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TECHNICAL MEMORANDUM

Maury Island Lone Star Gravel Mine Evaluation of Spring Water Quality, Proposed Stormwater Management Measures, and Potential Sediment Runoff Impacts

Prepared for

Washington State Department of Ecology

and

Pacific Groundwater Group

February, 2000

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ENVIRONMENTAL
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Prepared for

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February 3, 2000

Contents

Introduction

This memorandum presents the results of our water quality impact assessment and stormwater facility evaluation for the Lone Star mine site at Maury Island, Washington. This memorandum is organized into three sections: 1) a summary of the results of monitoring spring discharge and water quality, and an assessment of the impacts of the proposed mining activities on spring water quality; 2) an evaluation of the proposed stormwater infiltration/detention facilities; and 3) an evaluation of the potential for impacts related to stormwater runoff and sediment transport.

Spring Water Quality Characterization and Impact Assessment

This section summarizes the results of monitoring spring discharge rates and water quality at the Lone Star site and presents an analysis of the potential for contamination to be carried in spring flows during mining activities. The monitoring visits included documentation of field observations, field measurement of spring discharge rate and various water quality parameters, and collection of spring water quality samples for laboratory analysis. Onsite springs were previously identified in the site hydrogeological review conducted by Rongey Associates (1998). Figure 1 shows the locations of the springs observed on the site.

Field Observations

A dry weather site visit was conducted on October 14, 1999. This visit occurred during low tide with the objective of providing good access to the site springs, which were previously observed to discharge at or near the beach (Rongey Associates 1998). A previously unidentified spring was observed at the southwest end of the beach, with ponded water at the base of the hillside and three small rivulets running across the beach. These rivulets had enough flow for measuring discharge with a bucket. A water quality sample was collected from the ponded water at the base of the hill. This new spring was given the field designation "Spring E".

Water was observed seeping out of the near-shore sand over a large dispersed area encompassing approximately 50 feet of shoreline. This water was observed in the area between the existing conveyor dock and Spring E, and was too dispersed for sample collection or discharge measurement.

Spring water was observed north of the existing dock, adjacent to an abandoned concrete foundation on the beach. This location corresponds to Spring A, as defined by Rongey Associates (1998). Standing water was found at the base of the hillside, with four rivulets draining across the sand. A water quality sample was collected from the ponded water and a bucket discharge measurement was taken in the main rivulet. The three smaller rivulets were too small to measure discharge.

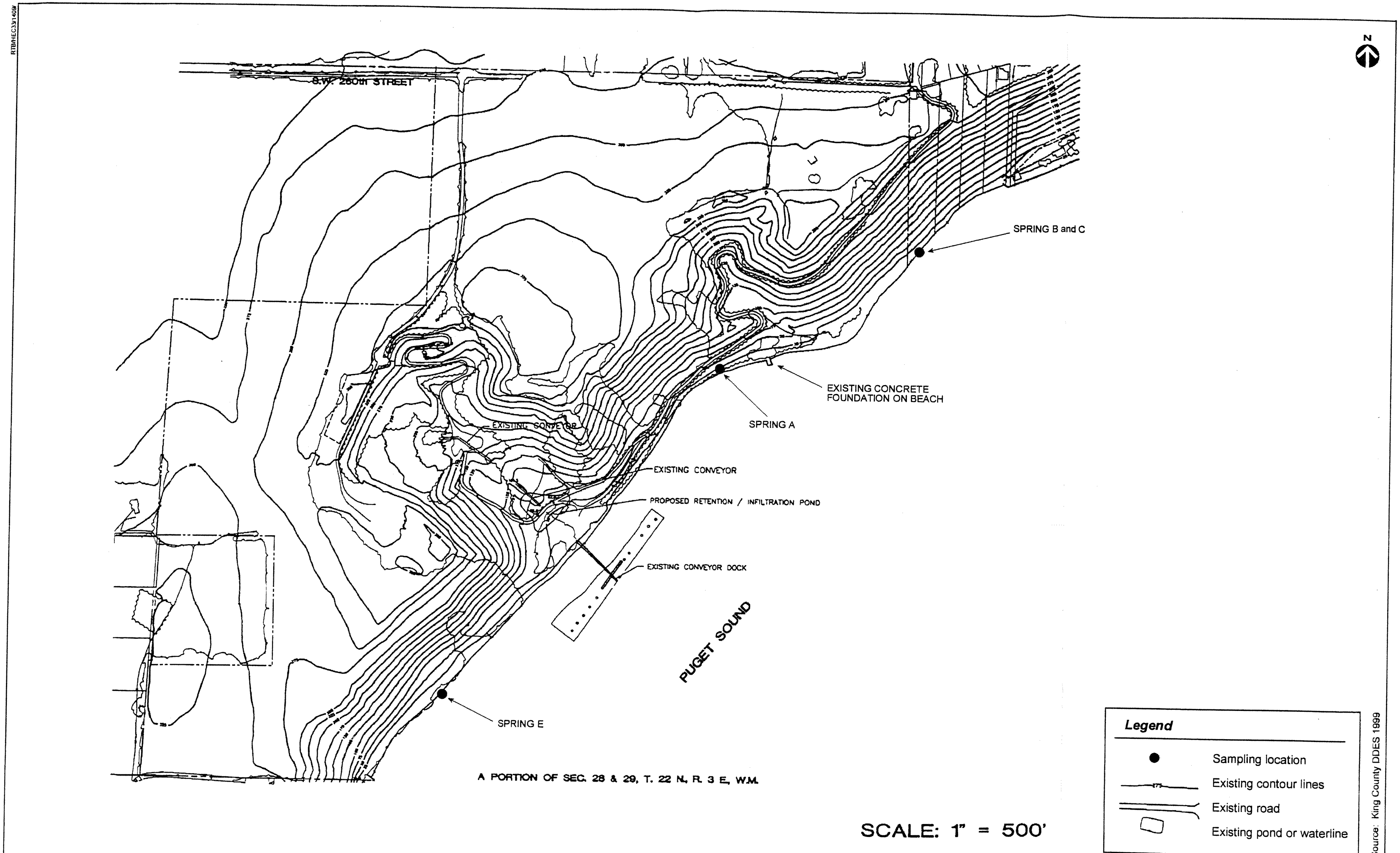

Figure 1. Spring sampling locations at the Lone Star Mine site, Maury Island, Washington.

A small amount of water was observed at the base of the hillside just northeast of the site property line. This spring flow was too small for a water quality sample or a bucket discharge measurement. Two springs were identified in this area by Rongey Associates (1998), Spring B and Spring C, and our field crew was not able to determine which, if not both, were responsible for the observed flow. A spring that was previously identified by Rongey Associates (1998) as Spring D, located just south of the dock, was not found during this site visit.

A wet weather site visit was conducted on November 28, 1999. During this site visit, Spring A and E were sampled again. Spring A had flow in two main channels, and bucket discharge measurements were recorded for both. Spring E again had three main channels in the sand, and bucket discharge measurements were recorded for all three. At the location of Spring B and C, a small amount of water was again observed at the base of the hillside and running across the sand. However, there was an insufficient quantity to allow the collection of a water quality sample or to measure discharge. A wide, dispersed seep on the sand was again observed south of the dock. Spring D, as identified by Rongey Associates (1998), was again not observed on this site visit.

Monitoring Methods

Spring discharge was measured using a graduated bucket and a watch. For each spring, a number of separate measurements were often necessary because spring water drained across the sand in several channels. Each bucket measurement was repeated twice, and an average of the measured values was used to calculate the discharge.

Water quality samples were collected at locations where a sample bottle could be submerged without disturbing sediment. Field measurements of temperature, pH, and conductivity were recorded using a portion of the sampled water. The remainder of the samples were transported on ice to the analytical laboratory and analyzed for total dissolved solids, nitrate and nitrite nitrogen, and total and dissolved metals (arsenic, cadmium, and lead). The detection limit used for arsenic was too high to evaluate the results according to the state groundwater quality standards, which are based on total arsenic rather than dissolved arsenic. Because the detection limit for total arsenic in the initial laboratory analyses was high, the samples were reanalyzed using a method with detection limits below the state groundwater quality standard.

Results

A summary of the discharge measurements and water quality analysis results are presented in Table 1. Table 2 summarizes the estimated elevation at the outlet of each spring on the site. The elevations of the springs were not surveyed for this study. These elevations are approximate and are based on field observations, geological cross-sections presented in the hydrogeological review (Rongey Associates 1998), and topographic mapping provided in the draft EIS (Figure 1-5, King County 1999).

Table 1. Spring data summary

Sample Location	Date	Discharge (l/s)	Temp (deg C)	pH	Conductivity (µmhos/cm)	Total Dissolved Solids (mg/l)	Nitrate+Nitrite Nitrogen (mg/l)	Total As (mg/l)	Total Cd (mg/l)	Total Pb (mg/l)	Dissolved As (mg/l)	Dissolved Cd (mg/l)	Dissolved Pb (mg/l)
Dry Weather Sample													
Spring A	10/14/99	1.0	12.9	7.15	182	143	0.277	0.0029	<0.00050	<0.0010	<0.0030	<0.00050	<0.0010
Spring E	10/14/99	2.2	12.8	7.24	214	141	1.03	0.0021	<0.00050	<0.0010	<0.0030	<0.00050	<0.0010
Wet Weather Sample													
Spring A	11/28/99	1.6	9.5	6.94	218	161	0.415	0.0029	<0.00050	<0.0010	<0.0030	<0.00050	<0.0010
Spring E	11/28/99	2.0	9.7	7.18	246	170	1.55	0.0020	<0.00050	<0.0010	<0.0030	<0.00050	<0.0010

l/s liters per second
µmhos/cm micromhos per centimeter
mg/l milligrams per liter
As arsenic
Cd cadmium
Pb lead

Table 2. Approximate Spring Elevations

	Approximate Elevation (ft)
Spring A	25-40
Spring B	12-20
Spring C	12-20
Spring D	--[a]
Spring E	12-20

[a] Spring was not observed in field

All sample results met Washington State water quality standards for Class AA (extraordinary) surface waters for the parameters analyzed. All sample results also met Washington State water quality standards for groundwater for the parameters analyzed, with the exception of arsenic. Total arsenic was detected in the spring samples at concentrations ranging from 0.0020 to 0.0029 mg/L. This exceeds the state standard groundwater protection standard of 0.0005 mg/L.

Potential Impacts of Mining Activities on Spring Water Quality

The primary water quality concern associated with the proposed mining activities on the Lone Star site is the potential for contamination of groundwater due to leaching or other transport of arsenic from overlying soils. Containment of all site soils with arsenic levels exceeding MTCA residential cleanup levels (i.e., 20 mg/kg or 20 parts per million) is proposed. An analysis of the proposed containment system has been conducted, the results of which are presented in a separate memorandum dated November 10, 1999 (Herrera 1999).

Tests were conducted in a previous study on the leaching of arsenic, cadmium and lead from contaminated soil samples collected at the site. This testing was conducted in a laboratory according to the Toxicity Characteristic Leaching Procedure (TCLP) as established by the U.S. Environmental Protection Agency (USEPA). Results of this testing indicate that leaching does not occur extensively because these contaminants are tightly bound to the soil matrix (Appendix B, King County 1999). While there is a possibility that leaching of metals is occurring on the site at a greater rate than laboratory tests conclude, low concentrations of arsenic and other contaminants in the shallow groundwater indicate that leaching to groundwater is not a significant pathway for contamination.

Mobilization of arsenic in the soil due to excavation is possible, however, and therefore there is a threat of surface runoff and groundwater contamination if rainfall occurs coincident with the excavation and transport activities for contaminated soils. If stormwater runoff becomes contaminated with arsenic during excavation and transport activities, that contamination could potentially pass to the subsurface via infiltration of the runoff in the porous sands on the site. If this occurs, it is possible that spring flows could exhibit higher concentrations of arsenic, and spring discharges could contaminate the near shore waters of Puget Sound near the affected springs. Similarly, if disturbance of the soil matrix releases increased amounts of arsenic, water percolating through the disturbed soils could transport that arsenic downward to shallow groundwater. To avert these potential impacts, it is recommended that excavation and transport of the highly contaminated soil material be conducted during dry weather, that the area of excavation and disturbance be limited at all times, and that other best management practices (BMPs) be applied for erosion and sediment control. Transfer of the contaminated soils to the containment cells will remove leaching as a contamination pathway on the site. Once that transfer is completed, it is anticipated that there would be no threat of the springs becoming contaminated.

Other potential impacts of the proposed mining activity on spring water quality include contamination associated with leaks and spills of fuel, oil, and other fluids on the ground surface resulting from heavy equipment usage on the site, followed by leaching into the subsurface. The draft EIS discusses the potential for spills of fuel and other materials in relation to heavy equipment operations, and a proposed measure to provide a liner in a designated fueling area to prevent impacts resulting from spills or leaks during fueling. While leaks of fuel and other engine fluids would not likely be a major problem in non-fueling areas, other BMPs should be implemented with heavy equipment operations to improve water quality protection. These types of BMPs could include: education of site workers to watch for leaks and drips and to quickly take cleanup actions; development of procedures for the collection, storage, and offsite treatment of soils where contamination is evident from spills or leaks; and providing "bibs" for heavy equipment to capture leaks and drips.

Stormwater Infiltration/Detention Facility Evaluation

The original intent of this task was to evaluate the design of an existing or proposed stormwater facility, however no stormwater facility is present on the site and a design has not yet been prepared (Summers 2000 personal communication). The draft EIS presents a conceptual design of an infiltration system and information on the design storm that would be targeted for facility design, but does not provide details on how the facility could be built given the existing site characteristics. While the intended evaluation was not possible, an analysis of the site conditions regarding the proposed facility was conducted. Given that all, or nearly all, of the site runoff is likely to infiltrate the ground, the design of this facility will be an important component in preventing water quality impacts at the site.

Methods of Evaluation

General soils characterization information for the site was reviewed. Likewise, soil grain size data for the proposed infiltration area were reviewed to determine the suitability of the native soils for infiltration treatment. Design criteria from the 1998 King County Surface Water Design Manual were reviewed in regard to desirable characteristics of infiltration facilities. The potential for overflow from the infiltration facility was evaluated based on knowledge of the effectiveness of infiltration facilities constructed elsewhere in the region and in other parts of the country. The following paragraphs summarize the results of this evaluation.

Soil Characteristics

Soils in the vicinity of the proposed stormwater infiltration/detention facility are very sandy, and likely have a very high infiltration rate. Grain size analyses conducted on 32 soil samples indicate that site soils are predominantly sands and gravels with most samples containing less than 10 percent silt and clay (AESI 1998, Pacific Groundwater Group 1999). The infiltration rate has not been measured on site, but sands typically have an infiltration rate of approximately 8 inches per hour or greater (Horner 1998).

Applicable Design Criteria

The Vashon-Maury Island aquifer system is designated as a sole-source aquifer by the USEPA. Therefore, stringent water quality controls are required for an infiltration facility at the Lone Star mine site. The King County Surface Water Design Manual (KCSWDM) provides detailed information on how an infiltration facility must be designed for sole-source aquifer protection (King County 1998). The criteria applicable to the site soil conditions are as follows:

- The measured infiltration rate of the natural soil must be less than 2.4 inches per hour unless that soil contains finer-grained particles (i.e. it is not sand, sandy loam or loamy sand).
- An exception is allowed if the measured infiltration rate is between 2.4 inches per hour and 9 inches per hour and either of the following is true: 1) the soil has a cation exchange capacity greater than 5 meq/100 grams soil and organic content greater than 0.5 percent, or 2) a sieve analysis of the soil meets specific limits specified in the KCSWDM.

Soils in the low-lying area of the site where the stormwater facility is proposed are mainly sands, with a natural infiltration rate that may approach or exceed 9 inches per hour. This must be confirmed by field infiltration tests. If this is found to be true, or if the soil conditions listed above are not found to be present, infiltration will be allowable only if imported topsoil is used to line the pond or other amendments are added to the native sandy soil that restrict the infiltration rate. Imported soil is not allowed for this purpose unless an approved adjustment is made to King County's groundwater protection criteria. This would require coordination with permitting agencies. If the site soils are found to have an infiltration rate between 2.4 and 9 inches per hour, it is possible that imported or amended soils will not be needed. Preliminary soil sample data from the site indicate that the grain-size distribution may meet the sieve analysis criteria to allow infiltration in the natural soil.

Adjustment factors will need to be applied to the measured infiltration rate to calculate the infiltration facility size. These factors take into account the infiltration rate testing method, geometry of the facility and depth to water table, and eventual soil clogging. This adjusted design infiltration rate will lead to a larger infiltration facility than if the measured infiltration rate were used.

An overflow route must be incorporated in the infiltration facility design, with conveyance capacity for up to the 100-year, 24-hour storm peak flow. The DEIS states that the infiltration facility will be sized to capture and infiltrate the runoff volume generated under the 25-year 24-hour storm event, and a preliminary design identifies a proposed overflow route (King County 1999). It is possible that flows from smaller storm events could overflow the infiltration system if it becomes clogged. Stormwater overflows from the infiltration system would be discharged to the Puget Sound shoreline.

The conceptual design for the infiltration facility presented in the draft EIS does not specify a spill control device or presettling facility (King County 1999). However, a spill control device must be installed upstream of the proposed infiltration facility to capture oils and other floatable contaminants that may be present in stormwater. A presettling facility must also be constructed upstream of the infiltration facility.

Infiltration Facility Performance

Given that the native soils are highly conducive to infiltration of precipitation and runoff, it is expected that minor amounts of runoff will be generated on the site. Therefore, the infiltration facility would not be expected to receive excessive amounts of flow. However, because the soils beneath the designated infiltration area may have a restricted infiltration rate, there is potential for clogging of the infiltration surface with finer particles that are carried in runoff.

It is likely that runoff on the mine site will typically contain high concentrations of suspended solids. Runoff with high solids content could rapidly reduce the rate of infiltration in the near-surface soils of the stormwater facility. The presettling facility that is required on the inlet side of the infiltration facility should minimize this problem. Due to the available area on the site and open-channel conveyance of stormwater, a pond is the most likely type of presettling facility to be used. The presettling pond will have to be lined to prevent infiltration of inflows through the bottom. Constant monitoring and maintenance will also be required to keep the proposed stormwater facility functioning correctly.

Runoff that infiltrates the ground in the designated stormwater facility should not adversely affect groundwater quality. As noted previously, there is potential for contamination in stormwater runoff due to leaks and spills of fuel and other fluids associated with heavy equipment operations on the site. The infiltration facility would remove most of the contaminants anticipated in runoff, thereby protecting groundwater.

Stormwater Runoff and Sediment Impacts Evaluation

Potential Sources of Pollutants

Because there are currently no stormwater facilities on the mine site that can be monitored, the assessment of potential impacts related to stormwater runoff and sediment quality is based on water quality data collected at onsite springs and on an estimate of the pollutant removal effectiveness of the proposed stormwater infiltration facility, rather than on existing stormwater and sediment quality data. As discussed above, under Spring Water Quality Characterization and Impact Assessment, soils contaminated with arsenic or other metals above the MTCA Method A residential cleanup level on the site will be transported to lined and capped containment cells. Soils with contamination levels below the Method A residential cleanup level will remain in place on site, and may provide a source for stormwater contamination. Minor sediment contamination associated with leaks and spills of fuel, oil, and other fluids on the ground surface could result from heavy equipment usage on the site. Implementation of pollution prevention best management practices and a spill control plan for the site mining activities will reduce the potential for soil contamination from this source.

Potential Contaminant Pathways

There are several potential pollutant pathways associated with the surface soils. Arsenic and other metals present in the highly contaminated soils may be mobilized during excavation and transport to the permanent containment cells if those activities coincide with rainfall events. Once the highly contaminated soils are contained within the permanent cells, surface and ground water quality impacts are not expected to occur in relation to those soils. Relocation of highly contaminated soils to the containment cells is expected to remove a primary source of existing groundwater contamination and reduce the leaching of metals to groundwater that is currently occurring on site.

Arsenic in the remaining (mildly contaminated) soils on the site may, however, continue to leach into water that infiltrates the ground and travel to the underlying groundwater aquifer. Monitoring data from this study indicate that leaching of arsenic to shallow groundwater has occurred on site and has led to elevated concentrations of arsenic in spring flows. Arsenic could also leach into surface runoff draining to the site stormwater facilities, or remain bound to soil particles that are transported to the site stormwater facilities as suspended sediment in runoff. Soils that may become contaminated as a result of heavy equipment usage on the site are subject to the same potential pollutant transport pathways.

A leaching study of site soils was conducted on samples with high concentrations of arsenic, and the resulting leachate concentrations were found to be at least an order of magnitude below federal Maximum Contaminant Levels for protection of drinking water (see Appendix B of the draft EIS [King County 1999]). Site-wide leaching of contaminants to groundwater is not expected to increase due to the proposed mining activities. Arsenic concentrations found in site springs were at levels similar to those previously found in shallow groundwater (see Appendix E of the draft EIS [King County 1999]), suggesting that shallow groundwater is the source of these springs.

Transport of contaminated soil particles in surface runoff is a more likely pathway on the mining site. The extent of potential water quality impacts that could occur due to contaminated sediments entrained in runoff will be a function of the amount of runoff that occurs, and that will be influenced greatly by the native soil characteristics. A limited amount of soil grain-size information is available for the site (AESI 1998, Pacific Groundwater Group 1999). These data, along with site soil characterizations (see Appendix B of the draft EIS [King County 1999]) and site observations, indicate a prevalence of larger-grained particles in the soil. While these larger-grained soil particles are less mobile in stormwater runoff, finer particles that are present to a lesser extent in the soil matrix will be more easily transported as suspended material. The amount of surface runoff that would occur on the site during mining activities is uncertain, but may be slight given the coarse soils. The quarry area of the site currently shows little evidence of consistent surface water flows. Compaction of soils due to mining activities could increase surface water runoff on the site.

Potential Impacts of Contaminated Stormwater and Sediments

Arsenic contamination of groundwater is not expected to increase due to mining activities on the site, either through site-wide soil leaching or through stormwater infiltration. This is primarily due to the proposed removal of highly contaminated soils to containment cells. Contamination of ground water should occur to a lesser extent as leaching of metals from surface soils is reduced. The source of spring flows is shallow groundwater that is recharged by precipitation and infiltrated runoff in the site area. Because ground water quality should not worsen, spring water quality should not worsen. Further, the springs are currently discharging water that has arsenic concentrations well below state surface water quality standards. Therefore, no surface water quality impacts are expected from spring flows.

Leaching of arsenic from mildly contaminated site soils into surface water runoff is not expected to occur to a high degree. As discussed in the previous section, transport of contaminated particles is a more likely contaminant pathway on the site. All surface water runoff generated on the disturbed mining site must be routed to the proposed stormwater management facility. This detention/infiltration facility must be designed in accordance with the 1998 King County Surface Water Design Manual, and will be required to include a spill control device and presettling pond. If this facility is designed, constructed, and maintained appropriately, it will protect the underlying groundwater from potential contamination that could occur due to inflows of stormwater runoff with contaminated soil particles.

An overflow event at the proposed stormwater facility may occur in the case of an extreme rainfall event or if the infiltration capacity is reduced over time due to clogging. In this event, runoff that is in excess of the storage and infiltration capacity of the facility would subsequently be discharged directly to Puget Sound. Overflow runoff may contain low concentrations of pollutants and suspended sediments. Impacts to Puget Sound would likely be limited to a turbidity plume that would be dispersed with currents and wave action. Minor amounts of pollutants in overflow runoff would likely mix with clean water in Puget Sound in the immediate vicinity of the discharge point and result in minimal adverse effects. It is anticipated that diligent monitoring and maintenance of the stormwater detention/infiltration facility would be required, and that would minimize the potential for facility overflow events.

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