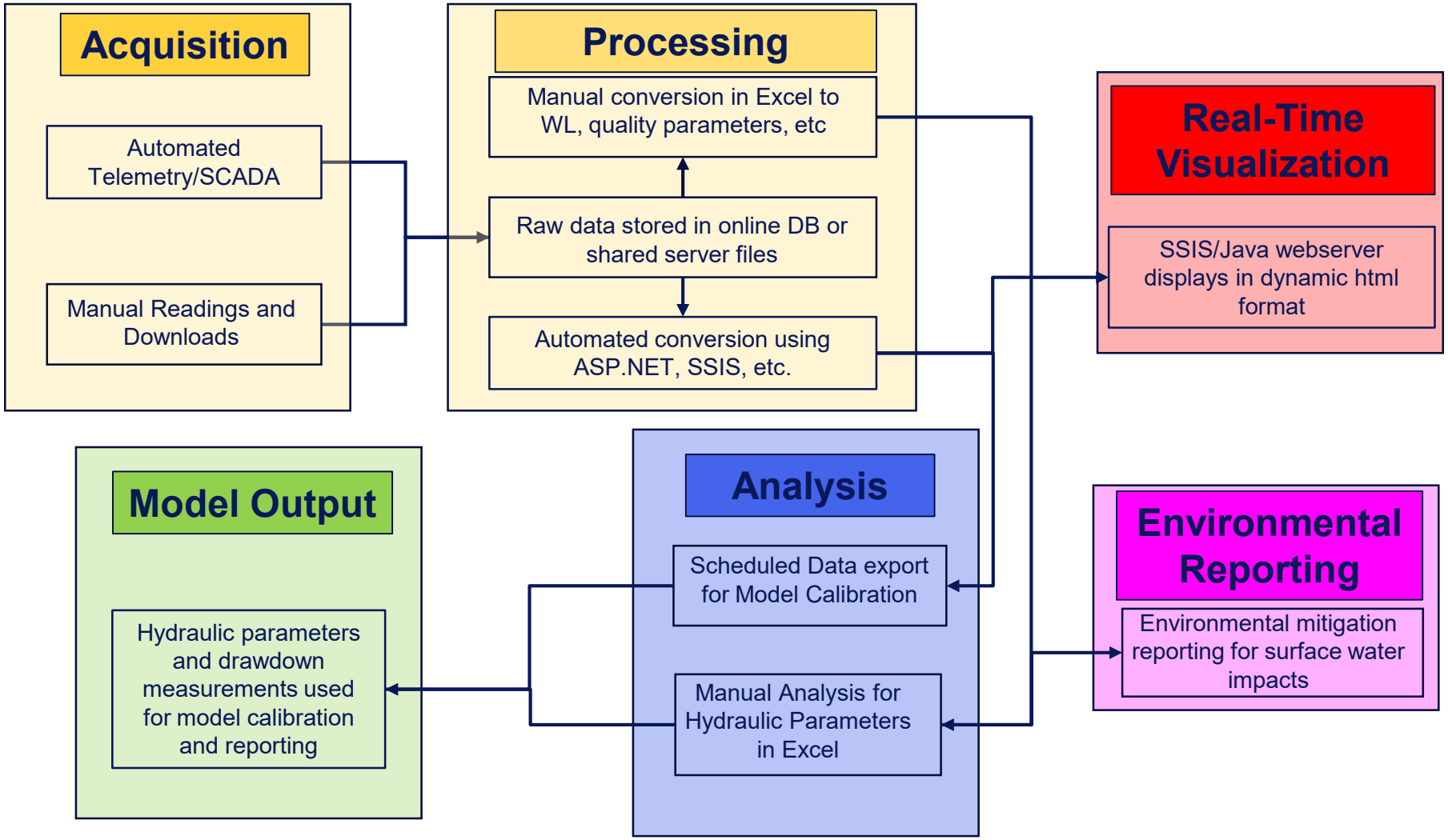
Temperature sensor readings for supplementation at Big Springs cooling tower



Data Acquisition

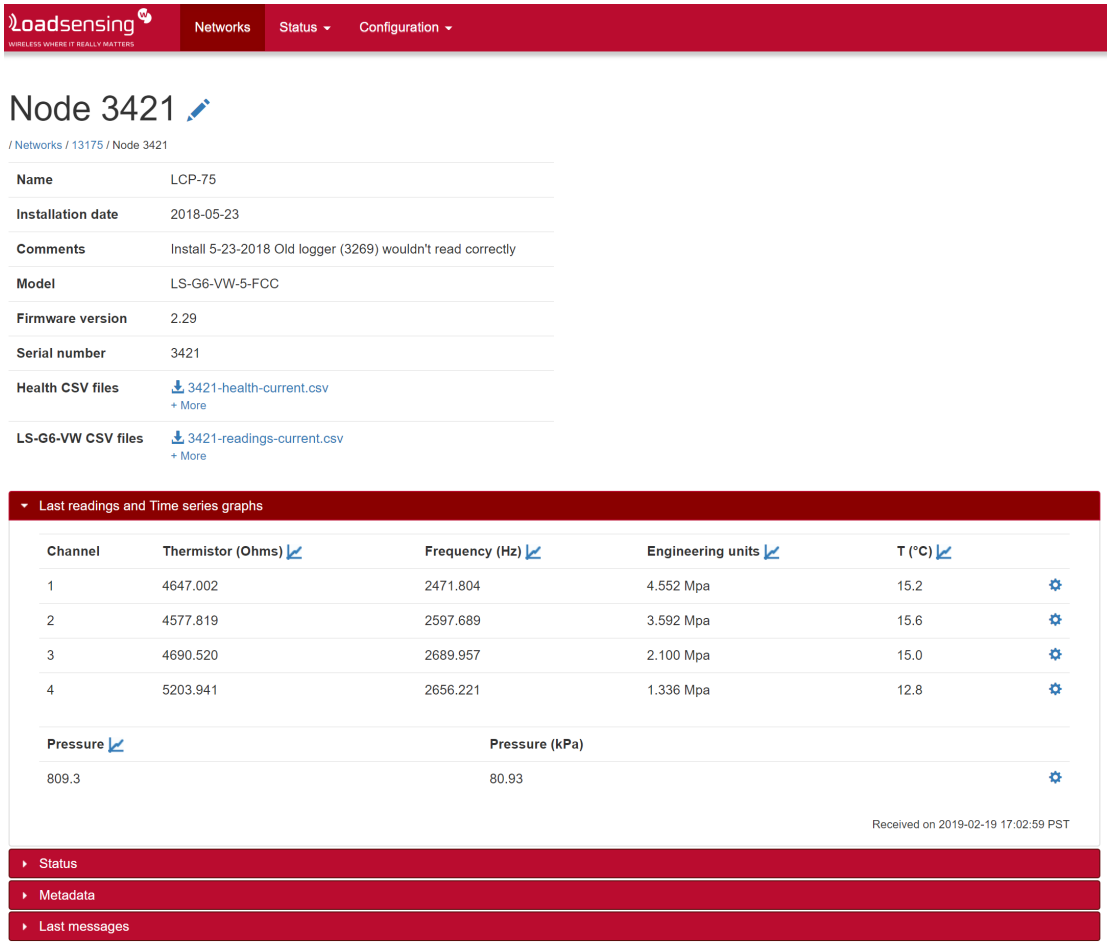
Hourly pumping discharge readings (gpm and pressure)

Data Flow


Acquisition
Automated Telemetry/SCADA
Manual Readings and Downloads
Processing
Manual conversion in Excel to WL, quality parameters, etc
Raw data stored in online DB or shared server files
Automated conversion using ASP.NET, SSIS, etc.
Real-Time Visualization
SSIS/Java webserver displays in dynamic html format
Model Output
Hydraulic parameters and drawdown measurements used for model calibration and reporting
Analysis
Scheduled Data export for Model Calibration
Manual Analysis for Hydraulic Parameters in Excel
Environmental Reporting
Environmental mitigation reporting for surface water impacts

Data Processing (GW)

Loadsensing™ node web interface for groundwater data



Data Processing (GW)

Raw data output from Loadsensing™ web server (time, temp., digits, etc.)

Node ID	3421																							
Gateway I	13175																							
Model	LS-G6-VW-5-FCC																							
Hw version																								
Fw version																								
Location Lat																								
Location Lon																								
Created ti	########																							
Timezone	America/Los_Angeles																							
Date-and-	AtmPress	freqInHz-	freqSqInD	thermRes	freqInHz-	freqSqInD	thermRes	freqInHz-	freqSqInD	thermRes	freqInHz-	freqSqInD	thermRes	freqInHz-	freqSqInD	thermRes	atmPress	p-3421-Ch	tInCelsius	p-3421-Ch	tInCelsius	p-3421-Ch	tInCelsius	p-3421-Ch	tInCelsius
########	814.1	2471.804	6109.82	4646.39	2597.57	6747.37	4577.26	2689.957	7235.87	4690.37	2656.221	7055.51	5203.54					4.552	15.25	3.592	15.57	2.1	15.05	1.336	12.83
########	813.9	2471.566	6108.64	4646.77	2597.689	6747.99	4577.31	2689.957	7235.87	4690.06	2656.34	7056.14	5203.04					4.554	15.25	3.591	15.57	2.1	15.05	1.335	12.83
########	814.2	2471.685	6109.23	4646.96	2597.689	6747.99	4577.58	2689.957	7235.87	4690.48	2656.459	7056.77	5204.01					4.553	15.25	3.591	15.57	2.099	15.05	1.335	12.83
########	813.9	2471.685	6109.23	4646.53	2597.689	6747.99	4577.55	2689.838	7235.23	4690.77	2656.221	7055.51	5203.65					4.553	15.25	3.591	15.57	2.1	15.05	1.336	12.83
########	813.4	2471.685	6109.23	4647.17	2597.689	6747.99	4577.93	2689.957	7235.87	4690.67	2656.221	7055.51	5203.4					4.553	15.25	3.591	15.57	2.1	15.05	1.336	12.83
########	813.7	2471.685	6109.23	4646.47	2597.57	6747.37	4577.5	2689.838	7235.23	4690.46	2656.102	7054.88	5203.21					4.553	15.25	3.592	15.57	2.1	15.05	1.336	12.83
########	813.8	2471.685	6109.23	4646.72	2597.57	6747.37	4577.54	2690.076	7236.51	4690.66	2656.221	7055.51	5203.45					4.553	15.25	3.592	15.57	2.099	15.05	1.336	12.83
########	813.9	2471.685	6109.23	4646.84	2597.57	6747.37	4577.78	2690.076	7236.51	4690.51	2656.221	7055.51	5203.3					4.553	15.25	3.592	15.57	2.099	15.05	1.336	12.83
########	814.1	2471.685	6109.23	4646.63	2597.808	6748.61	4577.55	2689.957	7235.87	4690.49	2656.221	7055.51	5203.14					4.553	15.25	3.59	15.57	2.1	15.05	1.336	12.83
########	814	2471.804	6109.82	4646.27	2597.689	6747.99	4577.12	2689.719	7234.59	4690.02	2656.34	7056.14	5202.99					4.552	15.25	3.591	15.57	2.101	15.05	1.335	12.83
########	813.9	2471.685	6109.23	4645.19	2597.808	6748.61	4576.08	2689.838	7235.23	4688.83	2656.459	7056.77	5201.29					4.553	15.26	3.59	15.58	2.1	15.06	1.335	12.84
########	813.4	2471.685	6109.23	4644.7	2597.57	6747.37	4575.89	2689.957	7235.87	4688.33	2656.34	7056.14	5201.38					4.553	15.26	3.592	15.58	2.1	15.06	1.335	12.84
########	812.5	2471.685	6109.23	4645.12	2597.689	6747.99	4575.57	2689.957	7235.87	4688.47	2656.34	7056.14	5201.31					4.553	15.26	3.592	15.58	2.1	15.06	1.335	12.84
########	811.8	2471.685	6109.23	4644.89	2597.57	6747.37	4575.58	2689.838	7235.23	4688.65	2656.221	7055.51	5201.15					4.553	15.26	3.593	15.58	2.101	15.06	1.336	12.84
########	811.5	2471.685	6109.23	4644.88	2597.689	6747.99	4575.74	2689.838	7235.23	4688.5	2656.34	7056.14	5201.45					4.553	15.26	3.592	15.58	2.101	15.06	1.335	12.84
########	811.4	2471.685	6109.23	4644.89	2597.689	6747.99	4576.06	2689.838	7235.23	4688.55	2656.34	7056.14	5201.49					4.553	15.26	3.592	15.58	2.101	15.06	1.335	12.84
########	810.9	2471.804	6109.82	4645	2597.689	6747.99	4575.75	2689.957	7235.87	4688.49	2656.34	7056.14	5201.6					4.552	15.26	3.592	15.58	2.1	15.06	1.336	12.84
########	810.7	2471.685	6109.23	4645.34	2597.689	6747.99	4576.05	2689.838	7235.23	4688.66	2656.221	7055.51	5201.76					4.553	15.26	3.592	15.58	2.101	15.06	1.336	12.84
########	810.9	2471.685	6109.23	4646.25	2597.689	6747.99	4577.22	2689.838	7235.23	4689.89	2656.221	7055.51	5203.2					4.553	15.25	3.592	15.57	2.101	15.05	1.336	12.83
########	810.8	2471.685	6109.23	4646.69	2597.689	6747.99	4577.39	2689.957	7235.87	4690.39	2656.34	7056.14	5203.09					4.553	15.25	3.592	15.57	2.1	15.05	1.336	12.83
########	810.4	2471.804	6109.82	4646.55	2597.689	6747.99	4577.35	2689.957	7235.87	4690.07	2656.221	7055.51	5203.07					4.552	15.25	3.592	15.57	2.1	15.05	1.336	12.83
########	810	2471.685	6109.23	4646.72	2597.808	6748.61	4577.57	2689.838	7235.23	4690.74	2656.34	7056.14	5203.41					4.553	15.25	3.591	15.57	2.101	15.05	1.336	12.83
########	810.1	2471.804	6109.82	4646.81	2597.689	6747.99	4577.73	2689.838	7235.23	4690.35	2656.34	7056.14	5203.55					4.552	15.25	3.592	15.57	2.101	15.05	1.336	12.83
########	809.5	2471.566	6108.64	4646.46	2597.57	6747.37	4577.12	2689.957	7235.87	4690.2	2656.221	7055.51	5203.4					4.554	15.25	3.593	15.57	2.1	15.05	1.336	12.83
########	809.4	2471.685	6109.23	4646.69	2597.57	6747.37	4577.44	2689.957	7235.87	4690.64	2656.459	7056.77	5203.21					4.553	15.25	3.593	15.57	2.1	15.05	1.335	12.83
########	809.1	2471.685	6109.23	4646.25	2597.689	6747.99	4577.34	2689.838	7235.23	4690.43	2656.459	7056.77	5203.1					4.553	15.25	3.592	15.57	2.101	15.05	1.335	12.83
########	809.1	2471.566	6108.64	4646.22	2597.689	6747.99	4576.97	2689.957	7235.87	4690.02	2656.34	7056.14	5203.01					4.554	15.25	3.592	15.58	2.1	15.05	1.336	12.83
########	808.7	2471.685	6109.23	4646.22	2597.57	6747.37	4577.36	2689.957	7235.87	4690.33	2656.34	7056.14	5202.94					4.553	15.25	3.593	15.57	2.1	15.05	1.336	12.83
########	808.4	2471.685	6109.23	4646.32	2597.57	6747.37	4576.91	2690.076	7236.51	4689.98	2656.34	7056.14	5202.99					4.553	15.25	3.593	15.58	2.099	15.05	1.336	12.83
########	808.1	2471.685	6109.23	4646.45	2597.689	6747.99	4577.14	2689.838	7235.23	4690.16	2656.34	7056.14	5203.07					4.553	15.25	3.592	15.57	2.101	15.05	1.336	12.83
########	808.2	2471.685	6109.23	4646.41	2597.689	6747.99	4577.61	2689.957	7235.87	4689.83	2656.221	7055.51	5202.77					4.553	15.25	3.592	15.57	2.1	15.05	1.336	12.83
########	808	2471.685	6109.23	4646.4	2597.689	6747.99	4577.35	2689.838	7235.23	4690.08	2656.221	7055.51	5203.46					4.553	15.25	3.592	15.57	2.101	15.05	1.336	12.83
########	808.3	2471.685	6109.23	4646.73	2597.689	6747.99	4577.08	2689.957	7235.87	4689.86	2656.34	7056.14	5202.44					4.553	15.25	3.592	15.57	2.1	15.05	1.336	12.84
########	807.8	2471.804	6109.82	4646.58	2597.689	6747.99	4577.04	2689.957	7235.87	4689.89	2656.34	7056.14	5202.33					4.552	15.25	3.592	15.57	2.1	15.05	1.336	12.84
########	807.7	2471.685	6109.23	4646.2	2597.689	6747.99	4576.9	2689.957	7235.87	4689.77	2656.459	7056.77	5202.48					4.554	15.25	3.592	15.58	2.1	15.05	1.335	12.84
########	806.7	2471.685	6109.23	4646.02	2597.689	6747.99	4577.08	2689.957	7235.87	4689.95	2656.221	7055.51	5203.02					4.554	15.25	3.592	15.57	2.1	15.05	1.336	12.83
########	805.5	2471.804	6109.82	4645.64	2597.57	6747.37	4576.3	2689.957	7235.87	4688.83	2656.34	7056.14	5201.65					4.553	15.25	3.593	15.58	2.1	15.06	1.336	12.84
########	804.3	2471.685	6109.23	4645.02	2597.689	6747.99	4575.92	2690.076	7236.51	4688.45	2656.34	7056.14	5201.5					4.554	15.26	3.592	15.58	2.1	15.06	1.336	12.84

Data Processing (GW)

Equation converting raw groundwater data into WL Elevation:

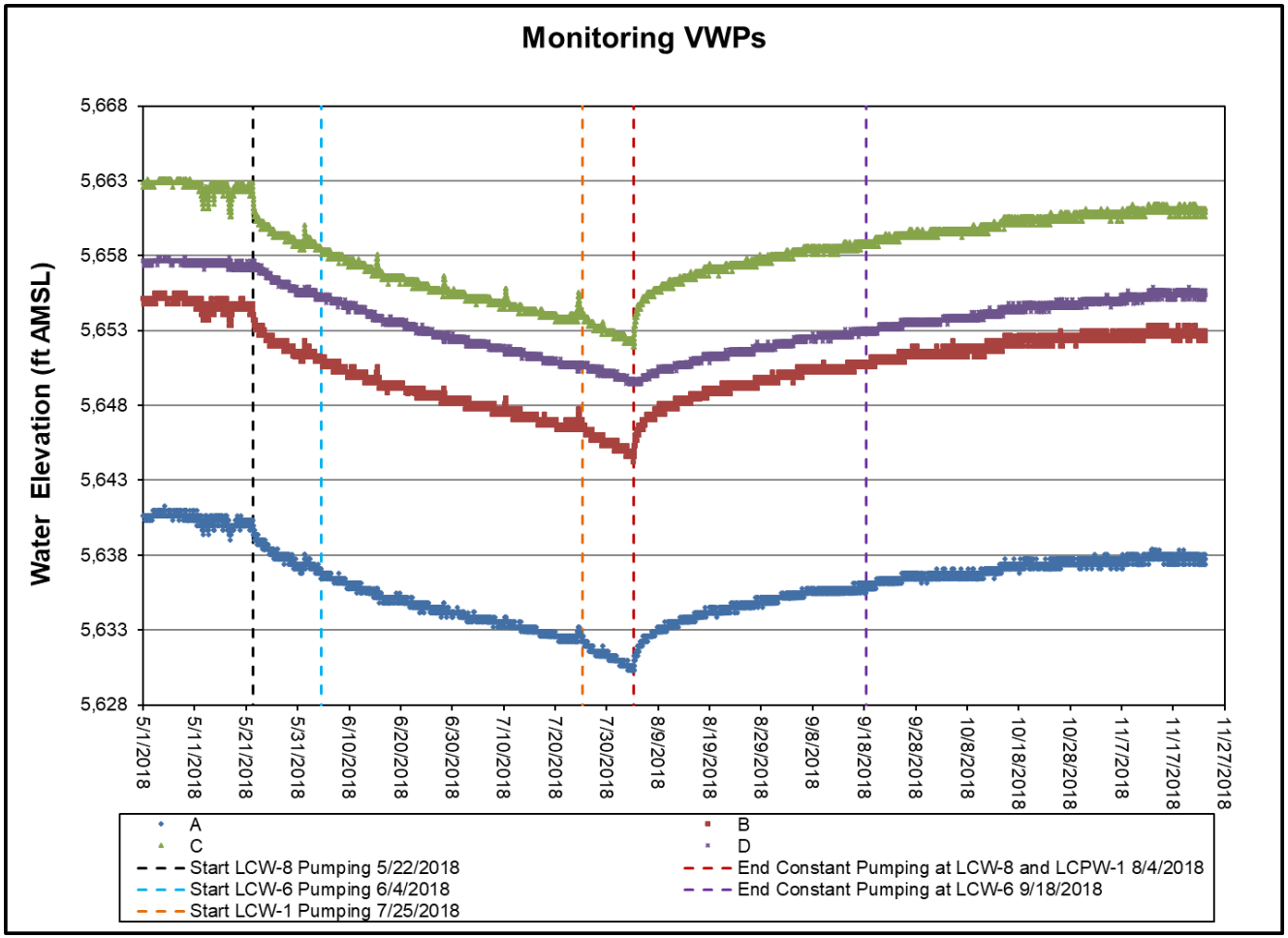
- Collar elev - (Interp Depth - (((G * (Ro – freq(digits))+(K * (temp) - To)))*2.31))

Formula string in Excel

			CONSTANTS FROM TABLE									
INT_ID	INT_NAME	INT_NAME_ALT2	CONST_COLLAR_ELEV	CONST_INTERP_DEPTH	ElevationCheck	CONST_INTERP_ELEV	CONST_G_psi_digi	CONST_K_psi_C	CONST_Ro	CONST_To		
-973672271	CLC-00604_A	3321_CH1	5933.5	965	4968.5	4968.5	0.12258	0.09076	9063.8	28.2		
			VALUES FROM QUERY THAT EXECUTES AND PERFORMS CALCULATIONS									
			CONST_COLLAR_ELEV	CONST_INTERP_DEPTH			CONST_G_psi_digi	CONST_K_psi_C	CONST_Ro	CONST_To	temp	freq
			5933.5	965			0.12258	0.09076	9063.8	28.2	15.88	6520.17
			CALCULATE WL	5686.170805								

Data Processing (GW)

Hydrographs of grouted-in VWPs

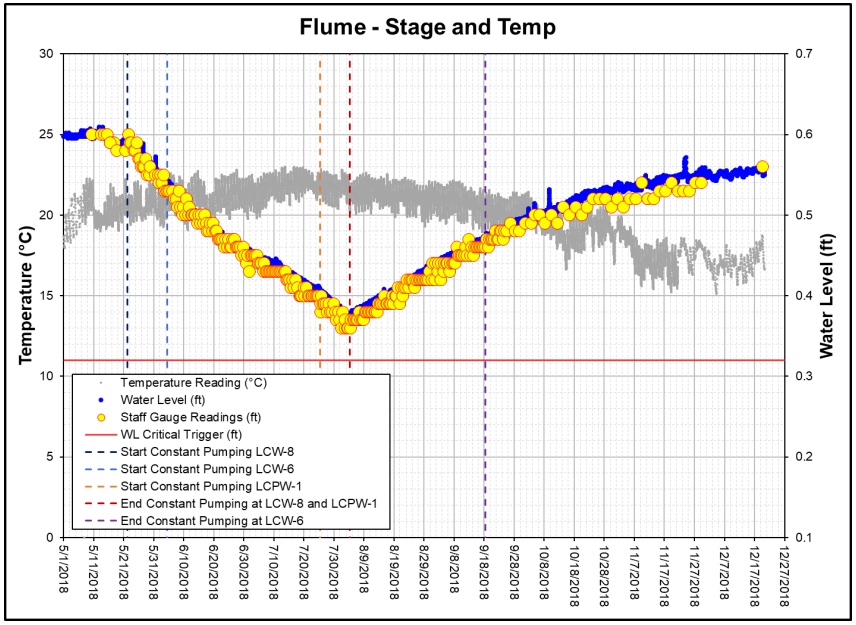


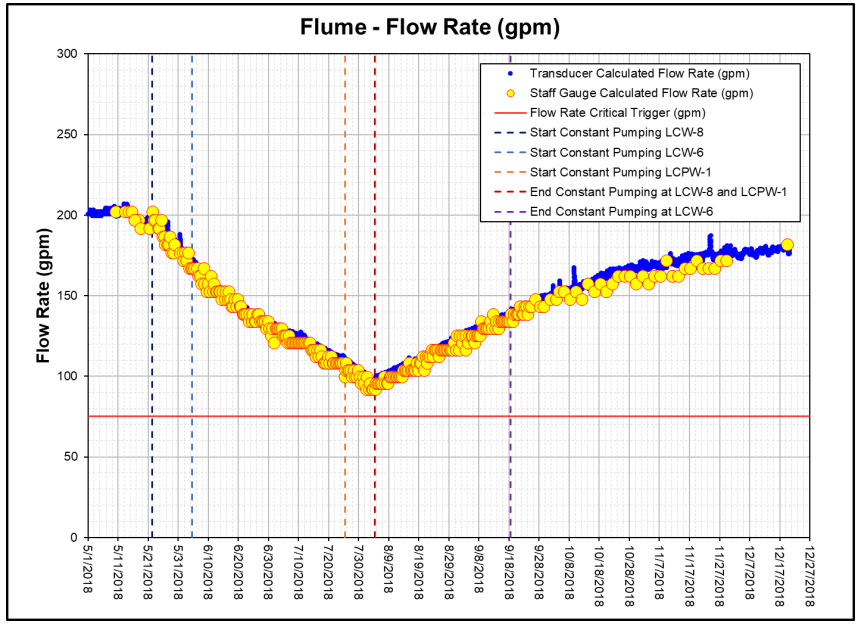
Data Processing (GW)

Automated Upload to Live Web Database

Data Processing (SW)

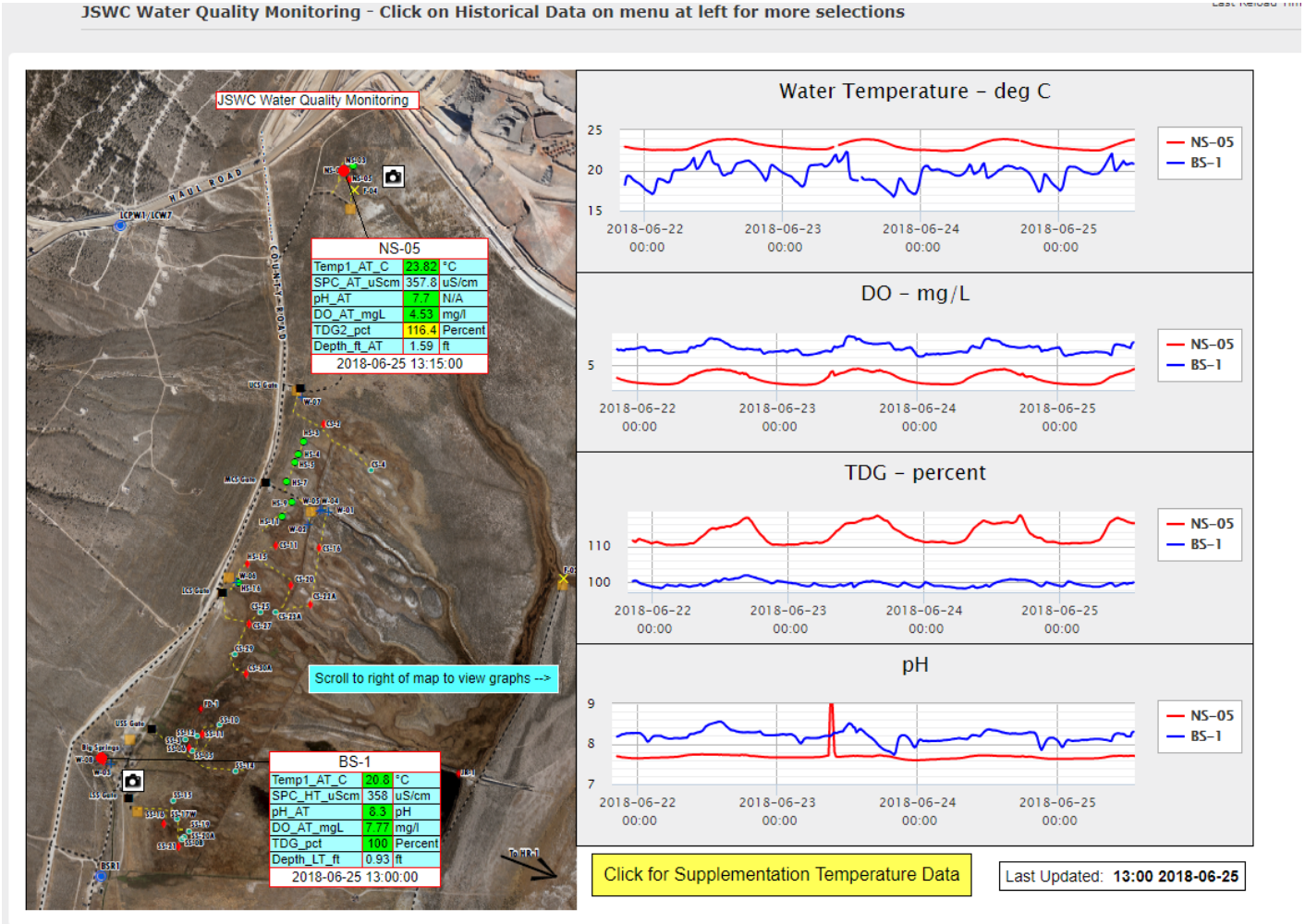
Manual staff gauge and automated transducer readings to display spring flow





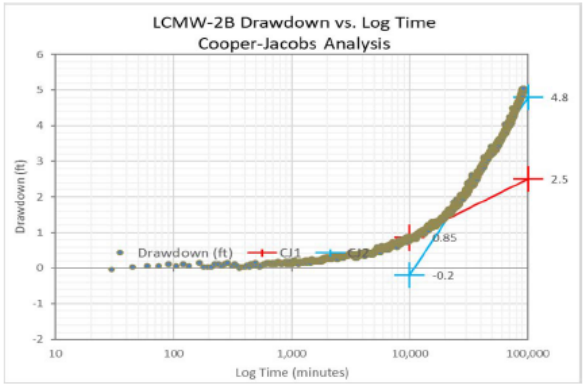
Data Processing (SW)

Water Quality data visualization with Vista-Data-Vision web application

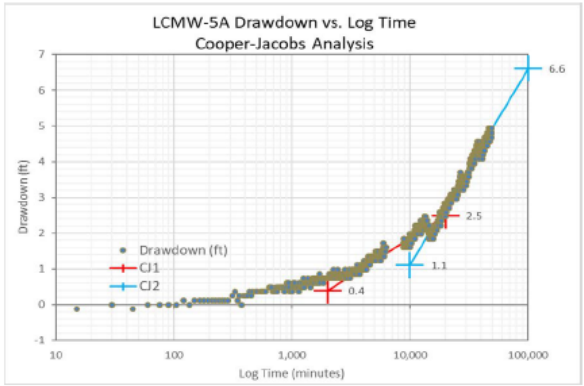


Data Analysis

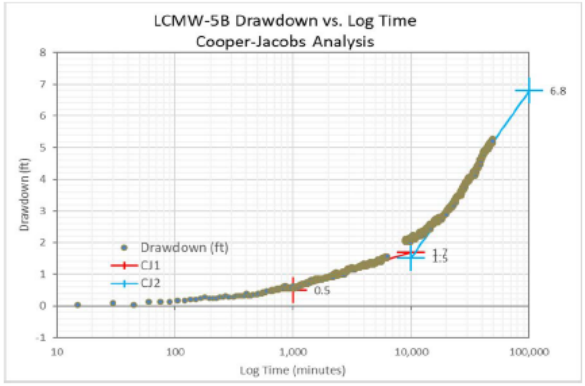
Cooper-Jacobs Hydraulic Transmissivity and Conductivity Estimates



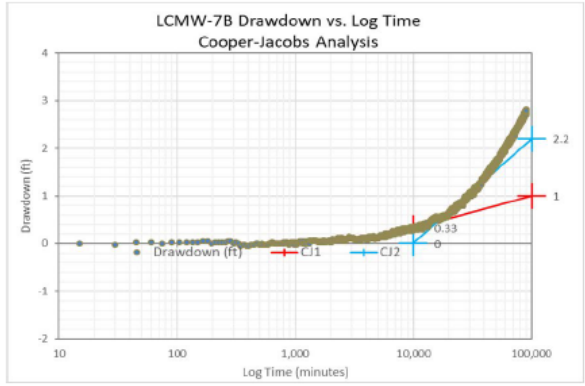
LCMW-2B		
T = 264 *Q / Del s		
Avg Q =	4035.4	
b =	1000	
CJ1		
10,000	0.85	
100,000	2.5	
Del s =	1.65	
T (CJ1) =	86,319	ft2/day
K (CJ1) =	86.3	ft/day
CJ2		
10,000	-0.2	
100,000	4.8	
Del s =	5	
T (CJ2) =	28,485	ft2/day
K (CJ2) =	28.5	ft/day
Slope Break 1@	15,000	minutes
Quality:	3	



LCMW-5A		
T = 264 *Q / Del s		
Avg Q =	4035.4	
b =	1000	
CJ1		
2,000	0.4	
20,000	2.5	
Del s =	2.1	
T (CJ1) =	67,822	ft2/day
K (CJ1) =	67.8	ft/day
CJ2		
10,000	1.1	
100,000	6.6	
Del s =	5.5	
T (CJ2) =	25,896	ft2/day
K (CJ2) =	25.9	ft/day
Slope Break@	12,000	minutes
Quality:	3	



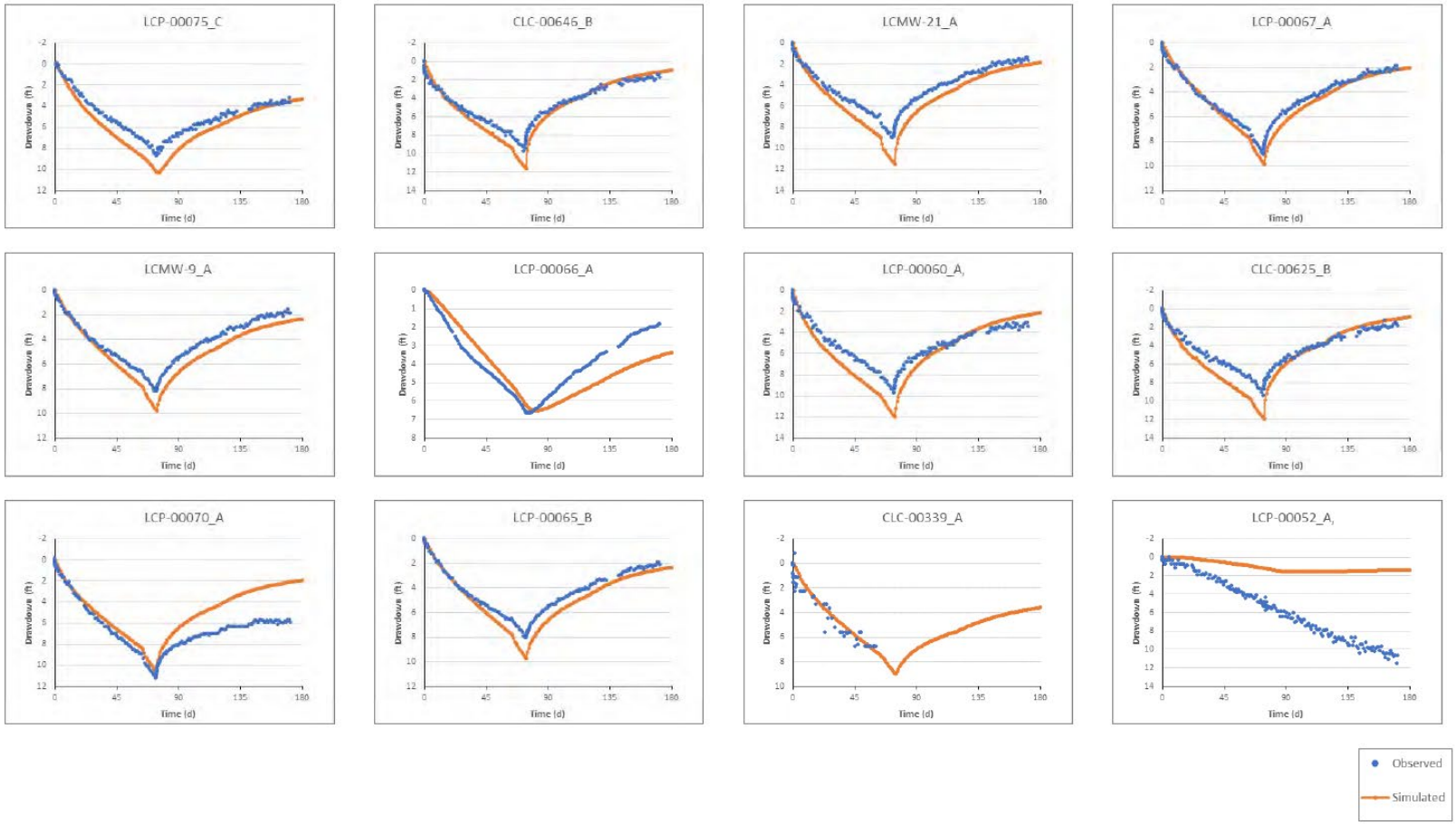
LCMW-5B		
T = 264 *Q / Del s		
Avg Q =	4035.4	
b =	1000	
CJ1		
1,000	0.5	
10,000	1.7	
Del s =	1.2	
T (CJ1) =	118,689	ft2/day
K (CJ1) =	118.7	ft/day
CJ2		
10,000	1.5	
100,000	6.8	
Del s =	5.3	
T (CJ2) =	26,873	ft2/day
K (CJ2) =	26.9	ft/day
Slope Break@	12,000	minutes
Quality:	3	



LCMW-7B		
T = 264 *Q / Del s		
Avg Q =	4035.4	
b =	1000	
CJ1		
10,000	0.33	
100,000	1	
Del s =	0.67	
T (CJ1) =	212,577	ft2/day
K (CJ1) =	212.6	ft/day
CJ2		
10,000	0	
100,000	2.2	
Del s =	2.2	
T (CJ2) =	64,739	ft2/day
K (CJ2) =	64.7	ft/day
Slope Break 1@	15,000	minutes
Quality:	3	

Data Analysis

Model calibrations comparing simulated results to observed drawdown



The Take Away

- Mine dewatering tests are an essential tool for development of numerical models that support the mine permitting process.
- Dewatering tests provide the most value when they approach the scale of planned operational dewatering.
- The larger the test the more defensible the model.
- Such large dewatering tests can only be conducted with the aid of modern data management technology.
- Modern data management allows for reduction of staffing costs.

Comments and Questions

Thank you

Questions?