STATUS REPORT FOR
REVISED OPEN PIT REMEDIATION PLAN
CUNNINGHAM HILL MINE RECLAMATION PROJECT
ABATEMENT PLAN AP-27

prepared by

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prepared for

LAC Minerals (USA) LLC
582 County Road #55
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STATUS REPORT FOR REVISED OPEN PIT REMEDIATION PLAN
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1.0 INTRODUCTION

The revised AP-27 open pit remediation plan (JSAI, 2011) was submitted to the New Mexico Environment Department (NMED), and was conditionally approved during the fall of 2011. The NMED conditional approval required a report in 2014 assessing the effectiveness of the revised remediation plan. John Shomaker & Associates, Inc. (JSAI) was contracted by LAC Minerals (USA) LLC (LAC) to assist with evaluating recommended source control measures, assess the current hydrogeologic conditions of the open pit water body, and determine compliance with Abatement Plan AP-27 (AP-27). A site map of the Cunningham Hill Mine Reclamation project open pit is presented as Figure 1.

1.1 Background

AP-27 (NMED, 2002) includes alternative abatement standards that apply to groundwater outside of the pit area, and permit conditions that include: 1) performance standards (APS-1) based on expected goals with remediation by filling the pit with diverted storm-water, and 2) a contingency plan (APC-1). The performance standard open pit pool sulfate trigger levels were exceeded during 4th Quarter 2010, and contingency plan APC-1 was implemented in 2011 (details can be referenced in JSAI, 2011). APC-1 required 1) re-sampling of the open pit pool, 2) re-calibration of the open pit pool chemistry and transport model, and 3) submittal of a revised remediation plan with schedule. All three tasks were completed in 2011.

1.2 Revised Remediation Plan

The revised remediation plan (JSAI, 2011) calls for implementing source control measures before treatment to reduce sulfate concentrations. Source controls include pH mitigation and prevention of acid wall seeps (AWS) by improving storm-water conveyance. A summary of the JSAI, 2011 proposed schedule is as follows:

- 2012 – Implement Source Control Measures
- 2013 – Monitor Effectiveness of Source Controls
- 2014 – Implement Sulfate Removal

2.0 HYDROGEOLOGIC CONDITIONS

Collected data and observations were evaluated to assess the hydrogeologic conditions, source control measures, and water-quality compliance with AP-27. Data collection includes the following:

1. weekly pit chemistry (field parameters of pH, temperature, and conductance for four different depths in open pit),
2. quarterly pit chemistry (APS-1 monitoring requirements),
3. quarterly sampling of four monitoring wells down gradient from open pit (MW95-53, MW95-54, MW84-7, and MW79-3),
4. water-level monitoring from the open pit and surrounding monitoring wells,
5. on-site weather station data,
6. metered diversions at the Upper Cunningham Gulch diversion channel, and
7. weekly observations and photographs made by LAC Minerals (USA) LLC staff, and observations from site visits by JSAI.

2.1 Hydraulic Containment

The Cunningham Hill Mine open pit is permitted as a pass-through type surface-water system where pit filling with storm water is to cause discharges to down gradient groundwater. The alternative abatement standards in AP-27 are for discharges to groundwater. As discussed in JSAI (2011a), the open pit water-level elevation is currently near equilibrium with surrounding groundwater elevations and discharges little to no quantities of pit water to groundwater.

Water-level data collected during the 4th Quarter 2013 were used to construct the water-level elevation contours shown on Figure 2. Groundwater elevations in the vicinity of the open pit are near the same elevations as the open pit water surface (Fig. 2). The 6,792-ft water-level elevation contour nearly encompasses the open pit, indicating the open pit may currently be a hydraulic sink. Although, the open pit may be discharging to groundwater on the north side, if there is not a complete groundwater divide and a hydraulic gradient exists between the open pit and MW96-65.

The open pit water level has remained around 6,790-ft elevation for the last 10 years (Fig. 3). Water-level elevations in nearby monitoring wells MW95-53 and MW95-54 are slightly higher than the pit level, indicating the pit is locally a hydraulic sink and water is not flowing from the pit towards MW95-53 and MW95-54 (Figs. 2 and 3). Water-level trends in MW95-53, MW95-54, and the pit have generally been similar.

Water-level trends in nearby monitoring well MW96-65, completed in bedrock beneath the waste rock pile and alluvium, differ from trends in the pit, MW95-53, and MW95-54. MW95-53 and MW95-54 have slightly deeper completions, but overlapping screen elevations with MW96-65. Water levels in MW96-65 have declined and departed from the open pit (Fig. 3), indicating a lack of hydraulic communication between these two data points. The current groundwater elevation north of the open pit (6,790 ft amsl) is well below the bottom elevation of the waste rock pile (6,900 to 7,000 ft amsl), providing evidence that potential discharges from the open pit will not cause acid rock drainage (ARD) in the waste rock pile.

2.2 Open Pit Chemistry

AP-27 requires the open pit water to meet surface water quality standards for wildlife (NMED, 2002; Performance Standard CHP-1). Table 1 is a summary of surface water quality data from the open pit and the standards specified in CHP-1. After the heavy precipitation event during September 2013, pH and alkalinity were slightly depressed below the trigger levels for the 3rd and 4th Quarter sampling events (Table 1). All other surface-water constituents met the standard or complied with the trigger level. Hydrated lime was added to the open pit water during November 2013, but it did not fully mix until after the 4th Quarter sampling event and the fall turn over occurred.

The APS-1 performance standard for open pit pool Trigger No. 2 was exceeded during the 4th Quarter 2010 (Fig. 4). During 2010, a 90-day pilot program to buffer pit water and reduce sulfate concentrations was implemented, and sulfate concentrations dropped below 1,200 milligrams per liter (mg/L). Since 2010, sulfate concentrations have gradually increased due to lack of source controls and subsequent input from AWS events. Sampling results from the various depths indicate the open pit water mixes and does not significantly stratify (Fig. 4).

Table 1. Summary of 2013 surface water quality results from the open pit

constituent	unit	CHP-1 standard or trigger level	1st Quarter 2013	2nd Quarter 2013	3rd Quarter 2013	4th Quarter 2013
pH	standard	< 6.0[a]	7.05	7.62	7.19	**5.99**
alkalinity	mg/L as CaCO3	< 20[a]	29	29	**10**	**3**
electrical conductivity	µS/cm	3,600[b] 13,500[c]	2,190	2,140	2,100	2,060
sulfate	mg/L	4,500[b]	1,300	1,420	1,470	1,500
chlorine	ppb	11[d]	0.1	0.23	0.02	0.00
manganese	mg/L	225[c]	0.87	0.66	0.46	1.55
total mercury	µg/L	0.77[d]	<0.00020	<0.00020	<0.00020	<0.00020
total recoverable selenium	µg/L	5[d]	<0.040	<0.040	<0.040	<0.040

[a] trigger level
[b] chronic trigger level
[c] acute trigger level
[d] Wildlife use standard

mg/L - milligrams per liter
ppb - parts per billion
µg/L - micrograms per liter
bold red values outside standard or trigger level range

2.3 Groundwater Chemistry

Groundwater sampling for AP-27 originally included MW84-7 and MW79-3. As part of the conditional approval of AP-27 revised remediation plan, monitoring wells MW95-53 and MW95-54 were added to the groundwater monitoring program (Fig. 1). Other wells in the open pit area, such as PW77-1 and MW96-65, are sampled as part of DP-55.

The open pit alternative abatement standards are related to temporary discharges to groundwater outside the open pit and within a defined area inside the LAC property boundary (NMED, 2002). Table 2 is a summary of groundwater-quality data from monitoring wells adjacent to and down gradient of the open pit, and the alternative abatement standards specified in AP-27. As demonstrated by 4th Quarter 2013 results, monitoring wells down gradient of the open pit comply with AP-27 alternative abatement standards (Table 2).

Table 2. Summary of 4th Quarter 2013 groundwater quality results and AP-27 alternative abatement standards

constituent	unit	AP-27 standard	MW95-53	MW95-54	MW84-7[a]	MW79-3
sulfate	mg/L	1,200	1,060	251	290	36
TDS	mg/L	2,000	1,740	474	765	205
manganese	mg/L	4.0	1.56	0.06	1.70	0.14
cobalt	µg/L	0.20	<0.006	<0.006	0.013	<0.006

[a] results from 4th Quarter 2012; well has been dry since
TDS - total dissolved solids
mg/L - milligrams per liter
µg/L - micrograms per liter

A graph of time-series sulfate concentration trends for the open pit and surrounding monitoring wells is presented as Figure 5. Only MW95-53 appears to follow a sulfate concentration trend similar to the open pit. Monitoring wells PW77-01 and MW95-54 have not shown any significant change in sulfate concentrations over the last 10 years. Sulfate concentrations in monitoring well MW96-65 are related to background conditions below the waste rock pile rather than the open pit (JSAI, 2004).

3.0 SOURCE CONTROLS

The assessment of source controls requires implementation of source control measures and observations from precipitation events. No significant precipitation and storm-water runoff events occurred during 2012 and most of 2013, until a significant event occurred during September 2013. Open pit AWS occurs at two locations: 1) southwest AWS, and 2) northeast AWS (Fig. 1). Both locations are along the Golden Fault fracture zone.

3.1 Open Pit pH Mitigation

Precipitation events that cause storm-water runoff can locally infiltrate fractured sulfide-bearing rock and report as AWS in the pit walls. The AWS discharges to the open pit water surface and suppresses pH and consumes alkalinity. After each AWS event, the open pit pool surface is impacted (4 and 15 ft depths). Mixing of deep and shallow water will commonly neutralize AWS inputs (Fig. 6). After mixing, AWS events during spring of 2005, spring of 2010, and September 2013 consumed all of the open pit pool alkalinity (Fig. 6).

Open pit pH mitigation is required to maintain the surface-water wildlife use standards specified in AP-27 performance standard CHP-1. The best measure of pH mitigation requirement is alkalinity concentrations in the open pit. Past open pit pH mitigation practices (1999 to 2006) solely involved the application of hydrated lime (Fig. 6). The 2010 pilot study involved the use of alkaline groundwater for pH mitigation (JSAI, 2011). The pilot program demonstrated that addition of alkaline groundwater to the open pit pool buffers acidity, builds buffering capacity (Fig. 6), and reduces sulfate concentrations (Fig. 4). Since the revised AP-27 remediation plan was approved, open pit pool pH mitigation was not needed until after the September 2013 precipitation event (hydrated lime was added November 2013).

3.2 Upper Cunningham Gulch Diversion

As discussed in JSAI (2011), repairs to Upper Cunningham Gulch diversion were required to prevent infiltration of storm water from Upper Cunningham Gulch into the Golden Fault zone and formation of southwest AWS (Fig. 1). During 2011, repairs were made to the Upper Cunningham Gulch diversion channel. Inspections after the work was performed revealed the contractor did not install the liner to industry standards. As a result, storm water generated during the September 2013 event infiltrated where the liner was not properly installed, and likely contributed to southwest AWS.

3.3 Open Pit Watershed

Field investigations and observations of storm-water flow paths were made during 2012 and 2013, and the primary issue identified was storm-water runoff along the north side open pit access road. Storm water generated from the western and northern portion of the open pit watershed flows along the north pit access road and infiltrates on the benches and reports as northeast AWS (Fig. 1).

4.0 PROJECT STATUS

4.1 Monitoring

The quarterly monitoring of MW95-53 and MW95-54 has been useful with determining groundwater interactions with the open pit water body. Likewise, data collection and observations after precipitation events have been useful for determining the proper action for source controls.

The requirement for weekly monitoring of field parameters from the open pit water profile depths was established for the past pilot programs, and is not necessary for monitoring source controls. Quarterly monitoring of pit chemistry and measuring field parameters for open pit surface water after precipitation events would be sufficient for managing pH control and determining compliance with AP-27.

4.2 Guest House Well

The revised remediation plan recommended repairing and permitting the Guest House well to use for buffering the open pit water body. A video survey was performed on the Guest House well during 2013 and it was determined the well will need to be replaced. Permitting with the New Mexico Office of the State Engineer to make the Guest House well a supplemental point of diversion to existing water rights is currently in progress. Water rights permitting will require public notice: therefore, no timeline can be established for completing this task.

4.3 Design of Storm-Water Controls

Observations from the September 2013 precipitation event have provided the needed detail to design storm-water controls. LAC is currently contracting reclamation engineers to design additional storm-water diversion and management features within the open pit watershed. Designed storm-water controls will include: 1) replacement liner and low flow collection system for Upper Cunningham Gulch diversion channel, 2) an in-pit storm-water conveyance channel, and 3) a storm-water collection system for the west and north watershed area.

5.0 RECOMMENDATIONS

LAC has been actively implementing the revised remediation plan approved during the fall of 2011. The schedule for implementing source controls had been delayed due to lack of precipitation events to collect data needed to determine how to design source controls. The September 2013 precipitation event provided the data needed for source control design.

Analysis of data from the monitoring program demonstrates minimal discharges from the open pit to groundwater and compliance with AP-27 alternative abatement standards. Therefore, there is no urgency to treat open pit water until source controls are implemented and effective. AWS inputs during the September 2013 precipitation event have consumed the buffering capacity of the open pit water, and there is a need to add alkaline groundwater or hydrated lime for pH mitigation.

JSAI recommends the following tasks to continue implementation of the revised remediation plan:

1. Use water collected from Residue Pile capture wells and RW97-03 to buffer open pit water. These two sources of water were successfully used for the pilot program. With the Guest House well requiring replacement and water rights permitting, this is currently the best option available for pH mitigation and rebuilding buffering capacity in the open pit water. The only other option is to add more hydrated lime which does not create long-term buffering capacity.

2. Revise the open pit water-quality monitoring program by discontinuing weekly monitoring of field parameters and observations, and perform field parameter profile monitoring and observations within 1 week following precipitation events of 0.5 inch or greater recorded at the site weather station. Quarterly monitoring as specified in AP-27 remains the same.

3. Complete engineer designs for fixing the Upper Cunningham Gulch diversion channel repairs and in-pit storm-water controls.

4. Permit and replace the Guest House well as soon as possible. Equip and use the well for pH mitigation and building of open pit water buffering capacity.

6.0 REFERENCES

[JSAI] John Shomaker & Associates, Inc., 2004, Baseline geochemistry of manganese, sulfate, and total dissolved solids in Dolores Gulch, Cunningham Hill Mine Reclamation Project, DP-55, Santa Fe County, New Mexico: consultant's report prepared by John Shomaker & Associates, Inc. for LAC Minerals (USA) LLC, 8 p., figures, appendices.

[JSAI] John Shomaker & Associates, Inc., 2011, Revised open pit remediation plan, Cunningham Hill Mine Reclamation Project, Abatement Plan AP-27: consultant's report prepared by S. T. Finch with John Shomaker & Associates, Inc. for LAC Minerals (USA) LLC, 8 p., figures, appendices.

[JSAI] John Shomaker & Associates, Inc., 2011a, Update and recalibration of groundwater-flow and solute-transport model for predicting potential effects from the Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico: consultant's report prepared by John Shomaker & Associates, Inc. for LAC Minerals (USA) LLC, 8 p., figures, appendices.

[NMED] New Mexico Environment Department, 2002, Re-issued Abatement Plan, AP-27, Cunningham Hill Mine Reclamation Project: permit issued by New Mexico Environment Department Groundwater Quality Bureau, October 31, 2002.

ILLUSTRATIONS

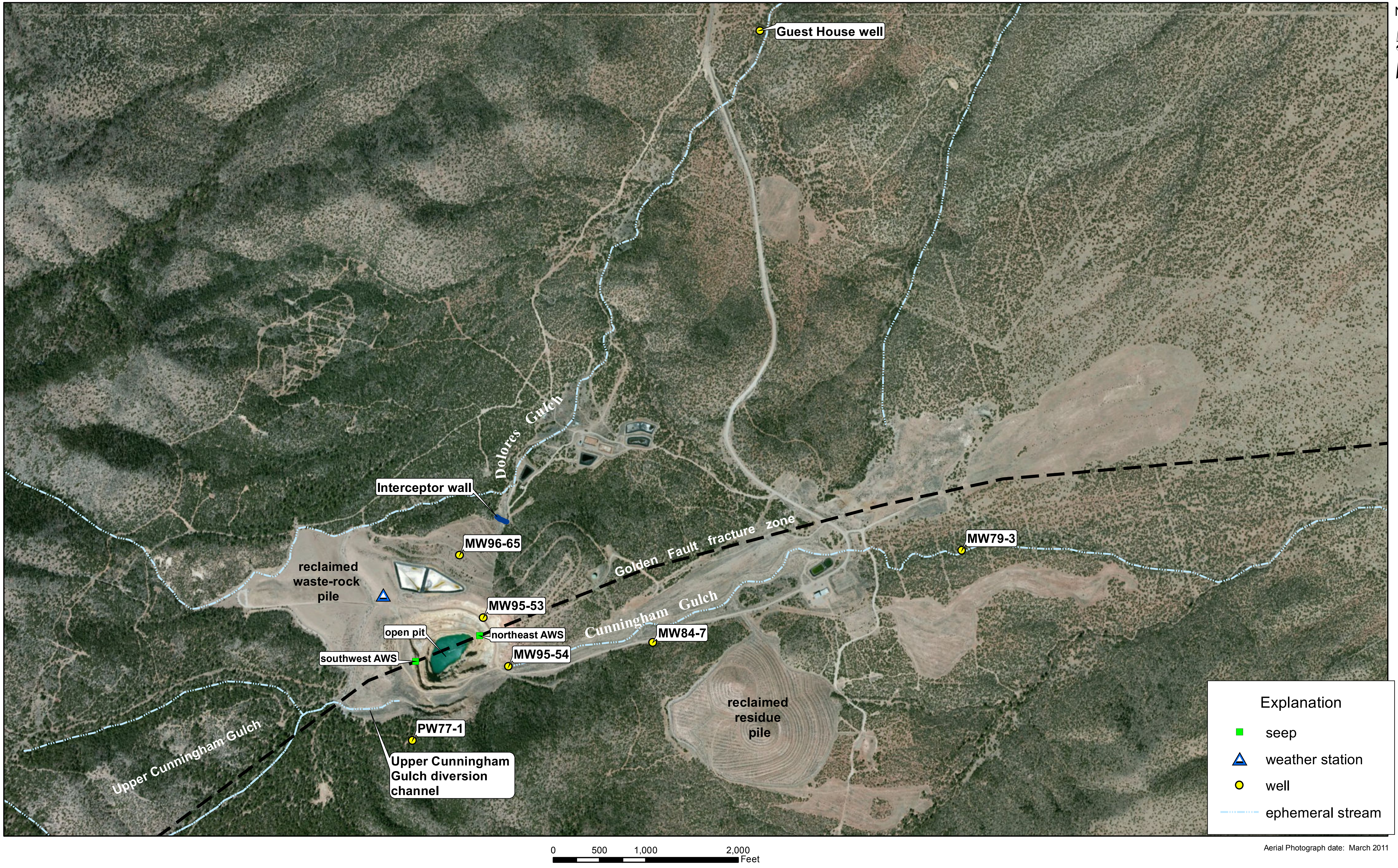

Figure 1. Aerial photograph showing location of Cunningham Hill Mine Reclamation Project open pit, surrounding facilities, and monitoring wells, Santa Fe County, New Mexico.

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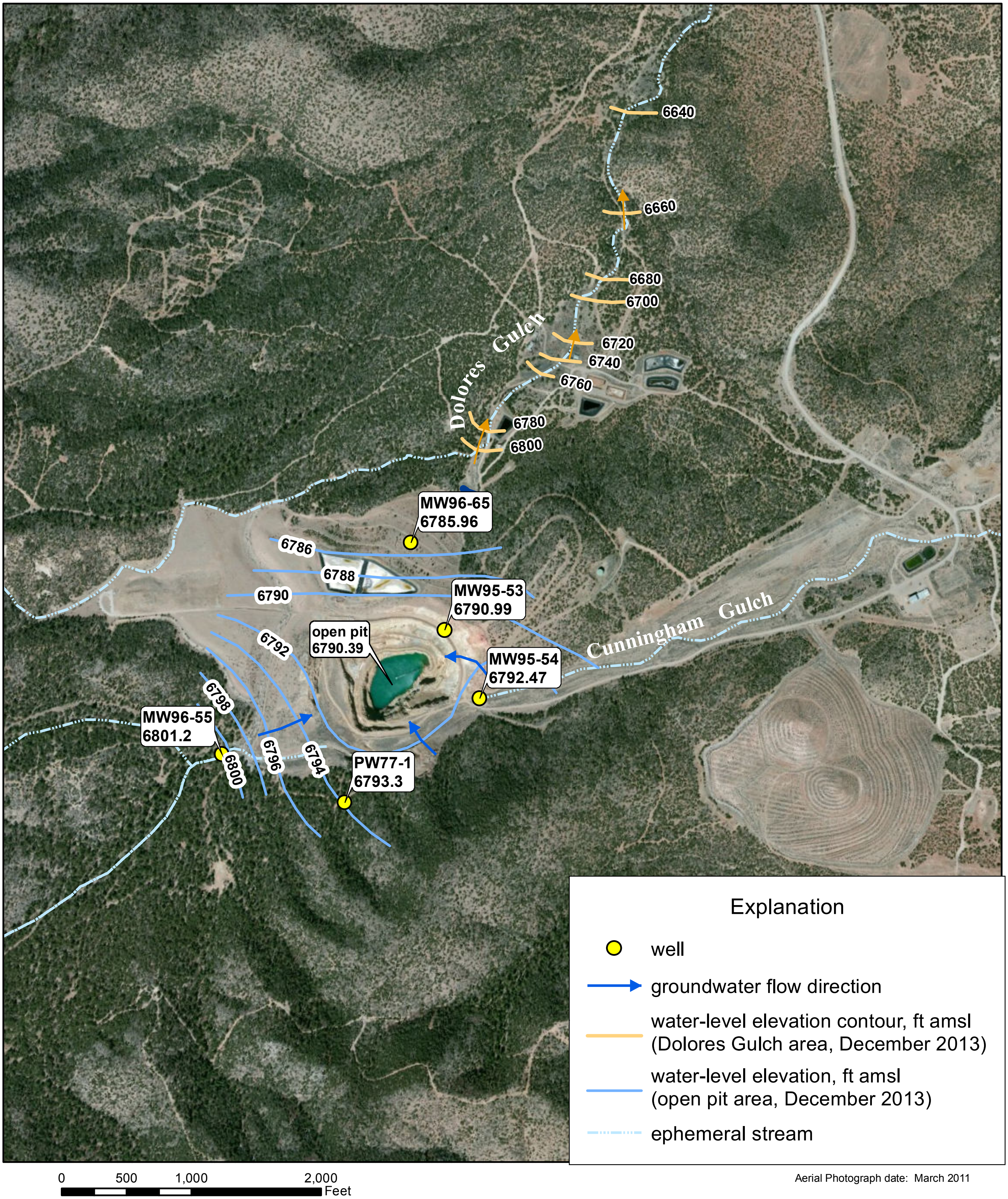

Figure 2. Aerial photograph showing 4th Quarter 2013 water-level elevation contours, open pit, and Dolores Gulch areas, Cunningham Hill Mine Reclaimation Project.

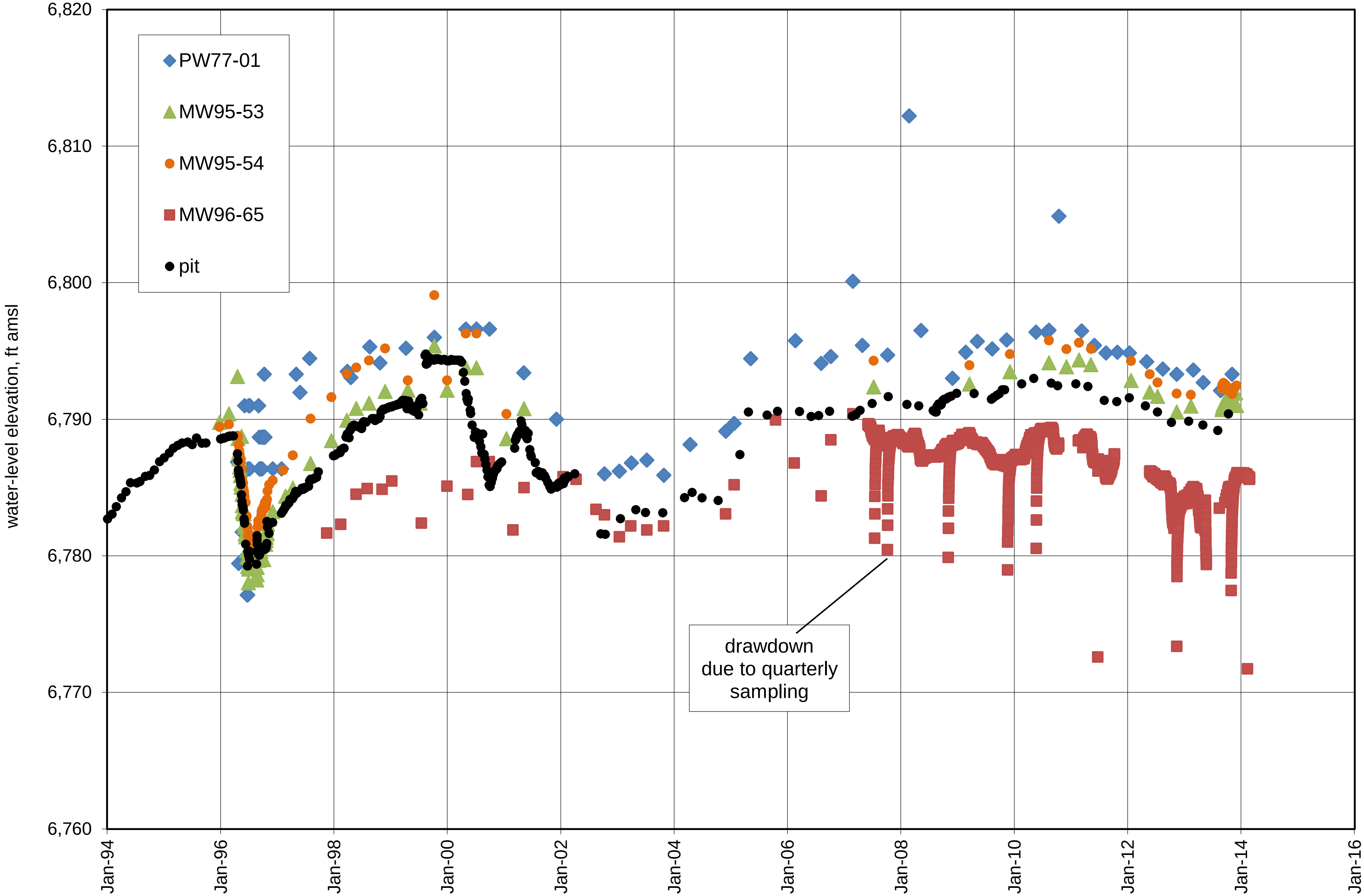

Figure 3. Graph showing observed water levels at the open pit and nearby monitoring wells, from 1994 through 2013, Cunningham Hill Mine Reclamation Project.

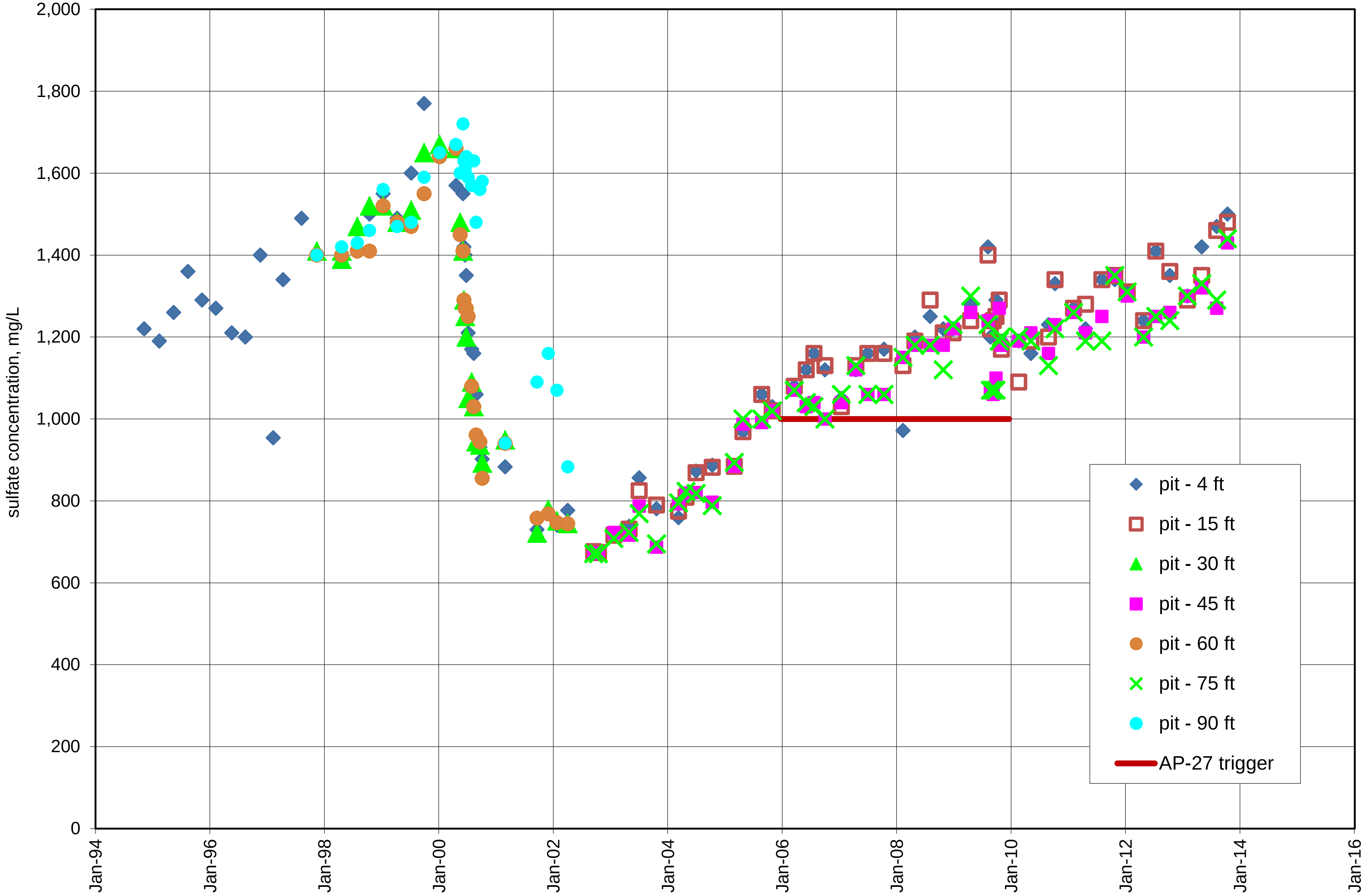

Figure 4. Graph showing sulfate concentrations at the open pit, from 1994 through 2013, Cunningham Hill Mine Reclamation Project.

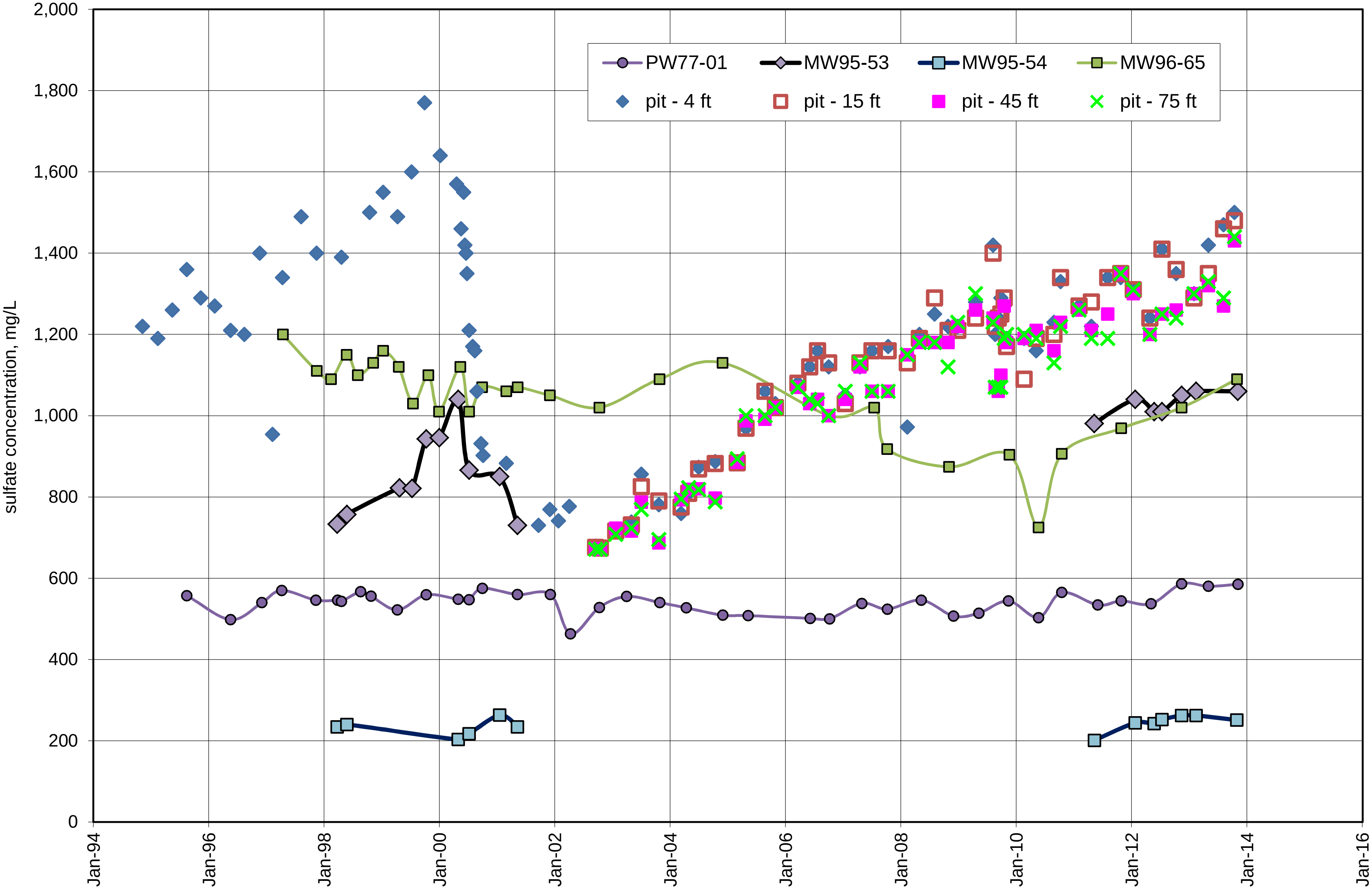

Figure 5. Graph showing sulfate concentrations at the open pit and nearby monitoring wells, from 1994 through 2013, Cunningham Hill Mine Reclamation Project.

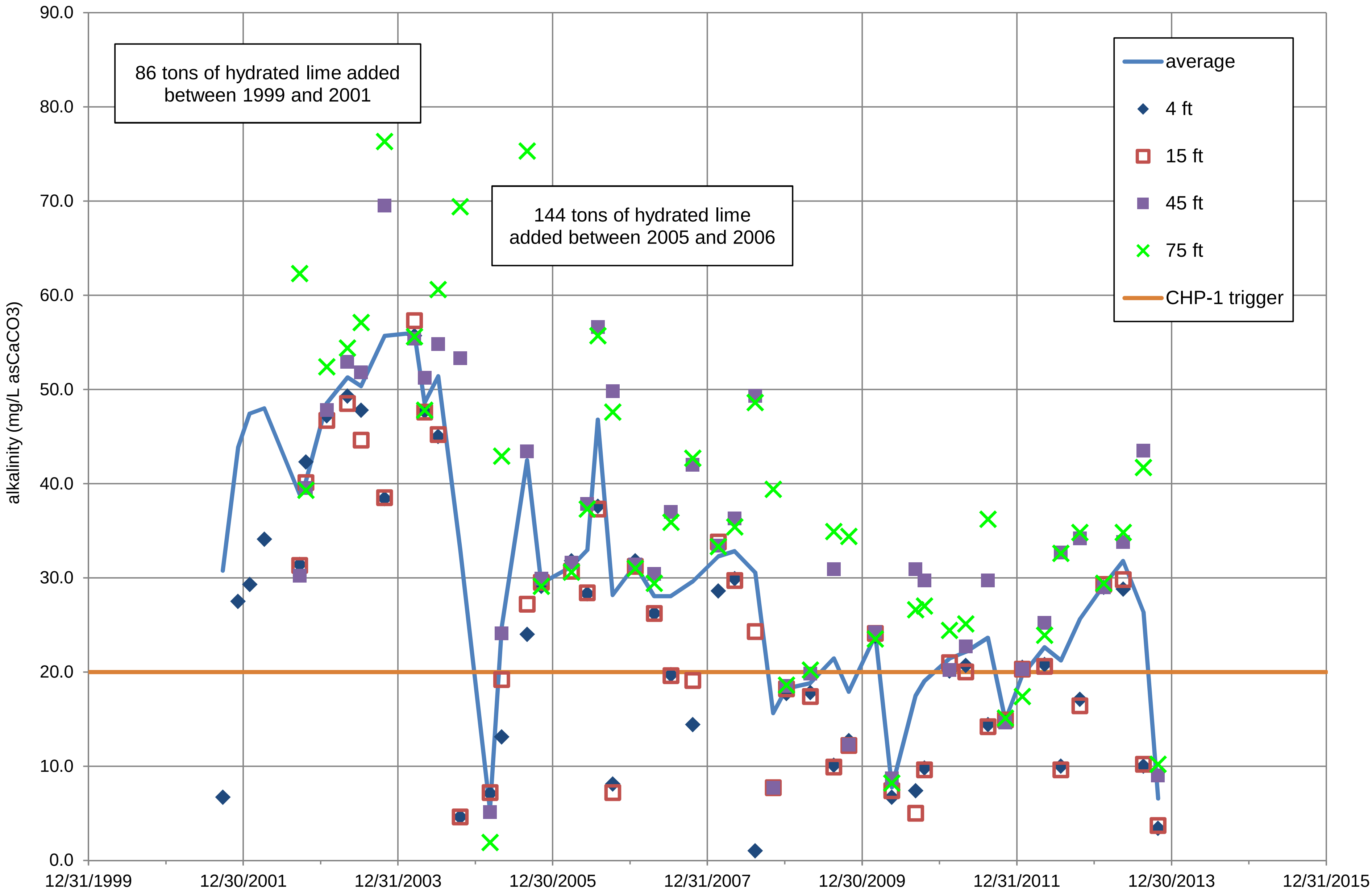

Figure 6. Time-series graph of open pit alkalinity, Cuniningham Hill Mine Reclamation Project.