4 Early Action Alternatives

Three different alternative engineering approaches were developed and evaluated in order to identify a preferred method of reducing migration of contaminated sediments into the Kuskokwim River. The following alternatives were evaluated:

1. Alternative 1 – No Action
2. Alternative 2 – Channelization and Line Creek with Solidifying Concrete Cloth
3. Alternative 3 – Line Creek with Culvert
4. Alternative 4 – Excavate Red Devil Creek Sediment

A number of design assumptions must be made to develop and evaluate each alternative. The basis of the design assumptions was provided in the engineering analysis presented in the Hydraulic Analysis Report prepared by the U.S. Army Corps of Engineers, which is provided in Appendix C. These design assumptions are applicable to the technologies proposed in the individual alternatives. Additionally, based on the level of effort associated with implementing each of the action alternatives, it was assumed that each could be implemented in a single construction season.

4.1 Early Action Alternatives

4.1.1 Alternative 1: No Action

Under this alternative, no action would be taken to remove, treat, or contain sediment migration in Red Devil Creek. Site conditions that promote tailings migration in Red Devil Creek would not be expected to change, and the ongoing loading in the Kuskokwim River would continue unabated.

4.1.2 Alternative 2: Channelization and Line Creek with Solidifying Concrete Cloth

In this alternative, approximately 250 linear feet of the creek in the area of the tailings pile would be channelized and lined with concrete cloth. The extent of the creek modifications would run from the upstream end of the Main Processing Area to an existing bridge that connects the north and south banks of Red Devil Creek. This alternative would break the contact between the surface water of Red Devil Creek and the contaminated sediment that has been identified along the channel bed and banks. By reducing contact between the flowing water and the contaminants, there will be a reduction in the fluidization of contaminants, as well

as a reduction in dissolved-phase contaminant migration. It should be noted that surface water may still be in contact with contaminated tailings located along the adjacent stream banks during channel overflow that results from large storm and/or snowmelt events until full-scale remediation is implemented.

Concrete cloth is a flexible, cement-infused fabric that hardens when hydrated. It forms a thin, durable, water- and fire-proof concrete layer which takes the shape of the surface to which it is applied. The benefit of this material, particularly for the RDM site, is that it does not require a concrete mix plant or mixing equipment, nor does it require heavy equipment for installation.

Clearing and grubbing of vegetation along the creek banks will be required prior to installation. Large boulders or rocks will need to be removed, hauled, and stockpiled to be addressed under the final remedial action. Additionally, the segment of Red Devil Creek that runs through the Main Processing Area will need to be slightly realigned, and the channel bed and banks excavated and prepared as described below in order to increase the capacity of the creek and mitigate flooding of the tailings pile and waste rock areas that have been the source of surface water contamination through erosion. It is assumed that during earthwork and channelization, approximately 1,050 cubic yards of material will removed from Red Devil Creek to be hauled and stored in the tailings stockpile to be included as part of the full-scale remedial action. It is assumed that erosion and sediment control measures (i.e., silt fences) will be installed around the perimeter of the stockpile to prevent erosion of the excavated sediment. Additionally, stockpiled materials will be covered with a 12-mil, UV-resistant, reinforced polyethylene geomembrane liner with tear-resistant polyester scrim. This cover will reduce the potential for the stockpiled material to leach contaminants into stormwater.

Preliminary hydraulic analysis indicates that channelization of Red Devil Creek will require a minimum channel bed width of 4 feet and channel bank slopes of 3:1 (horizontal to vertical) in order to contain the 100-year flood (approximately 117 cfs). The modified channel will have an approximate maximum water depth of 1 foot during the 100-year storm event, which is similar to what has been observed historically at the site. The channelized segment of Red Devil Creek will retain is natural grade (approximately 4.8%) to provide a relatively smooth transition to the natural stream.

Excavation and grading of the creek banks and channel bed will allow for a consistent base on which the concrete cloth can be applied. It is assumed that excavated material can be used as fill along Red Devil Creek where needed and excess excavated material can be stored temporarily in the stockpiles to be incorporated into the full-scale remedial action. The extent of the proposed lined channel is shown on Figure 4-1, and Figure 4-4 provides the cross sectional details of the concrete cloth installation methods. Installation can be achieved using conventional construction methods and equipment. The cloth will be

unrolled in horizontal strips across the width of the channelized creek bed, keyed into the stream bank, and secured with stakes at 2- to 3-foot intervals as shown on Figure 4-4. At the overlap of the strips, a layer of bonding sealant will be installed, and the concrete cloth layers will be screwed together prior to setting the material.

Standard construction equipment will be used to perform the earthwork and to remove excess sediment and load the material directly onto dump trucks for transport to the temporary stockpile locations identified on Figure 4-1. Side slopes of the temporary stockpile would have a maximum slope of 2:1 (horizontal to vertical). To minimize stormwater infiltration into the sediment stockpile, it will be covered with a 12-mil, UV-resistant, reinforced polyethylene geomembrane liner with tear-resistant polyester scrim. This cover will reduce the potential for the stockpiled material to leach contaminants into stormwater. A soil or vegetation cover will not be required as the stockpile is anticipated to be temporary. It is assumed that erosion and sediment control measures will be installed in the vicinity of the stockpiles to reduce erosion of the excavated sediment.

A dissipation pool is also proposed under Alternative 2 to help diffuse the increased energy and velocities of the stream flow that may result from modifying the channel bed material. Additionally, the dissipation pool will act as a settlement pond for suspended sediment. The dissipation pool will be sited immediately upstream of an existing bridge that is located downstream of the Main Processing Area. Preliminary design calculations show that the pool will require a minimum depth of 3 feet to contain the 100-year storm event. The basin will consist of a pool followed by a scour apron lined with riprap to help transition Red Devil Creek back to natural hydraulic conditions. Riprap fill required for the dissipation pool will be obtained from a local borrow source that will be identified prior to initiating construction. The conceptual dimensions and details of the cross section of the proposed dissipation pool are shown on Figure 4-6. Material excavated from the dissipation pool will be temporarily stored in a stockpile and will be incorporated into the final full-scale remedial design. It is estimated that approximately 161 cubic yards of contaminated sediment will need to be excavated in order to construct the dissipation pool.

Diversion of surface flow within Red Devil Creek will be required during channelization and installation of the concrete liner to prevent premature hardening of the concrete cloth. Dewatering of the construction areas will ultimately be determined by the contractor during implementation of the early action; however, for cost estimating purposes, it was assumed that construction would occur during low-flow conditions for Red Devil Creek with maximum anticipated stream flow rates of approximately 5 cfs (the estimated 2-year flood) based on stream measurements collected by E & E during the summer 2011 and fall 2012 (USACE 2013). Construction will be staged from the most upstream portion of the Mine Tailings Area and will progress downstream in 50-foot segments so that Red Devil Creek can be diverted during installation of the concrete cloth. An inflat-

able dam will be installed along the width of Red Devil Creek immediately upstream of the proposed work area, and stream flow will be pumped around the proposed construction zones and back into the creek or directly to the Kuskokwim River while earthwork is being performed and the concrete cloth is placed. It is anticipated that the concrete cloth installation can be completed within one construction season and will require 3 months from the time of mobilization to the time of demobilization.

Erosion and sediment controls will also be implemented along the stream banks and will be installed above the concrete cloth to stabilize soil, minimize erosion, and reduce the conveyance of sediment to surface water once the liner has been put into place. Best management practices (BMPs) considered under this alternative include silt fences, bank regrading, and vegetation. These controls would be temporary and could easily be removed or replaced during the installation of the full-scale remedial activities.

An annual visual inspection would be required for this alternative to record the concrete's integrity, which could be adversely impacted from damage associated with abrasion from ice and/or sediment, as well as to check for beaver dams that could restrict flow of Red Devil Creek. Therefore, there may be minor maintenance and debris removal required.

4.1.3 Alternative 3: Line Creek with Culvert

For Alternative 3, approximately 250 feet of Red Devil Creek within the area of the tailing piles would be lined with a 6-foot-diameter, bolted-together galvanized corrugated metal culvert. The culvert would be delivered in pieces and would be assembled on site. A hydraulic analysis was performed by the U.S. Army Corps of Engineers (USACE; see Appendix C), which indicates that the estimated 100-year flow (approximately 117 cfs), in its entirety, would be contained by the culvert; the water depth within the culvert was calculated to be approximately 3.0 feet during the large flood events. The culvert would extend from the most upstream portion of the Main Processing Area and discharge immediately upstream of the existing bridge into a constructed dissipation pool, as shown on Figure 4-2. Approximately 550 cubic yards of material will be excavated. Further discussion associated with the disposition of material is provided below.

This alternative would temporarily break the contact between the surface water of the creek and the contaminated sediment with the highest concentrations of metals that has been observed along the channel bed and banks of Red Devil Creek. Therefore, there will be a reduction in both solid and dissolved-phase contaminant transport. Since this is an interim action, the culvert will not be buried so that it can be removed during the implementation of the full-scale remedial action selected for the RDM site. The culvert will be secured using a series of straps anchored into the soil or bedrock. Based on the analysis performed and reported in the USACE Hydraulic Memo, the spacing of the straps was assumed at 25-foot intervals; however, confirmation of the final strap spacing will need to be con-

ducted during the design phase to ensure stability during flood events to prevent the piping network from being shifted or transported due to soil failure.

Limited excavation of the creek bed will be required under this alternative in order to provide a uniform grade for the placement of the culvert in the creek bed. The excavated material will be used where fill is required, and excess will be stockpiled on the tailings pile, which will be included as part of the full-scale remedial activities. Standard construction equipment will be used to perform the earthwork, remove excess sediment, and load the material directly onto dump trucks for transport to the temporary stockpile locations shown on Figure 4-2. Side slopes of the temporary stockpile would have a maximum slope of 2:1 (horizontal to vertical). To minimize stormwater infiltration into the sediment stockpile, it will be covered with a 12-mil, UV-resistant, reinforced, polyethylene geomembrane liner with tear-resistant polyester scrim. This cover will reduce the potential for the stockpiled material to leach contaminants into stormwater. A soil or vegetation cover will not be required as the stockpile is anticipated to be temporary. It is assumed that erosion and sediment control measures will be installed in the vicinity of the stockpiles to reduce erosion of the excavated sediment.

A headwall will be installed at the upstream end of the culvert to direct the stream flow into the piping network. It is assumed that the headwall will be constructed of gabions as shown on details provided on Figure 4-5. The culvert and gabion baskets will be barged into the RDM site; however, it is anticipated that the fill rock required for the gabion headwall will be obtained from a local borrow source that will be identified prior to commencement of construction. Figure 4-5 shows the proposed location of the culvert as well as a cross section representation of the proposed gabion headwall inlet. In the future, the gabion headwall could also be utilized during the full-scale remedial action to assist in dewatering and stream flow diversion prior to dismantling the culvert during the full remediation.

The piping network may cause increases in the stream velocity when compared to natural conditions. Therefore, Alterative 3 will also require a dissipation pool to help diffuse the energy of the stream flow during large storm events and mitigate potential scour of the natural creek bed downstream of the modified segment of Red Devil Creek. The dissipation pool will be located immediately downstream of the culvert discharge point and immediately upstream of the existing bridge. Preliminary designs show that the pool will require a minimum depth of 3 feet to contain the 100-year storm event, and the basin will consist of a pool and scour apron to help transition Red Devil Creek back to natural hydraulic conditions. The conceptual dimensions and details of the cross section of the proposed dissipation pool are shown on Figure 4-6.

Dewatering of the construction areas will ultimately be determined by the contractor during implementation of the removal action; however, for cost estimating purposes, it was assumed that the culvert installation will be conducted during the

low-flow season to the extent practical. For the purposes of this EE/CA, it is assumed that the low-flow conditions for Red Devil Creek would result in maximum flow rates of approximately 5 cfs during the proposed construction months (estimated 2-year flood) based on stream measurements collected by E & E during the summer 2011 and fall 2012 (USACE 2013). Work will be conducted so that installation of the culvert will start at the most upstream portion of the Mine Tailings Area and progress downstream in 50-foot segments. An inflatable dam will be installed along the width of Red Devil Creek immediately upstream of the proposed work area, and stream flow will be pumped around the proposed construction zones (approximately 50-foot segments) while earthwork is being performed and the culvert is installed. It is anticipated that the culvert installation will require 3 months from the time of mobilization to the time of demobilization.

Annual inspections will be required for this alternative to visually inspect the culvert for beaver dams, damage from ice, abrasion from sediment, and performance of the anchor straps. Minor maintenance and debris removal may be required.

4.1.4 Alternative 4: Excavate Red Devil Creek Sediment

Under Alternative 4, approximately 5,000 cubic yards of contaminated sediment along the tailings pile not meeting cleanup criteria would be excavated, loaded into haul trucks, and transported to a designated temporary storage area on site. A partial excavation of the tailings pile to 6 to 7 feet (or until bedrock is encountered) would remove the sediment that is available for transport within the Main Processing Area. Depths and distances for excavation are based on longitudinal limits and hydraulic limits associated with maintaining a flow consistent with the existing conditions.

The excavation is proposed to extend along Red Devil Creek for approximately 200 feet within the Main Processing Area. The excavation will be limited to the south side of the stream within the area of concern (see Figures 4-3 and 4-7). Excavation will begin at the existing centerline of Red Devil Creek below the processing area and proceed in a straight upstream direction, realigning the creek and maintaining its natural slope. The excavation will then terminate upstream of the processing area and rejoin the existing creek. The excavation will be 12 feet wide at the bottom and extend up at a 3:1 slope (horizontal to vertical) on the south side. The slope on the north side of the creek will vary between a 4:1 (horizontal to vertical) to a 6:1 slope (horizontal to vertical) on the north side. Excavation on the north side will terminate when the slope reaches the existing creek's north edge. The realigned channel sidewalls will be lined on each side with 3-foot gabion baskets to maintain the constructed alignment. The fill rock required for gabion protection is assumed to be obtained from a local borrow source that will be identified prior to commencement of construction.

No excavation is proposed to occur along the north bank of Red Devil Creek as part of the early action because the existing northern bank is well armored and does not contribute tailings to Red Devil Creek.

A vertical gabion drop structure is proposed to be installed just upstream of the excavated area to act as a transition between the gradient of the excavated channel and the longitudinal gradient in the upstream section of Red Devil Creek. The drop structure will also slow water velocities during larger storm events, and mitigate potential channel erosion. The drop structure will consist of side wall gabions and four gabion steps on the channel bottom, each of which will provide a 2-foot drop over a total stream length of approximately 28 feet (for total vertical drop of approximately 8 feet). The proposed realigned profile showing the drop structure, as well as cross section details of the drop structure, is provided on Figure 4-7.

A sediment trap will be installed downstream of the realigned channel, immediately upstream of an existing bridge near the mouth of Red Devil Creek as shown on Figure 4-3. This sediment trap will be sized to allow settling of medium-sized sand (0.50 millimeters) and greater, but not allow re-suspension of material. However, there is still the potential for some fine-grained sand to pass through the trap. Cross section details of the sediment trap are provided on Figure 4-7. Material excavated from the sediment trap will be hauled to the on-site stockpile and incorporated into the mine tailings and contaminated sediment excavated from the Main Processing Area.

Dry dredging methods are proposed for sediment excavation along Red Devil Creek. This will require isolating the sediment from the creek through dewatering, or diverting Red Devil Creek around the excavation area. Dry dredging will reduce the potential for re-suspension and releases of contaminants into the surface water. Dewatering of the construction areas will ultimately be determined by the contractor during implementation of the removal action; however, for cost estimating purposes, it was assumed that the work will be completed in 50-foot segments. It is anticipated that a dam and diversion system will be feasible to redirect stream flow around the disturbed area. An inflatable dam would be temporarily installed immediately upstream of the work area, and stream flow from Red Devil Creek will be pumped and discharged downstream of the disturbed areas or directly to the Kuskokwim River. BMPs will be implemented to ensure that the discharge does not cause re-suspension of sediment downstream of the Main Processing Area.

Standard construction equipment will be used to remove sediment and load the material for transport to the temporary stockpile locations identified on Figure 4-3. Side slopes of the temporary stockpile would have a maximum slope of 2:1 (horizontal to vertical). To minimize stormwater infiltration into the sediment stockpile, it will be covered with a 12-mil, UV-resistant, reinforced polyethylene geomembrane liner with tear-resistant polyester scrim. This cover will reduce the

potential for the stockpiled material to leach contaminants into stormwater. A soil or vegetation cover will not be required as the stockpile is anticipated to be temporary. Erosion and sediment control measures will be installed in the vicinity of the stockpiles as needed to prevent erosion of the excavated sediment.

Restoration of the stream in the area of excavation is not part of the proposed action for interim sediment excavation activities. Once the excavation is complete, the stream will be directed into the realigned channel in the vicinity of the tailings pile, then allowed to flow through the current channel between downstream of the Main Process Area before entering the sediment trap.

Based on the estimated volume of soil that exceeds cleanup criteria, it is estimated that this alternative would require approximately 3 months from the time of mobilization to the time of demobilization.

4.2 Common Components and Assumptions

All equipment and materials required to complete each of the alternatives described above will need to be transported to the site by barge. Navigation season for the Kuskokwim River is limited to the months of late May through early September; logistical constraints are key in meeting the construction schedules estimated in this EE/CA. No contaminated material will be removed from the site.

Alternatives 2, 3, and 4 assume that existing access roads will be used to haul equipment and material within the RDM site during the early action. Minor improvements may be required to the existing access roads, in which case any materials needed to stabilize or improve the road (i.e., sand, gravel) will be obtained from a nearby borrow source.

Alternatives 2 through 4 will require some earthwork or excavation of sediment within Red Devil Creek. Excess excavated material will be stored on site in a stockpile that will be covered with a 12-mil, reinforced polyethylene geomembrane liner. BMPs (such as silt fences and hay bales) will be installed around the perimeter of the toe of the stockpile to ensure that the excavated material will not erode and run off into Red Devil Creek.