Monitoring and Mitigation Plan

Jordan Aggregates LLC

June 2014

Monitoring and Mitigation Plan

Jordan Aggregates LLC

June 2014

Monitoring and Mitigation Plan

June 2014

Contents

1.0 Introduction 1

1.1 Project Description Summary 1

1.2 Summary of Potential Impacts 3

1.2.1 Potential Groundwater Quality Impacts 3

1.2.2 Potential Impacts from Ice Dams 4

1.3 Monitoring and Mitigation Plan Objectives 4

1.4 Responsibilities for Plan Implementation 5

1.5 Plan Changes and Amendments 5

1.6 Reporting 6

1.6.1 Annual Reporting 6

1.6.2 Flood-Event Reporting 7

1.6.3 Mitigation/Remedial Action Reporting 7

2.0 Hydrologic Setting 8

2.1 Surface Hydrology 8

2.2 Groundwater Hydrology 9

2.2.1 Hydrostratigraphic Units 9

2.2.2 Groundwater Flow Directions 9

2.2.3 Groundwater Interaction with Sand Creek 10

2.2.4 Groundwater Interaction with Nearby Wetlands 10

2.2.5 Pumping Wells 11

2.3 Summary of Modeling Results for Flood Events 11

3.0 Groundwater and Pit Monitoring Program 13

3.1 Monitoring-Well Network 13

3.2 General Sampling and QA/QC Procedures 14

3.3 Pre-Mining Water-Quality Sampling 15

3.3.1 Sampling Frequency and Duration 15

3.3.2 Water-Quality and Hydrologic Parameters 16

3.3.3 Statistical Evaluation of Background Conditions 16
3.3.4 Domestic and Non-Community Baseline Well Sampling 17
3.4 Routine (Quarterly) Sampling 18
3.4.1 Mine-Pit Sampling 18
3.4.2 Sand Creek Sampling 19
3.4.3 Monitoring Well Sampling 19
3.5 Flood-Event Monitoring 19
3.6 Response Actions and Levels 20
3.6.1 Mine-Pit Sampling 20
3.6.2 Monitoring Well Sampling 20
3.6.3 Determining Statistically Significant Increases (SSI) 21
4.0 Mitigation Plan 27
4.1 Mitigation for Groundwater Degradation 27
4.1.1 Evacuation and Treatment of Contaminated Mine-Pit Water 27
4.1.1.1 Conceptual Design and Implementation 27
4.1.1.2 Permit Requirements and Operational Considerations 28
4.1.2 Downgradient Pump-Out System 29
4.1.2.1 Conceptual Design and Implementation 29
4.1.2.2 Permit Requirements and Operational Considerations 29
4.2 Mitigation for Water-Supply Well Impacts 30
4.2.1 Installation of Deeper Wells 30
4.2.1.1 Permit Requirements and Operational Considerations 30
4.3 Mitigation for Channel Bank Erosion of Sand Creek 31
4.3.1 Channel Bank Stabilization 31
4.3.1.1 Permit Requirements and Operational Considerations 31
4.4 Mitigation for Formation of Ice Jams 31
4.4.1 Ice Weakening (Temporary Mitigation) 33
4.4.2 Ice Booms (Temporary Mitigation) 33
4.4.3 Tension Weirs (Temporary Mitigation) 34
4.4.4 Installation Steel or Concrete Piers (Permanent Mitigation) 34
5.0 References 37

List of Tables

Table 3-1 Existing and proposed monitoring locations 23
Table 3-2 List of Analytes and Methods 24
Table 3-3 List of Field Parameters 25
Table 3-4 Quarterly Sampling Analytes 26
Table 4-1 Summary of Mitigation Measures 36

List of Figures

Figure 3-1 Exiting and Proposed Monitoring Wells

1.0 Introduction

This Monitoring and Mitigation (Plan) describes the location, methods, and reporting requirements for environmental monitoring of the proposed Jordan Aggregates Sand and Gravel mine (Site), located in Sand Creek Township near Jordan, Minnesota. In addition to monitoring, various response actions and mitigation procedures are described in response to the data collected during monitoring and to other conditions that may ensue at the Site. The location of the Site and surrounding features are shown on Figure 1.

Potential environmental impacts were identified in the draft and final Environmental Impact Statement (EIS) for the proposed Jordan Aggregates Sand and Gravel mine (November 25, 2013). Scott County is the Responsible Governmental Unit (RGU) responsible for the EIS. Based on comments received on the Final EIS from various regulatory agencies and the public, the Scott County Board deemed the Final EIS to be inadequate in three areas: addressing the issue of potential ice jams and the proposed mitigation of that, addressing the potential for permanent incursion of Sand Creek into the mine pit and of monitoring and mitigation for impacts to the quaternary aquifer from periodic flooding of the deep mine pit from Sand Creek and requested that new monitoring and mitigation plans be developed that would address the deficiencies identified in these monitoring and/or mitigation plans developed by the project proposer; Jordan Aggregates LLC. Scott County agreed to work with regulatory agencies and other stakeholders to draft a revised Plan.

If the proposed project is approved through the EIS process, this Plan is intended to provide the basis for monitoring and mitigation that will be established by the Scott County Interim Use Permit (IUP) for the Site. It may be amended or otherwise revised as part of the IUP permitting process.

1.1 Project Description Summary

Jordan Aggregates, LLC proposes operating a sand and gravel mine at the property located at 17825 Valley View Drive in Sand Creek Township, Scott County, Minnesota, described as the southwest quarter of Section 8 and the northwest quarter of Section 17, Township 114 North, Range 23 West. The mine will encompass 84.7 acres and is anticipated to operate for approximately 25 years. Mined areas will be reclaimed using on-site overburden materials and imported fill.

The purpose of the Project is to mine aggregate resources from the Site, process the mined aggregate for commercial sale, and reclaim portions of the mine with overburden materials from within the mining limits as well as clean soil fill materials imported from off-site. The mining and processing portions of the Project will produce sand and gravel aggregate products that are in demand for construction and development projects in the region. The mining operations may in the future include operation of a

temporary asphalt plant and portable concrete mixing plant with receipt of waste concrete and asphalt to be crushed and recycled providing that applicable rules and regulations can be demonstrated to be met.

Within the mining limits at the Site, sand and gravel will be excavated down to the water table, which is anticipated to be at an elevation of approximately 720 feet above mean sea level (msl). Based on site topography, this results in excavation depths ranging from 4 to 49 feet. In the center of the site, excavation will extend below the water table to an approximate elevation 600 feet above msl or to within ten feet of the top of bedrock, should bedrock be encountered above an elevation of 600 feet above msl, leaving an open expression of the aquifer forming a pond of approximately 36 acres and 115 feet deep. Along the perimeter of the mine, excavation slopes will be graded to a slope of 1.5H:1V.

A mining and phasing plan, as described in the EIS, proposes the excavation depths within the proposed mining boundary and provides a general phasing layout for the operation. Mining will begin in the southern half of Phase 1 and proceed within Phase 1 until the appropriate grades for the processing plant are achieved. Mining in Phase 1 is expected to involve excavating a moderate amount of material and smoothing out the terrain, mainly for the purpose of preparing the plant site.

Mining will then proceed down to the base grade of an approximate elevation 720 feet above msl (but not below the water table) and then brought back up to the processing plant grades using a combination of on-site overburden and imported reclamation fill. While mining is occurring, overburden from within the Pond Phase and nearby areas will be stripped and transported on-site for use as reclamation fill. Base grades are then established, at approximately 720 feet above msl, with overburden from the pond mining phase used for reclamation. Imported material will not be used to reclaim below the 100-year flood plain (elevation 732.5 feet, msl). Excavated soils and imported soils to be used for site reclamation will be required to be stockpiled outside of the 100 year floodway and protected from erosion to preclude sediment impacts on Sand Creek.

The majority of the project site is below the 100-year flood plain. During mining, the process plant area will be brought to a grade above the 100-year flood plain and after reclamation the northern portion of the site will be graded such that it will be above the 100-year flood plain. Since virtually the entire site will be excavated below the 10 and 100 year flood elevation, reclaimed areas must be immediately compacted and vegetation established to prevent impacts to Sand Creek from sediment erosion into the Creek during flood events. A detailed reclamation soil stockpiling, placement and vegetation plan will likely be provided as an IUP application requirement and is not a part of this Monitoring and Mitigation Plan.

The aggregate resources on site consist of unconsolidated sand and gravel; therefore no blasting or dewatering will be required. Aggregates above the water table will be excavated and transported on-site

using common heavy construction equipment such as excavators, loaders, haul trucks, and conveyors. Below the water table, a barge-mounted clamshell-type excavator will be used.

Aggregate processing is expected to include crushing, screening and washing of natural aggregate products, as well as recycled concrete and asphalt in order to produce desirable gradations and aggregate products. Temporary portable hot mix asphalt and/or concrete batch plants may be operated on the Project Site through a separate Interim Use Permit applied for annually to provide material for area construction projects.

1.2 Summary of Potential Impacts

The EIS identified two areas of primary concern for the project that require monitoring and potential mitigation: impacts to groundwater quality and impacts associated with the formation of ice dams on Sand Creek. Alternatives to Site design and operation that would reduce the risk of impacts for these two conditions were not identified in the EIS. Both areas of concern are the result of the proposed mine pit's location in the flood plain of Sand Creek. Periodic flooding of the mine pit by Sand Creek during the operational life of the mine was found to be highly likely, due to the proximity of the mine pit to Sand Creek and the flood frequency. Based on the conceptual alternatives for the end uses of the Site, these conditions would likely also occur after mining at the Site is completed.

1.2.1 Potential Groundwater Quality Impacts

An aspect of the proposed mining at the Site that is unique in Minnesota is the excavation of a pit that will likely be inundated by stream flooding multiple times during and after mining operations. Portions of the mine pit will be excavated well below the water table in the Quaternary sand-and-gravel (water-table) aquifer. Flood water from Sand Creek will periodically overflow its banks and inundate the mine pit. Flooding will most likely occur during spring snowmelt but flooding of Sand Creek later in the year has occurred in the past. The types of contaminants and their concentrations in flood water from Sand Creek are not well-documented. It is also not known if the inundating flood water will displace groundwater in the mine pit, mix with groundwater in the mine pit, or stratify on top of the groundwater. It is also not known whether or not contaminants may adhere to sediment particles and settle to the bottom of the mine pit where they may concentrate.

Groundwater-flow and solute-transport modeling of the proposed mine pit, performed as part of the EIS, showed that mine-pit water will migrate in the Quaternary sand-and-gravel aquifer to the north, towards riparian wetlands and the Minnesota River. One and possibly two existing non-community public water supply wells and one residential well were shown to be subject to contamination especially resulting from flood events. One well (SCALE facility well) was found to have a greater potential for contamination from flood waters that may inundate the mine and migrate into the water-table aquifer. The modeling

predicted that there is a potential for aquifer water-quality degradation in areas north of the mine pit, which might limit future use of the Quaternary sand-and-gravel aquifer as a water supply.

1.2.2 Potential Impacts from Ice Dams

As a surface expression of the water table, ice will typically form during the winter months. During flood events in the spring, flood waters from Sand Creek will inundate the mine-pit area for several days to weeks. The proposed project includes the construction of a spillway and outlet pipe between Sand Creek and the Jordan Aggregates mine to provide for controlled flow of flood waters into and out of the mine during the rise and recession of Sand Creek flood waters. Providing controlled movement of flood waters between Sand Creek and the mine is intended to mitigate the potential for berm failure during flooding and re-channelization of Sand Creek through the mine. The spillway is proposed to be located on the mining boundary at a natural saddle location between the mine and Sand Creek. The spillway crest will be placed at elevation 726.0 feet, msl, bounded by natural ground at or above elevation 728.0 feet, msl. The spillway length is approximately 200 feet. The spillway drops into the mine on a 5H:1V sloped surface that terminates in a two-foot deep stilling basin. The vertical drop from the spillway crest to the mined bench on the east side of the mine pit is approximately four feet.

An unresolved issue from the EIS is the potential for the formation of ice dams (or jams) in the proposed spillway from ice on the surface of the mine pit and/or the movement of ice and debris through the inundated mine area from upstream areas. Ice jams at the 173rd Street bridge over Sand Creek (northeast and downstream of the Site) have occurred in the recent past and are a known hazard. If the spillway becomes partially or completely plugged by ice and debris during flood stage recession, there exists the possibility that flood water will overtop the constructed berms, resulting in erosion, which may lead to establishment of the Sand Creek channel through the mine-pit area. In addition, large chunks of pond ice and floating debris that flow through the spillway could further contribute to ice-jam formation at the 173rd Street bridge.

1.3 Monitoring and Mitigation Plan Objectives

The objectives of this Monitoring and Mitigation Plan are to:

- characterize the nature and distribution of water-quality parameters within the mine pit before, during, and after inundation by flood water;
- monitor short- and long-term changes in groundwater levels near the proposed project;
- monitor the water quality of groundwater in the Quaternary sand-and-gravel (water-table) aquifer at locations upgradient of the mine pit; directly downgradient (and adjacent to) the mine pit; and along the northwest (downgradient) Site boundary;

- monitor the water quality in the upper Wonewoc-Tunnel City (formerly Franconia-Ironton-Galesville) aquifer downgradient of the mine pit and establish a statistically reliable pre-project water-quality condition;
- provide an alternative water supply for private and community wells impacted or potentially impacted by the project;
- monitor ice and debris migration and ice-jam formation during flood events where ice is present and provide methods for long-term mitigation of ice-jam formation to prevent overtopping of the berms;
- identify monitoring actions in response to changes in water-quality conditions;
- identify alternative mitigation actions and approximate costs for preventing and/or remediating degradation of the aquifers if contamination from the mine pit occurs.

With regard to mitigation and remedial actions, it is not possible to include all of the potential actions or alternatives that might be undertaken in the event that monitoring discloses the onset of aquifer degradation. However, it is the intent of this Plan to characterize the most likely alternatives in order to estimate their cost of implementation so that appropriate financial assurances can be put in place.

1.4 Responsibilities for Plan Implementation

This Plan, if adopted, will be the responsibility of the project proposer to implement. The project proposer will be required to report the findings of the monitoring to Scott County in accordance with schedules outlined in the Plan. The project proposer is obligated to report, in a timely manner, any data or information that indicates that state or federal drinking water standards are being exceeded. This Plan should not be construed as a substitute for monitoring or reporting as required by any permits but it may be included as part of other permits, as agreed to by the permit-issuing entity.

1.5 Plan Changes and Amendments

This Plan should be reevaluated periodically as data are collected and a better understanding of the operations and potential impacts is developed. Some of the water-quality issues associated with flooding of the mine pit are the result of the absence of site-specific data on how flood waters affect mine-pit water quality. Detailed monitoring of the effects of flooding on the water-quality of the pit and aquifers may show that changes to the Plan are warranted. Such changes should be evaluated after sufficient supporting data are collected.

During mining operations, monitoring equipment may be inadvertently damaged or unforeseen changes in operations may require moving a monitoring location. All damaged monitoring locations should be fixed or otherwise replaced promptly and reported to Scott County within 30 days of first learning of

damage. Requests and justification to move or otherwise change monitoring locations should be presented to Scott County for approval.

1.6 Reporting

1.6.1 Annual Reporting

A monitoring report shall be prepared annually and submitted to Scott County by February 1 of each year. The report shall include the following:

- description of all monitoring activities for the past year, include dates of monitoring and location of monitoring points;
- description of any irregular or missed sampling events and/or other issues of deviation from the monitoring plan;
- narrative description of mining activities for the year, including changes in pit extent/depth, soil stockpiling, sources of stockpiled material; inventories; structures (built, moved, demolished, or additions), and cement and/or asphalt plant operations;
- table summarizing import and export of soils and other materials on a quarterly basis;
- description of flood events, if any;
- monthly pumping rates for any groundwater withdrawals for which a Water Appropriations Permit is required;
- tables that list the results of all laboratory and field monitoring results, including QA/QC qualifiers (table should be inclusive of previously collected data to-date), and comparison to applicable drinking water standards;
- time-series plots of all field and laboratory water-quality data;
- table of measured groundwater levels and mine-pit water levels, to date, including depth to groundwater, elevation of ground surface, elevation of measuring point, and calculated static-water level elevation in well;
- map of potentiometric surface of the Quaternary aquifer for each regular monitoring period;
- description of maintenance actions performed on the spillway and associated structures;
- narrative of QA/QC evaluations on laboratory data and discussion of irregularities, if any;
- calculation of statistical data for water-quality (as described in this plan); and
- recommendations for changes to monitoring for the upcoming year.

The annual report shall be submitted in electronic (pdf) format and shall include electronic copies of laboratory reports. Water-quality and water-level data shall also be submitted in Excel spreadsheet format.

1.6.2 Flood-Event Reporting

If flooding of Sand Creek inundates the mine-pit, special monitoring procedures are to be implemented, as described in this Plan. These special procedures require more frequent sampling and rapid turn-around analysis, as well as reporting. Data collected after a flood event shall be submitted to the County within three days of receipt and shall also be incorporated into the Annual Report.

1.6.3 Mitigation/Remedial Action Reporting

Additional reporting may be required if mitigation or remedial actions are implemented. Reporting of these data and information shall be incorporated into the Annual Report, unless a different format is required by the County or other regulatory agencies.

2.0 Hydrologic Setting

This section summarizes the hydrologic and geologic setting and the conceptual understanding of groundwater flow at the Site. This information is also presented in the EIS in greater detail but is included here to provide a technical framework for the proposed monitoring procedures.

2.1 Surface Hydrology

The Site is located in the lower watershed of Sand Creek; a tributary of the Minnesota River. The Sand Creek watershed has a drainage area of 274.3 square miles at its confluence with the Minnesota River. The Site is adjacent to and north of Sand Creek, approximately 8.8 miles upstream from the confluence of Sand Creek and the Minnesota River. The Site is approximately 1.7 miles downstream from where Sand Creek flows beneath Highway 169 at Jordan. The total watershed drainage area of Sand Creek at the Project Site is approximately 236.3 square miles.

Flow discharge in Sand Creek in the vicinity of Jordan and the Site is seasonally highly variable, with the largest flows occurring during the spring and early summer. Winter base flows at Jordan on average have been reported to be about 1.8 cubic feet per second (cfs) but the stream may be gaining further downstream as it approaches the confluence with the Minnesota River. The relationship between the elevation of the water table and the water-surface elevation of Sand Creek adjacent to the Project Site suggests that it may be a losing stream along this reach.

The mean discharges of Sand Creek at Jordan for the 10- and 100-year flood recurrence intervals are 5,019 cfs and 8,894 cfs, respectively. The 100-year flood plain elevation of Sand Creek at the Site is at approximately 732.5 feet above mean sea level (msl). The 10-year flood plain elevation is only slightly lower (731.5 ft msl). A flood control spillway is proposed to be constructed at Elev. 726 feet, msl at the Site into the natural berm separating the mine and Sand Creek. Thus, it can be expected that during a 10 and 100-year flood event, floodwater will enter the mine-pit area through the spillway and the mine will be inundated with flood waters from Sand Creek. Because the proposed spillway is two feet below stream bank elevation flooding into the proposed pit is expected to occur more frequently than overland flooding would have occurred but no projected frequency for this occurrence has been determined. As flood waters recede, water from the mine-pit area at the Project Site will flow back into the Sand Creek channel through the spillway to an elevation of 726 feet, msl, then through a concrete culvert to Elev. 722 feet. The remaining flood water that does not flow back into Sand Creek will infiltrate into the ground.

Valley View Road, along the northwest side of the Site, is constructed on a grade that is above the 100-year flood elevation. Flood waters during a 10- and 100-year flood event are not expected to encroach northward onto Valley View Road.

2.2 Groundwater Hydrology

2.2.1 Hydrostratigraphic Units

Because the Site is situated in the Minnesota River valley, some of the upper regional bedrock units have been eroded away by the ancestral River Warren, which flowed approximately through the modern-day Minnesota River valley drainage during the end of the Pleistocene. At the Site, all units above the St. Lawrence Formation (including the Prairie du Chien Group and the Jordan Sandstone) are absent. The St. Lawrence Formation is present only in the southern portions of the Site – the Tunnel City Formation (formerly the Franconia Formation) is the uppermost bedrock on the northern part of the Site. The elevation of the bedrock surface varies from approximately 670 feet, msl in the southwest corner of the Site to 570 feet, msl at the north end of the Site.

The St. Lawrence Formation in the area of the Project Site is characterized by dolomite-cemented, very fine-grained sandstone and siltstone, with some interbeds of shale and dolostone. In full section, the St. Lawrence Formation is 55 to 80 feet but at the Site it is about 0 to 20 feet thick.

The Tunnel City Formation is the uppermost geologic unit that makes up the Tunnel City- Wonewoc aquifer (formerly the Franconia-Ironton-Galesville aquifer). At the Site, the Tunnel City Formation is estimated to be 120 to 140 feet thick and composed primarily of shale. In much of Scott County, the Tunnel City-Wonewoc aquifer is a very poor producer of water to wells but where it is the uppermost bedrock, secondary permeability features (primarily pressure relief jointing) makes this aquifer a viable water supply for domestic wells and small community wells. Some residential wells in the vicinity of the Site have been installed in the Tunnel City-Wonewoc aquifer.

The uppermost hydrostatigraphic unit (in which the water table is present) is composed of highly permeable sand and gravel deposits, up to 70 feet thick, which are part of river terrace deposits of the Minnesota River. North of the Site, these deposits increase in thickness up to 150 feet within the ancestral stream channel of the glacial River Warren. Areas of clay silt loam floodplain deposits up to 20 feet thick are present in the upper horizons of the surficial deposits in lowland areas near Sand Creek and in the area to the northwest of the Project Site between Valley View Drive and the Minnesota River.

2.2.2 Groundwater Flow Directions

The Minnesota River is the regional discharge zone for all aquifers in the area (with the exception of the deep Mt. Simon-Hinckley aquifer). Therefore, the dominant groundwater flow direction in the aquifer system is northwest, toward the Minnesota River. Based on water-level measurements in piezometers and wells for August 2009 (McCain and Associates, Inc. 2009), the elevation of the water table at the Site is approximately 720 feet, msl. The horizontal hydraulic gradient of the water table is approximately 0.0025, which is relatively flat and indicative of a highly transmissive sand-and-gravel surficial aquifer.

The entire Minnesota River valley is an area where deeper groundwater flows both laterally to the Minnesota River and upward from deeper bedrock aquifers to the shallow surficial aquifer (i.e. it is an area dominated by upward vertical hydraulic gradients). These upward vertical gradients become greater near the Minnesota River and underneath the River, groundwater flow can be expected to be nearly vertical and upward. Based on a comparison of static water elevations in the two Tunnel City-Wonewoc wells at the Project Site (the Greenhouse Well and the House Well, both situated near the center of the site), there are moderate vertical upward gradients – approximately 0.004 – between the upper Tunnel City-Wonewoc aquifer and the water table.

2.2.3 Groundwater Interaction with Sand Creek

In general, streams generally are losing (i.e. stream water flows into the water-table aquifer) in headwater reaches and gaining (i.e. groundwater flows into the stream) near the stream mouth. However, there are several factors that can cause a deviation from this generality: local geologic conditions; seasonal variability; and stream-channel morphology. Stream-flow data for Sand Creek indicates that Sand Creek is a losing reach in the vicinity of the Project Site.

Hydrograph data from stream monitoring reports by Metropolitan Council Environmental Services for 2003 and 2004 show flows at or near zero during base flow conditions along the reach of Sand Creek adjacent to the Site, which indicates that Sand Creek receives negligible groundwater inflows in this area. Discharge measurements by the USGS (Mitton et al., 2003) show that the stream flow in Sand Creek changes from 1.8 cubic feet per second (cfs) in downtown Jordan. Further downstream, Sand Creek is expected to become gaining with base flows in the range of 14 cfs.

The surface-water elevation of Sand Creek under typical, non-flood conditions is in the range of 724 to 726 feet, msl. Typical water-table elevations, as measured by piezoemeters and monitoring wells near Sand Creek at the Site are approximately 722 to 723 feet, msl. These elevation relationships further indicate that Sand Creek is not a gaining stream along this reach and may naturally be a losing steam. But because the elevations of water table and stream are only a couple of feet different (at most), changes in the elevation of the water table would be expected to have some small change in the amount of stream loss from Sand Creek. For example, if the water table dropped underneath or next to Sand Creek, there would be a change in the moisture content or pore pressures in the sediments which would provide the hydraulic potential for increased stream losses. These losses may not be measurable and would only be a factor in the winter when base flow conditions are at their lowest.

2.2.4 Groundwater Interaction with Nearby Wetlands

There are several wetland areas north and northwest of the Site, between the Minnesota River and Valley View Road. Some of these wetlands have water-stage elevations that are above the water table,

indicating perching conditions on fine-grained deposits such as silt and clay. There are some wetlands that appear to be surface expressions of the water table, due to their depth. The perched wetlands may provide some recharge to the aquifer system but the amount is negligible compared to the effects of regional upwelling of groundwater in this discharge area. For those wetlands that are surface expressions of the water table, groundwater from the Site can be expected to discharge, flow under, or flow through the wetlands. These wetlands perform the same function as the Minnesota River – they serve as groundwater discharge features.

2.2.5 Pumping Wells

Twenty four (24) water supply wells were identified near the Site, include 19 domestic wells. Five other wells include: a well owned by the Metropolitan Mosquito Control District; the Juvenile Alternative Facility well; and two wells at the SCALE training facility. The majority of these wells are completed in the surficial aquifer. There are also two wells at a homestead on the Project Site that are completed in the upper Tunnel City-Wonewoc aquifer (the Greenhouse Well and the House Well). Two residences in the vicinity recently replaced their surficial aquifer wells with new wells complete in the Tunnel City-Wonewoc aquifer.

Domestic wells generally are not pumped frequently or for long duration and have an insignificant effect on groundwater flow conditions. The non-domestic wells pumped at the following average rates:

- Metropolitan Mosquito Control District Well (Unique Well No. 474684): 20 gpm
- Juvenile Alternative Facility Well (Unique Well No. 249319): 40 gpm
- SCALE building water supply Wells (Unique Well No. 235532): 50 gpm (combined)
- SCALE training exercise Well (Unique Well No. 753654): 0 gpm

The above rates are similar to those used in the McCain and Associates, Inc. (2009) evaluation for the Jordan Aggregates EAW with one exception – this evaluation assumed that the SCALE training exercise well was only used sparingly. McCain and Associates, Inc. (2009) assumed an average rate of 300 gpm that is not reflective of the average pumping rate of the well.

2.3 Summary of Modeling Results for Flood Events

A groundwater-flow model was developed and calibrated for the Site as part of the EIS. This model was used to predict the effects of flood inundation of the mine pit by Sand Creek on groundwater levels and groundwater flow direction. The flow model was also used in conjunction with a solute-transport model to predict where inundated pond water would migrate to in the groundwater system following a flood. This modeling assumed: (1) complete inundation and displacement over its entire depth of groundwater by flood water in the mine pit and (2) a non-reactive, non-degrading tracer to track the movement of the water in the aquifers.

The model predicted that once inundated, flood waters would recede in the mine pit to within a foot of pre-flood levels in approximately 180 days, with the majority of that drop taking place within the first 60 days. The effect of flooding on groundwater levels was predicted to be very localized and the effect on groundwater flow direction and rate was small. The most notable change with the presence of the pit is that seepage water would flow slightly more northerly and may flow towards the SCALE facility wells.

The model predicted that pit water would migrate in the sand-and-gravel aquifer to the northwest Site boundary within 180 days and would linger for at least 2 years. Within 5 years of a flood event, the pit water would have mostly migrated northwest (downgradient) of Valley View Road and the Site.

The model predicted that a small (but possibly detectable) amount of pit water would migrate downward into the upper portion of the Tunnel City Group and then migrate downgradient and back up into the sand-and-gravel aquifer northwest of the Site. The model did not predict any movement of pit water down into the underlying Wonewoc Formation.

In summary, inundation of the mine pit by flood water may result in downgradient degradation of the water quality in the sand-and-gravel aquifer and possibly the upper portion of the Tunnel City Group (upper portion of the FIG aquifer) IF (1) flood water displaces or mixes with existing groundwater in the pit, (2) the flooding causes a degradation of water quality in the mine pit, (3) the concentrations of contaminants in the flood water are sufficiently high to be detectable as they migrate downgradient in the sand-and-gravel aquifer, and (4) they do not degrade or otherwise attenuate. None of the above conditions are known with any degree of certainty – therefore monitoring will be required.

3.0 Groundwater and Pit Monitoring Program

This section describes the proposed groundwater and pit monitoring program during operation of the mine. This program may be continued after mining is completed, although such a program should be modified to consider the results of past monitoring. The monitoring program is divided into two parts: routine monitoring and flood-event monitoring. For both conditions, the same monitoring systems are utilized but frequency and parameters lists differ.

3.1 Monitoring-Well Network

The monitoring-well network consist of existing monitoring wells (completed in the shallow portion of the sand-and-gravel along the periphery of the Site) and new (proposed) monitoring wells that will require installation. The locations of the existing and proposed monitoring wells are shown on Figure 3-1. The construction of the existing and proposed wells are summarized on Table 3-1. The goals of this monitoring-well network are to provide water-quality and water-level data in three hydrostratigraphic intervals:

1. Shallow Sand-and-Gravel Aquifer: These are primarily the four existing shallow monitoring wells along the northwest and northeast sides of the Site, designated monitoring wells MW-1, MW-2, MW-3, and MW-4. A fifth shallow monitoring well (MW-5) is proposed to be located between the Site and Sand Creek to provide upgradient groundwater quality and level data. A sixth shallow monitoring well (MW-6) is proposed to be located directly downgradient of the center of the mine pit and nested with two deeper wells. The construction of these wells will allow for the detection of shallow and/or floating contaminants migrating downgradient of the pit. These wells have the following construction characteristics:
    a. completion depth to approximately elevation 700-705 feet, msl (approximately 10-15 feet below static-water level)
    b. 2-inch diameter PVC casing with 10-foot long screens
2. Deep Sand-and-Gravel Aquifer: Currently, there are no wells completed in the sand-and-gravel aquifer at depths corresponding to the lower portions of the mine pit. Three such wells are proposed: MW-2b (completed as a well nest near existing MW-2), MW-5b (completed as a well nest with MW-5 for the purpose of characterizing upgradient groundwater conditions between Sand Creek (a losing stream along this reach) and the mine pit), and MW-6b (completed as a well nest near proposed shallow well MW-6). These wells will have the following construction characteristics:
    a. completion depth to approximately elevation 650 feet, msl (approximately 50 feet below static water level)
    b. 2-inch diameter PVC casing with 5-foot long screens

3. Upper Tunnel City-Wonewoc Aquifer: A well completed in the upper Tunnel City-Wonewoc aquifer (MW-6c) is proposed to be part of a three-well nest (MW-6; MW-6b; and MW-6c) located directly downgradient of the mine pit. The purpose of this well is to monitor water quality in the upper Tunnel City Group, as well as provide information on vertical hydraulic head gradients (and how they may change during flooding). This well provides an "early warning" mechanism for movement of pit water down into the bedrock unit. This well will have the following construction characteristics:
    a. Outer 6-inch diameter steel casing from ground surface to 5 feet into bedrock.
    b. 2-inch diameter steel casing 20 feet into bedrock
    c. 10-foot long screen, stainless steel

All wells must be constructed in accordance with Minnesota Well Code and appropriately developed and permitted as monitoring wells. The locations of the wells can be moved slightly to accommodate site conditions and proposed operations. However, it is important that well nest MW-6-MW-6b-MW-6c be located no less than 35 feet and no greater than 60 feet from the proposed normal (non-flooded) wet perimeter of the mine pit.

Wells will also have to be constructed in accordance with the requirements for wells within a flood plain and will require appropriate sealing to prevent flood water from flowing into them and damage from ice flows or other flood-related conditions. These protections should include: (1) protective steel casing; (2) steel poles (three or more) within an approximately 5-foot radius of the each well; and (3) a concrete "pyramid" slab around each protective well casing. Wells located near proposed heavy-equipment operations should be adequately protected.

Currently, there are two shallow piezometers (PZ-1 and PZ-2) at the Site. Groundwater-level measurements can be made from these piezometers but water-quality samples may not be collected from them. It is recommended that these piezometers be included in the water-level measurement network or abandoned by a licensed well driller.

3.2 General Sampling and QA/QC Procedures

A Quality Assurance Project Plan (QAPP) shall be developed for the monitoring program. The QAPP shall address the following:

1. Well Stabilization. All wells shall be equipped with dedicated bladder pumps to minimize cross-contamination between wells. Wells shall be evacuated a minimum of three well volumes. Well stabilization tests shall be performed using in-line measuring devices and/or flow-through cells, measuring for specific conductance, temperature, pH, and Eh. Optional measurements for dissolved oxygen (DO) are recommended. The well will be considered stabilized when

parameters do not vary. A log of stabilization and well-volume evacuation shall be kept for each well.

2. Sample Containers and Preservatives. Laboratory-provided sample containers and preservatives, appropriate for the types of samples, shall be used.
3. Decontamination Procedures. Equipment and personnel decontamination between sample locations shall be addressed.
4. Sample Storage and Transport. Chain-of-Custody shall be observed. Appropriate trip and sample blanks shall be used. Appropriate transportation temperatures shall be maintained.
5. Designated Laboratory. A designated Minnesota Department of Health-certified laboratory shall be used and identified in the QAPP. If a specialty laboratory is required for certain types of analyses, the laboratory must be approved by the County before use.
6. Laboratory Duplicates. The QAPP shall identify the number of laboratory and sample duplicates per sampling round.
7. Split Sampling. The County reserves the right to split samples for independent analysis.
8. Quality Assurance Review and Data Validation. Procedures for reviewing data to determine if it meets minimum quality standards shall be developed and followed. Appropriate qualifiers shall be used.

Sampling and reporting shall be performed by individuals qualified by training and experience. Analytical turn-around (i.e. the period between collection and receipt of results from the laboratory) shall be stated in the QAPP. Standard turn-around may be used for quarterly and baseline sampling. Expedited (7 day minimum) turn-around shall be used for flood-event sampling, as described in this Plan.

3.3 Pre-Mining Water-Quality Sampling

Pre-mining water-quality sampling is designed to develop a statistically reliable data base of water-quality conditions in the groundwater at the site, prior to extensive mining. Ideally quarterly sampling would be performed but it is more important to obtain a larger data set with slightly more frequent sampling events than to protract pre-mining sampling. The purpose of the pre-mining sampling is to establish the natural seasonal variability of groundwater quality conditions to compare to later, when mining is taking place.

3.3.1 Sampling Frequency and Duration

In order to obtain a water-quality data set that represents conditions prior to extensive mining, *ten sampling rounds, spaced approximately 6 weeks apart* shall be performed in all monitoring wells. This pre-mining sampling period will encompass an entire year of seasons and must commence as soon as permitted. In addition to collecting water samples from wells, each sampling event shall also include a grab sample from Sand Creek adjacent to the 173rd Street bridge.

3.3.2 Water-Quality and Hydrologic Parameters

Samples shall be analyzed for the parameters listed in Table 3-2. Table 3-3 lists the field parameters to be collected at the time of sampling. Field parameters will be measured in wells using flow-through sampling cells, upon completion of well stabilization and prior to sample collection. Water-level measurements shall be made prior to and after sample collection.

Stable isotope analyses for the isotopes of hydrogen and oxygen are collected for purposes of characterizing the "evaporative signature" of groundwater, compared to that of the mine pit water and Sand Creek. Water that has undergone evaporation will be concentrated in the heavier isotopes of oxygen and hydrogen, compared to precipitation (and infiltrating precipitation). While not definitive, changes in isotopic ratios in groundwater downgradient of open water bodies is generally indicative of the migration and influence of the water body. In addition, water bodies that undergo flooding (such as the proposed mine pit) can experience rapid changes in isotopic characteristics due to mixing with flood waters.

There are generally more analytes listed in Table 3-2 than will be measured during routine monitoring. This is because it is important to establish with reasonable reliability the background/baseline conditions at the Site so that if future sampling discloses groundwater quality degradation, a baseline database will be available to determine which constituents are naturally occurring and which can be attributed to mine-related activities.

3.3.3 Statistical Evaluation of Background Conditions

Sample distribution for each parameter shall be developed for each well using the eight sampling events. Statistical analyses shall be performed to determine if all of the shallow sand-and-gravel aquifer wells (monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, and MW-6) meet the condition of a single population or if intra-well variability amongst this group requires individual treatment of the wells. Similar statistical analyses shall be performed on the deeper sand-and-gravel wells (MW-2b, MW-5b, and MW-6b). Separate statistics will be developed for the Tunnel City- Wonewoc monitoring well MW-6c.

Establishment of background conditions (i.e. conditions prior to mining) must be done in a manner that recognizes that potential contaminants of concern may be naturally occurring, may be anthropogenic in nature but beyond the control of the mine operator, and likely have concentrations that can vary both temporally and spatially. Obtaining sufficient water-quality data to establish this pre-mining, baseline variability is necessary in order to establish a statistical basis for recognizing if increasing concentrations at monitored points are the result of groundwater degradation by the mine (which may require response actions and mitigation) or are the result of naturally occurring variability. Establishing a statistical basis for

baseline or background conditions also provides a rational for identifying potential monitoring "outliers" that may indicate that analytical results are in error.

Individual groundwater samples are only representative of groundwater quality at a particular time in a particular location. Groundwater quality often varies seasonally or changes with time and/or location, so a single groundwater sample may not be representative of groundwater conditions throughout the Site or over a period of time. The greater the number of independent samples collected over time, the more representative the characterization of the groundwater quality. Larger sample populations also increase the statistical confidence in the evaluation of groundwater quality. Valid statistical testing depends upon collection of adequate data. Statistical tests rely on using estimates of the true mean and true variance of a population. For example, the estimate of the true mean is the average of the data points collected. The estimate of the true standard deviation is the standard deviation of the data points collected. There must be 8 to 10 independent samples collected before passable estimate of the population's standard deviation having normal or lognormal (parametric) distributions can be generated.

For the water-table sand-and-gravel aquifer, the hydrogeologic setting may be sufficiently uniform in the area where the mining and monitoring wells will be located that the baseline data from all of the shallow and deep water-table sand-and-gravel monitoring wells can be pooled to establish a robust set of data to statistically characterize background (or "baseline") water-quality conditions. However, this assumption needs to be statistically justified by comparing the population distributions of the individual wells with the population distribution for all of the water-table wells (typically using an Analysis of Variance (ANOVA) testing procedure). For this reason, ten sampling events, 6-weeks apart for each well are being required.

For each parameter and at each well, the mean and standard deviation shall be calculated. Appropriate statistical tests (ANOVA testing) shall then be used to determine if the mean and standard deviation for all of the water-table wells can be used to establish background conditions.

3.3.4 Domestic and Non-Community Baseline Well Sampling

The Minnesota Department of Health has recommended that one pre-mining baseline well sample be collected from domestic and non-community wells in close proximity to the project. This sampling round should be performed after approximately 5 monitoring rounds of baseline data have been collected from the monitoring wells on Site in order to determine what constituents will be analyzed for. Analysis of samples collected from the domestic and non-community wells may be limited only to those constituents detected in samples from monitoring wells. The domestic and non-community wells recommended for sampling include unique well numbers 211711; 498564; 777320; 271924; 235522; 474684; 404675; 249319; 235532; and 753654.

3.4 Routine (Quarterly) Sampling

After the first year of pre-mining sampling, routine monitoring will commence on a quarterly basis. Sampling methods and procedures shall be similar to those employed for pre-mining sampling. In addition to monitoring well sampling, Sand Creek at the 173rd Street bridge and the mine pit pond shall be sampled.

Quarterly sampling shall consist of four sampling events per calendar year. The first quarter sampling event shall be between January 1 and March 31, the second between April 1 and June 30, the third between July 1 and September 31, and the fourth between October 1 and December 31.

3.4.1 Mine-Pit Sampling

The water-quality of the mine pit will be a crucial factor in whether or not the proposed project impacts groundwater quality. A number of factors come into play that determine the water quality of the mine pit, including temperature, nutrient productivity, runoff, spills, turbidity, and interaction with wildlife. The history of flooding of the mine pit will also be a very important fact. Because the mine pit will eventually be quite deep, it is important to obtain samples at discrete depths.

Sampling shall be conducted at the deepest portion of the mine pit. The mine pit will be sounded to ascertain the maximum depth and sampling will commence from a stable watercraft. Winter sampling may be through the ice. Appropriate safety precautions must be adhered to. Samples shall be collected at four depths:

1. At the water surface
2. At a depth of 10 feet
3. At a depth of 40 feet (or half the total depth, whichever is deeper)
4. At approximately 1 foot above the bottom

Discrete depth samples shall be collected using a "beta bottle" or similar sampling apparatus. A portion of the sample shall be split for field parameter measurements of pH, Eh, DO, temperature, and specific conductance. Samples will also be collected at all depths and analyzed for turbidity using EPA Method 180.1. Sampling equipment shall be decontaminated between samples. Samples shall be analyzed for the parameters listed in Table 3-4.

Samples for isotopic analysis (stable isotopes of oxygen and hydrogen) need only be collected from the 40-foot depth.

In addition to water-quality sample collection, the stage elevation of the pond shall be measured using a permanent staff gauge, installed in the pond. A Secchi disk shall be used to determine Secchi depth.

3.4.2 Sand Creek Sampling

A grab sample shall be collected from the flowing portion of Sand Creek at the 173rd Street bridge. A portion of the sample shall be split for field parameter measurements of pH, Eh, DO, temperature, and specific conductance. Sampling equipment shall be decontaminated between samples. Samples shall be analyzed for the parameters listed in Table 3-4.

3.4.3 Monitoring Well Sampling

Samples shall be collected from all monitoring wells on a quarterly basis and analyzed for the parameters listed in Table 3-4. Table 3-3 lists the field parameters to be collected at the time of sampling. Field parameters will be measured using flow-through sampling cells, upon completion of well stabilization and prior to sample collection. Water-level measurements shall be made prior to and after sample collection.

3.5 Flood-Event Monitoring

Monitoring the mine pit and monitoring wells following inundation of the pit by flood water is crucial to the overall evaluation of environmental impacts by mining at the Site. As previously discussed, there are many unknowns regarding how flood water impacts the water quality in the mine pit.

Flood-event monitoring begins after flood waters have receded from the site and monitoring wells are accessible by foot. Sample collection initially includes only the mine-pit water background monitoring wells MW-5, MW-5b, and well-nest 6 (MW-6, 6b, and 6c) closest to the pit. Downgradient wells are added and flood-event monitoring phases into quarterly monitoring. Field and analytical parameters are identical to those listed in Tables 3-2 and 3-3. The sampling schedule for flood-event monitoring shall be:

1. Within 3 days following recession of flood waters. Monitoring Wells, MW-5, MW-5b, MW-6, M6b, and MW-6c and four discrete depth samples from the mine pit. One-week turn-around for analytical results required.
2. Approximately 14 days after the flood event. Monitoring Wells, MW-5, MW-5b, MW-6, M6b, and MW-6c and four discrete depth samples from the mine pit. One-week turn-around for analytical results required.
3. Approximately 28 days after the flood event. Monitoring Wells, MW-5, MW-55b, MW-6, M6b, and MW-6c and four discrete depth samples from the mine pit.
4. Approximately 50 days after the flood event. Monitoring Wells, MW-5, MW-5b, MW-6, M6b, and MW-6c and four discrete depth samples from the mine pit.

If a second flood event occurs during the implementation of the flood monitoring, the flood-event monitoring schedule is reset. Flood-event sampling results shall employ seven-day analytical turn around (i.e. seven days from sample collection to reporting of results by the laboratory). Laboratory results from

sampling events following a flood shall be submitted to the County upon receipt. No sampling event can be skipped or terminated unless approval is received from the County.

3.6 Response Actions and Levels

Response actions to begin mitigation of groundwater contamination are contingent upon the type of mitigation that is to be undertaken and these measures are described in Section 4.1. This section describes monitoring results that will trigger mitigation and/or interim response actions.

For groundwater to be degraded a concentration of a contaminant of concern (i.e. a contaminant with either a primary or secondary drinking water standard) must meet two conditions: (1) the contaminant must be above background conditions and (2) the degradation must be of statistical significance. If groundwater quality is not degraded, then no further action is necessary. If groundwater quality is degraded, but the constituent is present at a concentration below a groundwater quality standard, a response action may be required. At a minimum, the degradation (and supporting data) must be reported immediately to the MPCA and to Scott County.

3.6.1 Mine-Pit Sampling

Mine-pit sampling after a flood event is the first defense against groundwater quality degradation. If the water-quality of the mine pit is equal to or better (i.e. lower concentrations) than baseline conditions in monitoring wells, then it follows that flooding of the mine pit *for that particular flood event* does not constitute a likely source of groundwater quality degradation. Continued sampling, per this plan, shall continue but no further response actions are required.

If sampling of the mine pit, following a flood event, shows concentrations of constituents above statistical background levels, confirmatory sampling need not be performed because this plan calls for mandatory additional pit water sampling soon after the first sampling event. Therefore, a response action can immediately commence unless and until additional sampling demonstrates that the sampling results that triggered a response action were affected by false-positive values.

One of the mitigation actions described in Section 4.1 shall be implemented.

3.6.2 Monitoring Well Sampling

Response actions and mitigation for groundwater degradation will commence if a statistically significant increase (SSI) in the concentration of a constituent is measured above background. SSI shall be calculated within four days of receipt of sampling results and if found to be present, shall be reported to the County within seven days, along with a plan to resample all wells to confirm the SSI.

If an SSI is found in upgradient monitoring well MW-5, or MW-5b confirmatory sampling shall be performed and reported to the County. Modifications to background water-quality conditions may be warranted and an analytical justification for changes may be developed and presented to the County for review.

If an SSI is confirmed in downgradient wells, a mitigation action, as described in Section 4.1 shall commence to prevent groundwater degradation from occurring beyond the mine property. This mitigation may include operation of a pump-out system or other measures.

If an SSI is reported in Tunnel City-Wonewoc monitoring well MW-6c, measures must commence to begin sampling of the SCALE and JAF wells and appropriate measures will be required to ensure that the water quality for these wells is not impaired.

3.6.3 Determining Statistically Significant Increases (SSI)

SSIs shall be determined using the method of prediction limits. Prediction limits are generally easy to construct and have a straightforward interpretation. Background data are used to construct a concentration limit PL, which is then compared to one or more observations from a compliance point population. The acceptable range of concentrations includes all values no greater than the prediction limit. The appropriate prediction interval will generally have the form [0, PL], with the upper limit PL as the comparison of importance (i.e. increases in constituent concentrations are of primary interest, not decreases).

The prediction interval for a given constituent is calculated with the mean and standard deviation of the data as follows (from Gibbons, 1994):

$$PL = x + S\sqrt{1 + \frac{1}{n}}\ \ t(n-1, k, 1 - \frac{\propto *}{k})$$

Where: PL = prediction limit

x = mean

S = standard deviation

n = number of background samples

t = t-statistic from Table 1.2 (Gibbons, 1994)

k = number of future comparisons =5

α^* = site wide error rate = 0.05

The prediction limits for the water-table wells will be updated annually incorporating the most recent upgradient background data for MW-5 and MW-5b.

Table 3-1 Existing and proposed monitoring locations

Monitor-ing Location	Type	Unique Well No.	UTM Northing	UTM Easting	Monitored Unit	Well Depth (ft)	Top of Riser (ft,	Ground Elevation (ft, msl)	Well Diameter	Riser Material	Well Screen Length (ft)	Bottom Elevation (ft, msl)
MW-1	monitor well	767636	4948483	45065	shallow water table	33.37	741.45	739.1	2	pvc	10	708.8
MW-2	monitor well	767637	4948630	450806	shallow water table	22.99	732.12	730.51	2	pvc	10	708.8
MW-2b	monitor well	tbd	4948632*	450806*	deep water table	80*	733*	731*	2	pvc*	10*	
MW-3	monitor well	767638	4948786	450976	shallow water table	23.56	731.99	730.59	2	pvc	10	708
MW-4	monitor well	767639	4948884	451233	shallow water table	29.9	740.19	738.53	2	pvc	10	710.4
MW-5	monitor well	tbd	4948361*	451248*	shallow water table	35*	737*	735*	2	pvc*	10*	700*
MW-5b	monitor well	tbd	4948361*	451250*	deep water table	85*	737*	735*	2	Pvc*	10*	650*
MW-6	monitor well	tbd	4948583*	450972*	shallow water table	30*	737*	735*	2	pvc*	10*	705*
MW-6b	monitor well	tbd	4948585*	450972*	deep water table	85*	737*	735*	2	pvc*	10*	650*
MW-6c	monitor well		4949587*	450972*	Tunnel City	175*	737*	735*	2	stainless steel*	10*	560*
Sand Creek - 173rd St. Bridge	surface water	na	4946613*	451508	Sand Creek	na	na	na	na	na	na	na
Mine Pit depth 1	mine pit water	na	4948467*	451063*	mine pit water surface	na	na	na	na	na	na	na
Mine Pit depth 2	mine pit water	na	4948467*	451063*	mine pit 10 ft deep	na	na	na	na	na	na	na
Mine Pit depth 3	mine pit water	na	4948467*	451063*	mine pit 40 ft deep	na	na	na	na	na	na	na
Mine Pit depth 4	mine pit water	na	4948467*	451063*	mine pit bottom	na	na	na	na	na	na	na
PZ-1	piezometer	none	4948294	451137	shallow water table (wl only)	not measured	729.66	727.11	0.75	pvc	3	718.1
PZ-2	piezometer	none	4948566	451460	shallow water table (wl only)	not measured	728.63	726.3	0.75	pvc	3	717.3

Table 3-2 List of Analytes and Methods

Analyte	Method	units	preservative	Holding time	Detection limit
Alkalinity - Total as CaCO3	SM2320-B	mg/L	None	14 days	4
Ammonia - Nitrogen as N	EPA 350.1	mg/L	H2SO4 to pH<2	28 days	0.1
BOD5	EPA 405.1	mg/L	None	48 hours	2
Chloride	EPA 300.0	mg/L	None	28 days	1
Isotope Ratio: H2/H1	Stable isotope mass spectrometry	ppt	None	1 year	Na
Isotope Ratio: O18/O16	Stable isotope mass spectrometry	ppt	None	1 year	Na
Lab conductivity	EPA 120.1	umhos/cm	None	28 days	0.1
Metals (Sb, As, Be, Cd, Cr, Cu, Mn, Pb, Hg, Ni, Se, Ag, Tl, Zn)	EPA 6020A	mg/L	HNO3 to pH <2	6 months	0.005
Nitrate+Nitrite as N	353.2	mg/L	H2SO4 to pH<2	28 days	0.1
Phosphorus, Total	EPA 365.1	mg/L	H2SO4 to pH<2	28 days	1
Total Dissolved Solids	SM2540-C	mg/L	None	7 days	1
Total Suspended Solids	SM2540-D	mg/L	None	7 days	1
SVOCs	8270D	ug/L	None	14 days	1
VOCs	8260B	ug/L	HCL to pH <2	14 days	1
Pesticides	8081B	ug/L	None	7 days	1
Chlorinated Herbicides	8151A	ug/L	None	14 days	1
PAH	8270	ug/L	None	7 days	0.2
DRO	8015	mg/L	HCL to pH <2	7 days	0.2
Total Coliforms	SM9222B	organisms / 100 mL	Sodium Thiosulfate	30 hrs	<1 org / 100mL

Table 3-3 List of Field Parameters

Parameter	Units	Field Method	Laboratory Method
Field pH	Standard pH units	pH meter	Na
Field redox potential	Millivolts	Eh meter	Na
Field Specific Conductance	umhos/cm	Specific conductance meter	Na
Field Temperature	Degrees C	Thermometer	Na
Field dissolved oxygen	mg/L	DO meter	Na
Secchi Disk Reading*	Depth (meters)	Secchi disk	Na
Turbidity**	ntu	Collected for lab	Method 180.1

Note: * indicates measurement for mine pit only
**indicates measurement for mine pit and Sand Creek only

Table 3-4 Quarterly Sampling Analytes

Analyte	1st Quarter	2rd Quarter	3rd Quarter	4th Quarter
Alkalinity - Total as CaCO3		X		X
Ammonia - Nitrogen as N	X	X		
BOD5		X		X
Chloride	X	X		X
Isotope Ratio: H2/H1	X		X	
Isotope Ratio: O18/O16	X		X	
Lab conductivity	X	X	X	X
Metals (Sb, As, Be, Cd, Cr, Cu, Mn, Pb, Hg, Ni, Se, Ag, Tl, Zn)		X		X
Nitrate+Nitrite as N	X	X	X	X
Phosphorus, Total	X	X	X	X
Total Dissolved Solids	X	X	X	X
Total Suspended Solids	X	X	X	X
SVOCs		X		X
VOCs		X		X
Pesticides		X		X
Chlorinated Herbicides		X		X
PAH		X		X
DRO	X	X	X	X
Total Coliforms	X	X	X	X
Field pH	X	X	X	X
Field Eh	X	X	X	X
Field Temperature	X	X	X	X
Field Specific Cond.	X	X	X	X
Field DO	X	X	X	X
Secchi Depth*		X	X	X
Turbidity**		X	X	X

Note: * indicates measurement for mine pit only
**indicates measurement for mine pit and Sand Creek only

4.0 Mitigation Plan

The Mitigation Plan describes procedures and alternatives to prevent or otherwise substantially reduce the environmental impacts of mining activities at the Site. The environmental impacts are described in the EIS and include: water-quality impacts (i.e. degradation) to groundwater system; water-quality impacts to affected water-supply wells; impacts associated with the formation of ice dams as a result or contribution of the mine pit; and impacts to the channel and banks of Sand Creek as a result of the mine pit.

For a particular impact, there may be multiple alternatives for mitigation, depending on the severity and nature of the impact. Some mitigation alternatives can be implemented prophylactically to substantially reduce the potential for future impacts by changing aspects of the project or other conditions in the area, as currently exist or are proposed. Other alternatives are reactive and would require implementation after an impact has occurred or where conditions have changed such that an impact is likely to occur in the future.

4.1 Mitigation for Groundwater Degradation

Mitigation for groundwater degradation are those alternatives or actions that, when implemented, will either prevent groundwater degradation from occurring or will remediate groundwater degradation if it has already occurred. During mine operations, implementation of these mitigation measures shall be the responsibility of the mine operator, in consultation with the County and MPCA. After mine operations have ceased, implementation will be transferred to the County.

4.1.1 Evacuation and Treatment of Contaminated Mine-Pit Water

If the water in the mine pit becomes contaminated due to flooding, spills, or from other sources, pumping the water out of the pit and treating it (if necessary) before discharge into Sand Creek is a mitigation option. The type of treatment that would be required would depend upon the source and type of contamination. The most likely source of contamination addressed in this Plan is flooding of the mine pit by Sand Creek.

4.1.1.1 Conceptual Design and Implementation

The conceptual design for this mitigation measure includes:

- Installation of temporary high-capacity pumps and pump intakes into the mine pit.
- Installation of temporary discharge lines.
- Supply of electrical power for pumps.
- Permanent or temporary settling basins to remove suspended sediment before discharge into Sand Creek.

- Additional treatment, as necessary, to reduce contaminant levels prior to discharge.

The volume of the pit (down to elevation 640 feet, msl), after flood water recede, is estimated to be about 75,000,000 cubic feet (@ 560 million gallons). A reasonable rate for pumping with high-capacity pumps is about 2,000 gallons per minute (gpm) or about 4.5 cfs. Pumping at this rate, 24 hours per day, seven days per week, will require approximately 6 months to evacuate one pit volume. In practice, a somewhat shorter period of time would be required to bring the concentrations of any contaminants down to background (groundwater levels) because pumping of the pit will induce groundwater flow into the pit, mixing, and dilution. Nevertheless, pumping would likely be required for several months.

Pumping periods could be shortened by adding additional pumping capacity.

4.1.1.2 Permit Requirements and Operational Considerations

A temporary Water Appropriations Permit would likely be required from the DNR for pumping pit water because the water would be considered a groundwater source, even though it contains surface flood water. A temporary NPDES permit would likely be required from the MPCA, along with permit limits for constituents and total suspended solids. Provisions would likely need to be made at the discharge point to Sand Creek to prevent scour and erosion. Discharge may be limited during certain times of the year due to high water conditions.

In addition to permits and monitoring of the effluent, periodic monitoring of the pit water quality and monitoring wells would be undertaken as part of the mitigation activities.

Electrical power costs for operation of the pumps is in the range of $2,500 to $4,000 per year (assuming $0.06 per kilowatt-hour). Depending on the size of the pumps (estimated to be 10 to 20 hp), an extra Demand Charge may be applied to power use (this extra demand charge is assessed by the power company on a case-by-case basis and is a fixed fee that is assessed on the basis of the equipment and not the use).

Pumping and piping equipment of this type can be rented on an as-needed basis. However, considering that flooding would likely occur several times during the life of the mine and perhaps multiple times in a single year, having this equipment on-hand would be required. In order to implement this mitigation, provisions would need to be made to have this equipment in operation within a couple of days of recession of a flood. Settling ponds would need to be constructed prior to a flood and be regularly maintained.

4.1.2 Downgradient Pump-Out System

A downgradient pump-out system is a proven technology for containing groundwater contamination, removing contaminant mass (over a period of time), and minimizing the chance that an aquifer will become degraded downgradient of the system. Pump-out systems may include a treatment component, depending on the nature and level of contamination and where the water will be discharged.

4.1.2.1 Conceptual Design and Implementation

Multiple pumping wells, located downgradient of the mine pit, would be installed to capture groundwater beneath the site that has become contaminated with flood waters (or from other contamination sources to the mine pit). There is a trade-off between the number of wells needed to capture pit water and the total pumping rate – more wells, pumping at lower individual rates, generally results in less total pumping than one or two wells.

The proposed aggregate wash well could be used as one of five pump-out wells. In addition to the wash well, four more wells (completed to a total depth of about 50 feet with 10-to 20 foot long screens) would be needed. Wells that fully penetrate the entire aquifer thickness are not required because partially penetrating pumping wells in an unconsolidated aquifer, such as the sand-and-gravel aquifer will fully capture the entire aquifer thickness at the projected pumping rates. Each well would pump at approximately 180 gpm. The wells would be installed downgradient of the pit, approximately equally spaced, and inside the northwestern Site boundary, bordering Valley Creek Drive. It is likely not practical to install wells closer to the mine pit because of processing facilities and operations.

In addition to wells, the pump-out system will require submersible pumps, electrical power, well appurtenances, controls, flow meters, piping, and a discharge line to Sand Creek. The discharge point will likely require a means of dissipating the flow to minimize erosion.

Water treatment prior to discharge will likely be required to meet NPDES water-quality permit requirements. The type of water treatment will depend on the constituents in the water. Likely constituents include nitrate and pesticides/herbicides. Treatment options include reverse osmosis (RO) and micro- or nano-filtration. Self-contained mobile, modular treatment systems could be used with capacities of up to 1,000 gpm.

It is estimated that the pump-out system would need to operate for approximately 6 to 12 months after a flood event.

4.1.2.2 Permit Requirements and Operational Considerations

A Water Appropriations Permit would likely be required from the DNR for pumping. A NPDES permit would likely be required from the MPCA, along with permit limits for constituents. Provisions would likely

need to be made at the discharge point to Sand Creek to prevent scour and erosion. Discharge may be limited during certain times of the year due to high water conditions.

In addition to permits and monitoring of the effluent, periodic monitoring of the pit water quality and monitoring wells would be undertaken as part of the mitigation activities.

Electrical power costs for operation of the pumps is in the range of $1,000 to $3,000 per year (assuming $0.06 per kilowatt-hour). An extra Demand Charge may be applied to power use.

4.2 Mitigation for Water-Supply Well Impacts

Mitigation for water-supply well impacts are those alternatives or actions that, when implemented, will substantially reduce the risk of introducing contaminants in the wells of groundwater users that might be impacted by the mine (primarily as a result of flooding of the mine pit by Sand Creek.

4.2.1 Installation of Deeper Wells

The Proposer has forwarded a proposal to mitigate potential impacts from floodwater contamination to existing well receptors in the surficial aquifer by installing new, deeper wells in the Wonewoc Formation (the lower portion of what was formerly called the Franconia-Ironton-Galesville, or "FIG" aquifer). A total of three new wells are proposed: one at the Robling property (assuming the existing well is completed in the surficial aquifer), one at the Scott County Association for Leadership and Efficiency (SCALE) training facility, and one at the Scott County Juvenile Alternative Facility (JAF). The wells will be installed prior to excavating the mine pit below the water table.

Wells completed in the Wonewoc Formation will likely provide an adequate supply of potable water to the proposed users. However, the new wells may require point-of-use treatment to address water aesthetics, specifically hardness and iron content. For the purposes of this mitigation plan, it is assumed that water from the bedrock aquifer is of inferior quality with respect to hardness and iron relative to the surficial aquifer. As such, each water supply is expected to be equipped with a water softener and iron filter. Water testing upon completion of the replacement wells will ultimately determine the extent of treatment necessary.

Wells will be installed by a licensed well driller and equipped with submersible pumps, pitless adaptors, piping, and controls. Point-of-use treatment with a water softener and iron filter will also be provided and plumbed into the existing structures.

4.2.1.1 Permit Requirements and Operational Considerations

Well installation permits will be required from MDH. Operation and maintenance of the softener and iron-removal systems will be required.

4.3 Mitigation for Channel Bank Erosion of Sand Creek

Mitigation for channel bank erosion of Sand Creek includes those alternatives or actions that, when implemented, will prevent or repair stream-channel divergence into the mine site. The primary concern is that, during a flood event, a new stream channel is cut through the erodible deposits southwest of the mine site and into the mine pit.

4.3.1 Channel Bank Stabilization

The risk for channel bank erosion during flood events will likely be substantially reduced by ensuring that the bank areas and the mine berms are adequately vegetated and the berms are maintained. Placement of DNR-approved stabilization material along the channel bluff and berm areas will further reduce the potential for erosion during floods. Use of rip-rap is not endorsed by the DNR for bank stabilization. In general, properly designed bank stabilization will not require additional maintenance in the future and additional stabilization will likely occur over time as vegetation is established.

4.3.1.1 Permit Requirements and Operational Considerations

Changes to the channel morphology and placement of vegetation and bank stabilization will likely need to be coordinated with the DNR and a DNR permit for work in Waters of the State will be required for any work below the bank. Access and/or easement to land not owned by the Proposer will need to be obtained to perform work off the mine site.

4.4 Mitigation for Formation of Ice Jams

Mitigation for ice jam formation at the 173rd Street bridge over Sand Creek (just north and downstream of the Site) includes those alternatives or actions that, when implemented, substantially reduce, eliminate, or mitigate the formation of ice jams by limiting the size of ice and debris flowing from the mine pit area during a spring flood event.

The condition to be mitigated would occur when spring flooding of Sand Creek inundates the mine pit and the mine-pit water surface is covered with ice. The concern is that flood waters, perhaps combined with wind, cause the pit ice to float and move in large masses through the proposed spillway or over the berms and into the main channel of Sand Creek, where it flows toward the 173rd Street bridge (which has experienced ice jams in the past). The mine-pit ice pieces would create or contribute to an ice jam that causes flood waters to back-up and spread over a larger area.

Ice jam mitigation falls into one of four categories: structural, non-structural, freeze-up mitigation, and break-up jam mitigation (USACOE, 2002). Some are permanent, some are deployed in advance of an anticipated flood threat, while others are deployed under emergency conditions when a jam has formed and flooding has occurred. The elements of each are as follows:

1. Structural Mitigation

Structural measures for ice jam control may incorporate features that can be used to alleviate open-water flooding, as well as those designed specifically for ice-jam floods. The cost of such measures includes construction, operation, and land acquisition, as well as costs associated with recreation and environmental mitigation. While they are often very successful, structural solutions tend to be expensive (USACO, 2002). Structural solutions remain appropriate on rivers where chronic or serious threats persist, and where the extent of potential damages justifies the cost. Although the majority of the structural mitigation techniques are, by their very nature, permanent, some are designed to be removable. These removable structures are usually installed at the beginning of winter and removed after spring breakup when the threat of ice jam flooding no longer exists. A few removable structures are designed to be deployed after an ice jam threat has been identified and, in this respect, can be considered advance mitigation measures.

2. Non-Structural Mitigation

Non-structural mitigation measures are designed to modify vulnerability to the flood threat or to reduce the severity of the ice jam and of the resulting flood. They are generally less expensive than structural solutions (USACOE, 2002). The majority of the nonstructural techniques are used for advance and emergency measures when serious ice jam flooding is imminent or under way. Blasting and mechanical removal are often employed only as emergency mitigation measures once ice jams have happened. The creation of ice storage zones upstream from a known jam site to minimize the amount of ice reaching the jam site is a permanent measure, since these areas, once established and properly maintained, can be used year after year.

3. Freeze-Up Mitigation

Freeze-up ice jam control targets the production and transport of the frazil ice that causes jams. This may be accomplished by encouraging the growth of an ice cover that insulates the water beneath, thereby decreasing the production of frazil ice. The ice cover collects and incorporates frazil ice that is transported from upstream. This reduces the amount of ice moving downstream (USACOE, 2002). Freeze-up mitigation is not applicable to the Site because ice-jam formation on Sand Creek, downstream of the project Site, has been associated with spring melt conditions and not freeze-up conditions.

4. Break-Up Mitigation

Break-up ice jam mitigation focuses on affecting the timing of the ice cover breakup, thereby reducing the severity of the resulting jam to the point where there is little or no flooding. Break-up mitigation may also

aim at controlling the location of the ice jam by forcing the jam to form in an area where flooding damages will be inconsequential (USACOE, 2002).

Temporary mitigation measures are implemented on an as-needed basis and are typically tailored to the temporal site conditions, flood hydrology and the severity of the potential for ice-jam formation. Permanent mitigation measures are implemented in anticipation of future ice jam formation and involve some form of structural modifications to the stream channel or river banks. Permanent mitigation measures are inherently more costly but require little or no operation and maintenance costs, whereas temporary mitigation measures require timely human intervention (USACOE, 2002). During mining operations, when the mine operator has control of the Site, temporary measures could be implemented by the mine operator. However, after mine operations have ceased, the responsibility for implementing temporary mitigation measures will become the responsibility of the County or another party. Therefore, the mitigation measures discussed below will identify whether or not they are permanent (and require minimal intervention after mine operation or temporary).

One of the most effective structural mitigation approaches to minimize the formation of ice jams is to allow ice to flow over a spillway or weir. A spillway is proposed as part of the project and would be effective at breaking up ice, provided mine-pit ice moves as flood waters are receding through the spillway. However, if the ice moves when the area is completely flooded, the spillway would be under water and ineffective in breaking up the ice.

4.4.1 Ice Weakening (Temporary Mitigation)

In the late winter of years when spring flood conditions are forecasted or otherwise anticipated, a program of weakening the ice on the mine-pit can be carried out. This approach has proven to be successful in similar settings and reduces the potential size of ice chunks, as well as promotes melting (USACOE, 2002). Mechanical techniques, such as cutting trenches with portable trench cutters or breaking the ice with an excavator can be employed. Auguring holes through the ice on a 10-foot grid pattern and dusting the ice surface with sand are both methods that can be used to encourage more rapid melting of the ice, leading to break-up into smaller pieces. The advantage of these methods is that they can be employed on an as-needed basis. However, once the Site is no longer mined, it may become the responsibility of public agencies to perform this work.

4.4.2 Ice Booms (Temporary Mitigation)

Ice booms are the most widely used type of ice-control structure (USACOE, 2002). They are a series of timbers or pontoons tethered together and strung across a river or section of river to control the movement of ice. Booms are flexible and can be designed to release ice gradually and partially when

overloaded. Ice booms are relatively inexpensive and can be placed seasonally to reduce negative environmental impacts. They are removable and can be seasonally deployed.

Booms commonly stabilize or retain an ice cover in areas where surface flow velocities are 2.25 cfs or less and relatively steady (USACOE, 2002). In some cases, a weir or small structure can improve hydraulic conditions at the ice boom location, especially on small, steep streams. Some booms are located at the outlets of lakes or reservoirs to keep ice from entering downstream ice-jam-prone reaches. This approach to using ice booms would be most applicable to the Site.

4.4.3 Tension Weirs (Temporary Mitigation)

Tension weirs consist of a cable-supported wire mesh, similar to submarine net, strung across the stream to temporarily hold ice from upstream while the downstream reaches of the stream are cleared of ice. Tension weirs will likely need to be installed during ice-free conditions so that they can be employed when ice is present. Ends must be securely attached to well-anchored structures - most likely steel piers or posts. They often require local bed and bank protection against scour for stability and effectiveness. Provisions to allow part of the flow to divert around the structures to limit the upstream flow depth may be required (USACOE, 2002). Equipment for constructing tension weirs would need to be readily available and quickly installed in order to be effective.

4.4.4 Installation Steel or Concrete Piers (Permanent Mitigation)

Regularly spaced steel or concrete piers installed above the flood elevation, can function as ice retention structures to control breakup jams by promoting the initiation of an ice jam at a suitable location where flooding will cause little or no damage. This type of permanent structural mitigation has been proven to be highly effective at other locales in the United States (USACOE, 2002). Fragmented ice is captured and retained upstream from the retention structures to create a smaller ice jam that is not a part of the main channel. The purpose of the piers is not to break up ice (although that may be one result) but to prevent the ice (and associated debris) from flowing into the main portion of the Sand Creek channel and add to any existing jam conditions at the 173rd Street bridge.

One method that might be employed as a preemptive mitigation at the mine site is to install steel posts or piling along the northeast portion of the mine-pit berm (adjacent to the Sand Creek channel) on 25-foot centers, extending to an elevation of approximately 735 feet, msl. The spacing of the piers or posts is critical because it determines the maximum size of ice floe that would be permitted to pass into the main channel of Sand Creek and flow toward the 173rd Street bridge. Smaller debris and ice would be allowed to pass between the piers. Larger pieces would either break up on the piers or form a small ice jam that would prevent additional ice and debris from flowing into the Sand Creek channel toward the 173rd Street bridge. A 25-foot wide piece of ice can be expected to flow between the bridge piers.

The piers could be constructed using steel piling or posts (driven or cemented in place) or reinforced concrete, paced on 25-foot centers along the berm separating the mine from Sand Creek and in the proposed spillway structure. The piers must be of sufficient size and anchored sufficiently deep to resist toppling under the force of wind-driven and flowing ice. Piers could be supplemented with tension weirs.

Table 4-1 Summary of Mitigation Measures

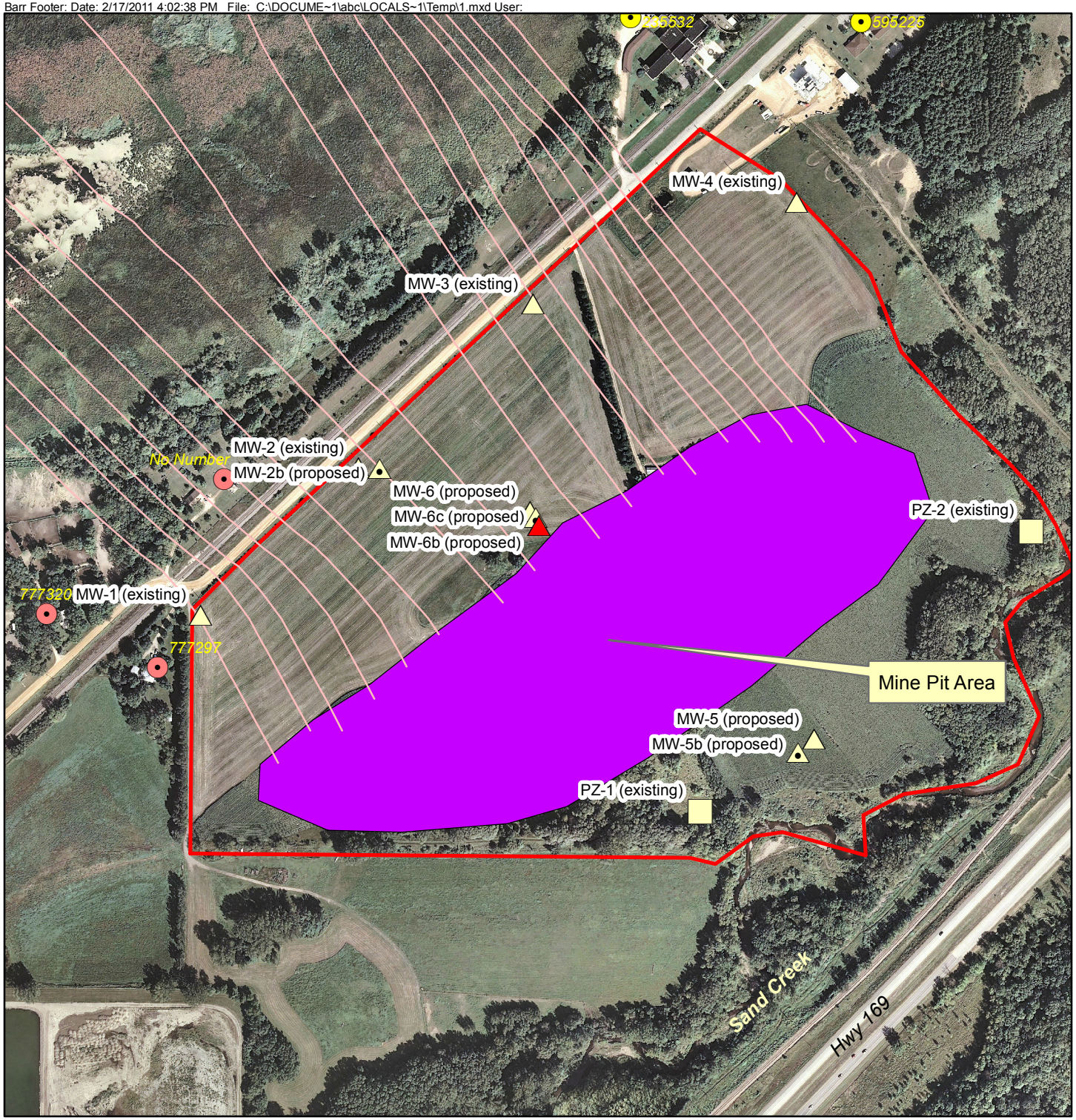
Environmental Impact	Mitigation	Capital	Operation/Maintenance
Sand-and-Gravel Aquifer Groundwater Degradation	Evacuation & Treatment of Contaminated Mine Pit Water	Pumps; Piping; Settling Basins; Discharge Structures; (possibly treatment)	Implementation per each event; maintenance and replacement of pumps; sampling; electricity
Sand-and-Gravel Aquifer Groundwater Degradation	Pump Contaminated Groundwater and Treat (as needed)	Wells: Pumps: Piping: Controls; Discharge Structures; (possibly treatment)	Implementation per each event; maintenance and replacement of pumps and equipment; sampling; electricity; well maintenance
Contamination of Nearby Water Supply Wells	Proactively Replace SCALE, JAF, and Possibly One Residential Well with Deep Wonewoc Aquifer Well	Wells; Pumps; Piping; Controls; Point-of-Use Treatment	Periodic maintenance of softening and treatment equipment
Channel Bank Erosion	Channel Bank Stabilization and Rip-Rap	Rip-Rap Placement; Grading; Vegetation	Inspection; possible vegetation maintenance
Ice-Jam Formation from Mine-Pit Ice	Ice Weakening	Augers and/or Mechanical Ice Cutting/Breaking Equipment	Implementation on as-needed basis; maintenance and replacement of equipment
Ice-Jam Formation from Mine-Pit Ice	Ice Booms	Tethered pontoons and cabling	Implementation on as-needed basis; maintenance and replacement of equipment
Ice-Jam Formation from Mine-Pit Ice	Tension Weirs	Tethered wire netting and cabling – installed; Anchor points	Periodic replacement of netting and cabling; seasonal inspection
Ice-Jam Formation from Mine-Pit Ice	Steel or Concrete Piers	Steel or Reinforced Concrete Piers Along Berm on 25-Ft Centers	Periodic inspection and replacement of piers, as needed.

5.0 References

Gibbons, R., 1994. Statistical Methods for Groundwater Monitoring. John Wiley and Sons, Inc.

U.S. Army Corps of Engineers, 2002. Ice Engineering, Engineering and Design Manual 1110-2-1612, Chapter 12 – Ice Jam Mitigation Techniques.

Barr Footer: Date: 2/17/2011 4:02:38 PM File: C:\DOCUME~1\abc\LOCALS~1\Temp\1.mxd User:



EXPLANATION

Aquifer, Type

- Deep Water Table,
- Deep Water Table, Monitoring Well
- Shallow Piezometer, Piezometer
- Shallow Water Table, Monitoirng Well
- Shallow Water Table, Monitoring Well
- Tunnel City-Wonowoc, Monitoring Well
- Groundwater Flow Paths
- Proposed Mine Pit
- Mine Site

Local Wells

AQUIFER

- Quaternary
- Jordan Sandstone
- St. Lawrence Fm.
- FIG Aquifer
- Mt. Simon Aquifer

N

Feet
220 0 220 440

Figure 3-1

EXISTING AND PROPOSED
MONITORING WELLS
Jordan Aggregates LLC
Monitoring & Mitigation Plan
Scott County, Minnesota