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McGrane Water Engineering, LLC

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E-Mail [illegible]

July 13, 2015

Mr. JC York
J&T Consulting, Inc.
305 Denver Avenue, Suite D
Ft. Lupton, CO 80621

Via email at:

RE: Loloff Pit - Slurry Wall Assessment

Dear Mr. York:

The Loloff gravel pit mine is located approximately 1 mile east of Greeley, Colorado in Section 4, Township 5 North, Range 67 West of the 6th principal meridian. The site is located approximately ½ mile north of the Poudre River, approximately 5 miles upstream of the confluence with the South Platte River. The pit is currently being mined under permit M-1985-112 by Loloff Construction Company.

J&T Consulting, Inc. (JT) requested that McGrane Water Engineers, LLC. (MWE) determine the hydrologic impacts of installing a slurry wall around the Loloff pit during reclamation. Anticipated impacts include a rise in the water table on the up gradient side of the slurry wall compared to predevelopment conditions and a decline in the water table on the down gradient side. Water level increases to within 10 feet of the surface on the up gradient side of the pit could flood existing structures such as basements or cause water logging and phreatophyte growth. A decline in water levels on the down gradient side could reduce the aquifer saturated thickness and well yields if pumping rates are already maximized.

Results

Using a MODFLOW model with reasonable boundary conditions and aquifer properties, MWE determined that the maximum increase in water levels up gradient from the mine will be approximately 2 feet, and the maximum decrease in water levels down gradient from the pit will be approximately 2 feet. The average depth to groundwater for 79 wells with reported water levels located within the model area (approximately a mile from the pit in all directions) is 16 feet. However, there are several wells located within the up gradient area of influence (greater than 0.5 feet increase) that have reported water levels of less than 10 feet. Table 1 shows the impacted wells located within the area of influence.

Table 1 – Wells within area of Influence of Proposed Slurry Wall

Well Status: Dry, Abandon, Dry, Dry, Dry, Down, Down, Unknown or Abandon

Well Data from Wells Within Area of Influence							Model Results			
Name	Pemit		Well Depth	Rate (gpm)	Reported Depth to Water (ft)	Saturated Thickness (ft)	Max. Change in Water Levels (ft)	Future Depth to Water (ft)	Future Saturated Thickness (ft)	% Change in Sat. Thick (ft)
DOWNGRADIENT WELLS										
VARRA	75865	F	ND	ND	ND	ND	ND	ND	ND	ND
DAVIS FARMS	14960	R	101	1150	31	70	-1	32	69	-1%
BAAB A C	620	W(	45	800	9	36	-1	10	35	-3%
TAYLOR JAMES	223885		44	10	11	33	-1	ND	ND	ND
UPGRADIENT WELLS										
TRUJILLO	23312		25	10	5	20	1	4	21	5%
ORONA	28174		19	20	8	11	1	7	12	9%
PALMA	297435		ND	ND	ND	ND	1	Uncertain	Uncertain	Uncertain
HARRELL ELDON	226878		50	15	16	34	2	14	36	6%
ROTHE	259513		27	20	2	25	1	1	26	4%
TRUYELLO	2947	F	21	400	6	15	1	5	16	7%
HARRELL BRIAN	287278		30	50	ND	ND	2	Uncertain	Uncertain	Uncertain
DILKA	44539		34	25	3	31	1	2	32	3%
VANBEBER	25941		25	50	2	23	1	1	24	4%
WADSWORTH	19472	F	ND	105	ND	ND	1	Uncertain	Uncertain	Uncertain
VANBEBER	16038		25	24	4	21	1	3	22	5%

Three down gradient wells can be expected to experience a decline in water levels of approximately 1 foot. Since well yield is proportional to the saturated thickness, we would expect less than a 5% decrease in the maximum theoretical pumping rate of those wells. We do not believe this is a significant impact.

Based on our modeling, eleven up gradient wells can be expected to have 0.5 to 2 foot increases in water levels. Only one of those wells (Harrell Eldon) has a reported pre-mining water level depth exceeding 10 feet. The rest of the wells either have reported depths to water of less than 10 feet or no recorded level so the depth remains "uncertain." If the recorded well locations and depth to water are correct relative to the pit and if the wells are located near vulnerable structures (homes with basements or excavations), those structures could be vulnerable to rising groundwater resulting from the slurry wall.

Uncertainty

Whether future flooding or water logging will occur depend on numerous factors including: 1) well location relative to the pit and slurry wall; 2) the location and depth of vulnerable structures such as homes with basements; 3) the location, magnitude and timing of well pumping and recharge from precipitation, agriculture, and canal seepage that could also affect water levels; and 4) the location of existing drainage or canals that may intercept rising groundwater. Therefore, there is considerable uncertainty whether there is a real and quantifiable risk of significant impact.

Mitigation

Potential mitigation includes: 1) installing a drain around the slurry wall to minimize any mounding or shadow effect to keep the aquifer at equilibrium 2) or moving or abandoning structures with basements. JT has indicated that the installation of the drain around the slurry wall at other similar gravel pit locations has been successful in mitigating the mounding and shadow effects. The depth, location, and size of a drain will depend on the timing and location of rising water and hydrologic properties of the aquifer.

Recommendations

We recommend:

1. Canvasing the area within the area of influence to confirm well locations and determine whether any basements or structures could potentially be impacted;
2. Evaluating whether the existing monitoring well network is adequate to monitor recovery after the slurry wall is installed, and installing additional wells if necessary;
3. If actual recovery appears to be excessive, utilize the model to evaluate drain locations and designs (depths and size) to mitigate the situation. Intercepted groundwater could be piped down gradient and recharged to prevent impacts to senior water rights.

Hydrologic Setting

Up to approximately 100 feet of saturated sand and gravel make up the alluvial aquifer located within 2 miles of the Poudre River. The stratigraphy of the valley fill and particle size distributions beneath the Poudre River observed in gravel pits was examined in detail by Langer and Lindsey, 1999. The aquifer consists primarily of sand and gravel with minor fine-grained interbeds. The aquifer was evaluated and modeled in detail by CDM-Smith, 2013 to support the Colorado Water Conservation Board's (CWCB) South Platte Decision Support System (SPDSS).

Model Construction

MWE constructed a groundwater model of the alluvial aquifer north centered on the Loloff pit, extending approximately one mile on either side. The model domain is 10,000 feet square on each side, consisting of 100 rows and 100 columns with model 100 foot square model cells. The model includes all of Sections 4 and 5 in Township 5 North, 65 West (6^{th} PM), and the northern half's of Sections 8 and 9. The model also includes the southern half's of Sections 31 and 32 in Township 6 North, 65 West (6^{th} PM). Approximately 15,000 feet of the Poudre River crosses the model from west to east. The river is hydraulically connected to the alluvial aquifer at all times, and the groundwater gradient is from west to east. This is consistent with Figures 4-3 and 4-4 of the South Platte Alluvial groundwater model (CDM-Smith, 2013).

Well Data

Appendix A includes well data from 104 wells located within the model area. The database consists of only active well permits with the exception of a few abandoned wells with usable well data, none of which are included in Table 1. We removed shallow monitoring wells that did not penetrate the alluvium, wells in excess of 119 feet deep thought to be completed in bedrock, and all duplicate well permits. The depth of wells range from 21 to 119 feet and averages 45 feet. The depth to water ranges from 2 to 46 feet and averages 16 feet. The reported