SWIFT CREEK SEDIMENT MANAGEMENT PLAN
Proposed Design

A Component of the Sumas Mountain Naturally-Occurring Asbestos Management Strategy

Prepared for Whatcom County Public Works
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1 Executive Summary

An active landslide on Sumas Mountain in Whatcom County, Washington, delivers over one hundred thousand cubic yards of sediment each year into a small perennial stream. The sediment contains high concentrations of naturally occurring asbestos and heavy metals. The stream, locally known as Swift Creek, flows into the Sumas River causing sediment to be deposited along approximately 45 river miles in the Sumas Valley in the United States and Canada. Release of asbestos, nickel, and magnesium from the landslide is entirely natural; nonetheless, state and federal agencies have declared that the asbestos can impose "significant health risks" to those who are exposed to the sediment in certain conditions (EPA, 2006).

The Swift Creek Sediment Management Plan contained herein, prepared by Whatcom County in consultation with Federal and State partners, establishes a civil works strategy aimed at controlling sediment transport, deposition, and flooding caused by the Swift Creek landslide. The strategy is intended to reduce future uncontrolled releases of asbestos in the lower Swift Creek drainage and Sumas Valley. Construction of the engineered civil works structures presented in this plan is expected to reduce flooding by Swift Creek and control the downstream transport of landslide sediments. These works will improve the human environment by diminishing flood-related deposition of sediment on roads, in ditches, around farms, and near private homes. The works provide a feasible and relatively low cost management option that can be built in stages and financed by combined Federal, State, and local governments when suitable funding authority is identified. The cost of design and construction is estimated to be $10 Million dollars. The works could be functional in 3 years.

Implementation of the Swift Creek Sediment Management Plan is currently burdened by unclear regulatory authorities and, more importantly, potential liability incurred by any non-federal party that acts to manage the asbestos-containing sediment. Current laws are designed to safeguard against releases of asbestos. These laws penalize land-owners, handlers and operators of facilities who enable releases. There are no allowances within the law for acting in response to natural releases, even in defense against a common enemy. Liability remains the preeminent limiting factor, followed closely by the inability to secure funding through existing agency authority.

These limiting factors are substantial. Overcoming them requires creativity, trust, cooperation, and support from governments and communities. Failure will leave Sumas Mountain sediments in an unmanaged state. This 'no action' outcome will likely weaken the local economy, degrade the natural environment, reduce the functionality of public infrastructure, affect international relations, and generally diminish community health and well being.

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2 Problem Summary

The Sumas Mountain Naturally-Occurring Asbestos (NOA) problem is complex and multifaceted. In its simplest terms, the problem results from:

- An active landslide generates large quantities of sediment laden with naturally-occurring asbestos and heavy metals that are transported downstream, filling stream channels and flooding asbestos and metal-laden sediment into the farmlands, wetlands and built environment along Swift Creek and the Sumas River (Appendix A)
- Potential health risks arise from the introduction of asbestos into the human environment via uncontrolled, natural releases of asbestos (Appendix B)
- Existing state and federal regulations do not accommodate management of asbestos in response to natural processes. Liabilities for handlers and managers of such materials are imposed under CERCLA and MTCA (Appendix C)
- Federal funding is extremely limited because the “problem” does not fit within any known federal agency authorities

The above-listed natural occurrences result in a suite of management issues, including:

- Risk to public safety from landslide hazards
- Asbestos-laden sediment is suspended in the water and transported downstream of the slide via the receiving waters
- Asbestos-laden bedload sediment (sand and gravel) is deposited in the channels exacerbating flooding
- Unquantified risks to public health from asbestos deposited onto the landscape by flooding
- Increasing flood frequency and extent over time from the chronic sedimentation in the channels
- Recurring damage to public infrastructure from sedimentation, avulsions and flooding
- Impacts to the economy (private property, agriculture and businesses) from asbestos and heavy metals
- Impacts to the environment (fish, wetlands, insects, etc.) from the distribution of large amounts of injurious sediment
- Potential degradation of drinking water caused by metal leaching from the sediment
- Questions of liability related to handling and managing the sediment

A Sumas Mountain/Swift Creek NOA problem overview, in slide presentation format, that is used as a tool to assist in communicating this complex problem to agencies, elected officials and the public is provided in Appendix H – Summary Presentation.

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3 Purpose and Objectives

This Swift Creek Sediment Management Plan is one component of the evolving overall Sumas Mountain Naturally-Occurring Asbestos Management Strategy. The Sumas Mountain Naturally-Occurring Asbestos Management Strategy is an evolving work being developed by Whatcom County in consultation with federal and state partners. Its purpose is to providing a framework of management strategies that will adapt to the continuously changing conditions on the ground and fulfill the following objectives:

(1) sediment management and abatement of flooding risk,
(2) community and health information outreach, and
(3) land-use planning and regulation.

The Swift Creek Sediment Management Plan, presented in this report, focuses on providing solutions for the sediment and flooding risk objective. The Swift Creek Sediment Management Plan meets these objectives with a system of engineered works designed to control sediment transport, deposition, and flooding caused from the Swift Creek landslide and reduce future uncontrolled releases of asbestos in the lower Swift Creek drainage and Sumas Valley. Implementation of these civil works will meet the following management objectives by controlling sediment in the upper alluvial fan area of Swift Creek before it can be transported downstream and impact the built environment:

- flooding control to reduce the potential for future uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage, and reduce potential private property impacts.

4 Background

The Swift Creek landslide on the western slope of Sumas Mountain in Whatcom County, Washington mobilizes hundreds of thousands of cubic yards of asbestos containing sediment into Swift Creek and Sumas River annually (Figure 1). The sediment fills the channels and is deposited on the floodplain of the Sumas Valley in the United States and Canada during floods. Historically, Swift Creek and the Sumas River were dredged to reduce flooding. Dredged sediments were stockpiled in unmanaged locations next to the creek where they were available for off-site use. This management strategy it is no longer viable due to concerns about asbestos. These concerns center on public health, but extend to legal, regulatory and liability risks. With sensitivity to asbestos risks growing, the complexity and scope of the Swift Creek problem has expanded greatly. Now management objectives must consider the impacts of sediment quantity and quality, flooding, and liability problems not just to Swift Creek, but to the Sumas River as well. Figure 1 also shows the potential NOA impact area estimated from a combination of hydraulic modeling, field observations and professional judgment (Whatcom County 2009).

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An alternatives analysis completed in 2010 recommended:

- Construction of engineering structures (sediment basin, berms, grade control) on the upper Swift Creek alluvial fan (east of Goodwin Road) to capture and manage bedload and suspended load sediment to arrest the downstream migration of sediment.
- Assessment of potential landslide stabilization methods and feasibility and implementation if viable.
- A regular and frequent Repair and Maintenance program be implemented to address areas of acute risk until such time that the overall sediment management strategy could be implemented.

A summary of proposed sediment management plan and a sequencing strategy is presented in Table 1 (modified from PSE, 2010). The recommended engineering concepts developed in KWL, 2008 and PSE, 2010 were built upon to develop preliminary engineering designs and are presented in Section 5.

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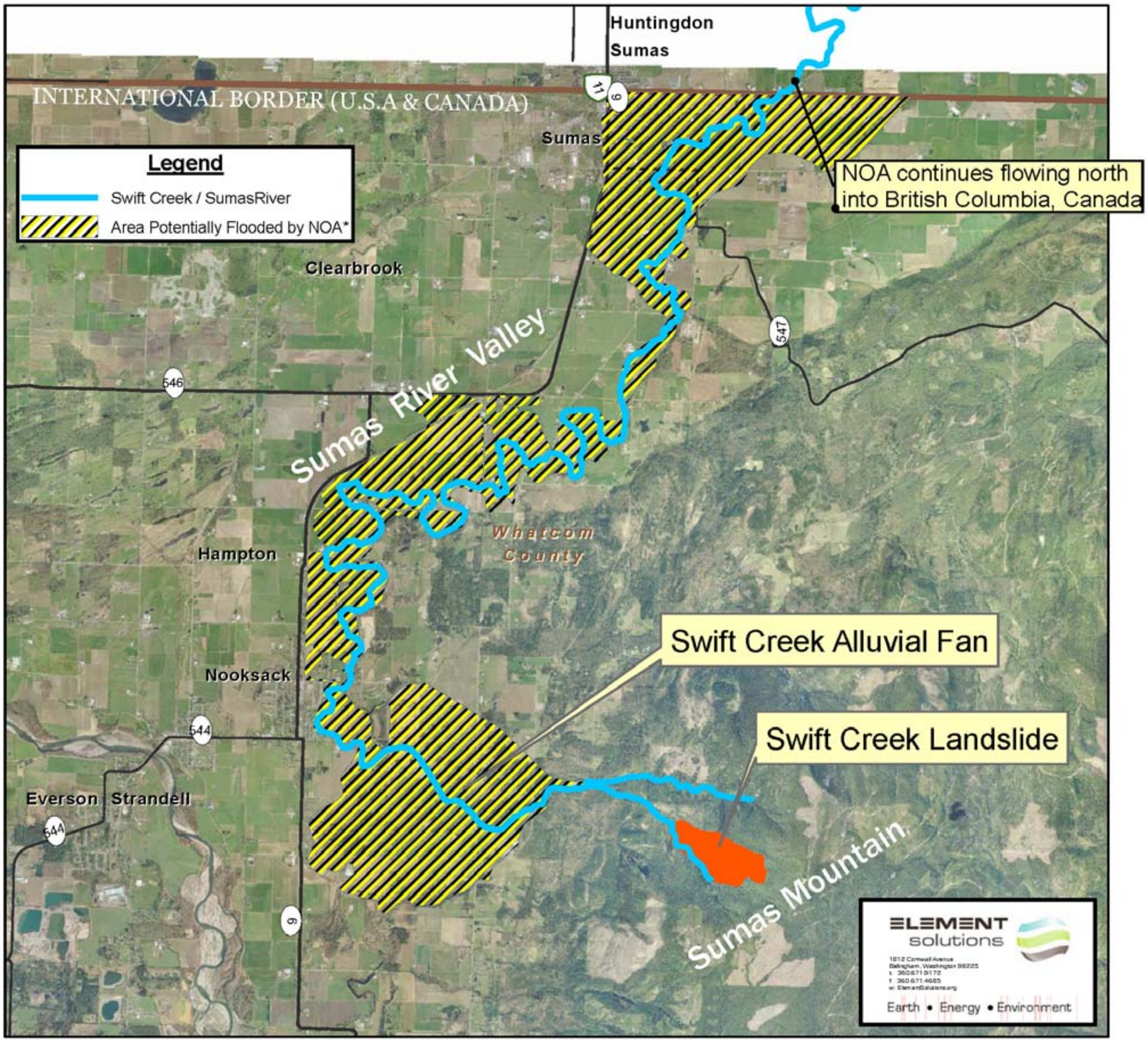
Figure 1: The "Area Potentially Flooded by NOA" was determined by combining hydraulic modeling from City of Nooksack, City of Sumas, and FEMA and modified based on field observations during the January 2009 flood and by professional judgment. The assumption is that the floodwaters of the Sumas River will carry some asbestos from Swift Creek and deposit it within the areas inundated by floodwater.



Project Benefits	Estimated Costs	Sequencing							
	(total)								
more	$1.5 – 5.5 M				**Landslide Stabilization** Yr 3 and beyond (long-term) → Construction: $150,000 -$4 M Assessment ($150,000)	Maintenance (assume $150,000/year for 5 years)			
↑	$4.5 M		Basin Design & Permitting ($600,000)	**Basin Construction** Yr 3 (2-4 yrs to build) ($4 M)		20-year benefit (increased benefit with Landslide Stabilization) →			
Project Benefits	$2.5 M (Yr10)	Levee Design ($50,000)	**Levee Construction** Yr 2 ($1.6 M) (add ~ $800k for maintenance and acquisition)					Grade control and levee maintenance needs diminish assuming landslide stabilization is successful	
	$1.5 M (Yr10)	Design ($50,000)	**Grade Control Construction** – phased and scalable ($500,000 for small to mid-range scale) (maintenance required during basin operation: $50,000/year)						
less	~$250k/yr will vary	R & M Works ($250,000)	R & M Works ($250,000)	R & M Works ($250,000)	R & M Works ($250,000)	This R & M program can be discontinued or greatly reduced once the interim project is implemented			
		Year 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 10**	**beyond**

Table 1: Summary of recommended sediment management alternatives (modified from PSE, 2010 – Appendix D). The Repair and Maintenance program (R & M) is projected to be annual maintenance needs to address acute sediment management and flooding issues to keep infrastructure open. The design elements of the Grade Control structures, Levees, and Sediment Basin were developed into preliminary designs as part of this study, the Swift Creek Sediment Management Plan Preliminary Design Phase. These design elements can work individually or combined and will provide mid-term management for several decades once implemented. The long-term plan includes landslide stabilization measures, which are outside of the scope of this study.

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5 Basis For Engineering Designs

5.1 Structure Designs

The '*Sumas Mountain Naturally-Occurring Asbestos Interim Alternatives Analysis*', Prepared by Pacific Survey & Engineering April 27, 2010 (hereinafter referred to as the Alternatives Analysis), identified a sediment management plan to control sediment transport by capturing and storing asbestos containing sediment on the alluvial fan, near the base of the landslide, and then if practical methods are developed, address the source at the landslide. This document contains design information for engineering structures that will facilitate planned intervention into the natural delivery of NOA sediment from the landslide to the populated valley below.

These works include grade control structures, setback levees, and sediment basins, see Table 2 and Figure 2 below. The proposed works can function as stand-alone structures for localized control of sediment, or as an integrated system that imparts a regional benefit to public health and safety.

Table 2: Alternatives Management Type and Identification Summary

Management Type:	***Alternative Strategy:***	***Main Objectives***
Bedload	In-stream grade control structures	Bedload storage
Fine Sediment	Bermed & Excavated Sediment Basins	Suspended sediment storage and public health
Flood Control	Debris Flow Deflection Levee (East Setback Levee)	Debris flow containment and public safety
	West Setback Levee	Sediment storage and public safety
	South Pass Rd. Setback Levee	Sediment storage and public safety

For preliminary design drawings, reference Exhibits 'A' through 'G' attached to this report.

Supporting technical information is assembled in Appendix E. The information includes the hydraulic modeling, geotechnical information, survey data, suspended sediment monitoring, bedload monitoring, and ground water monitoring.

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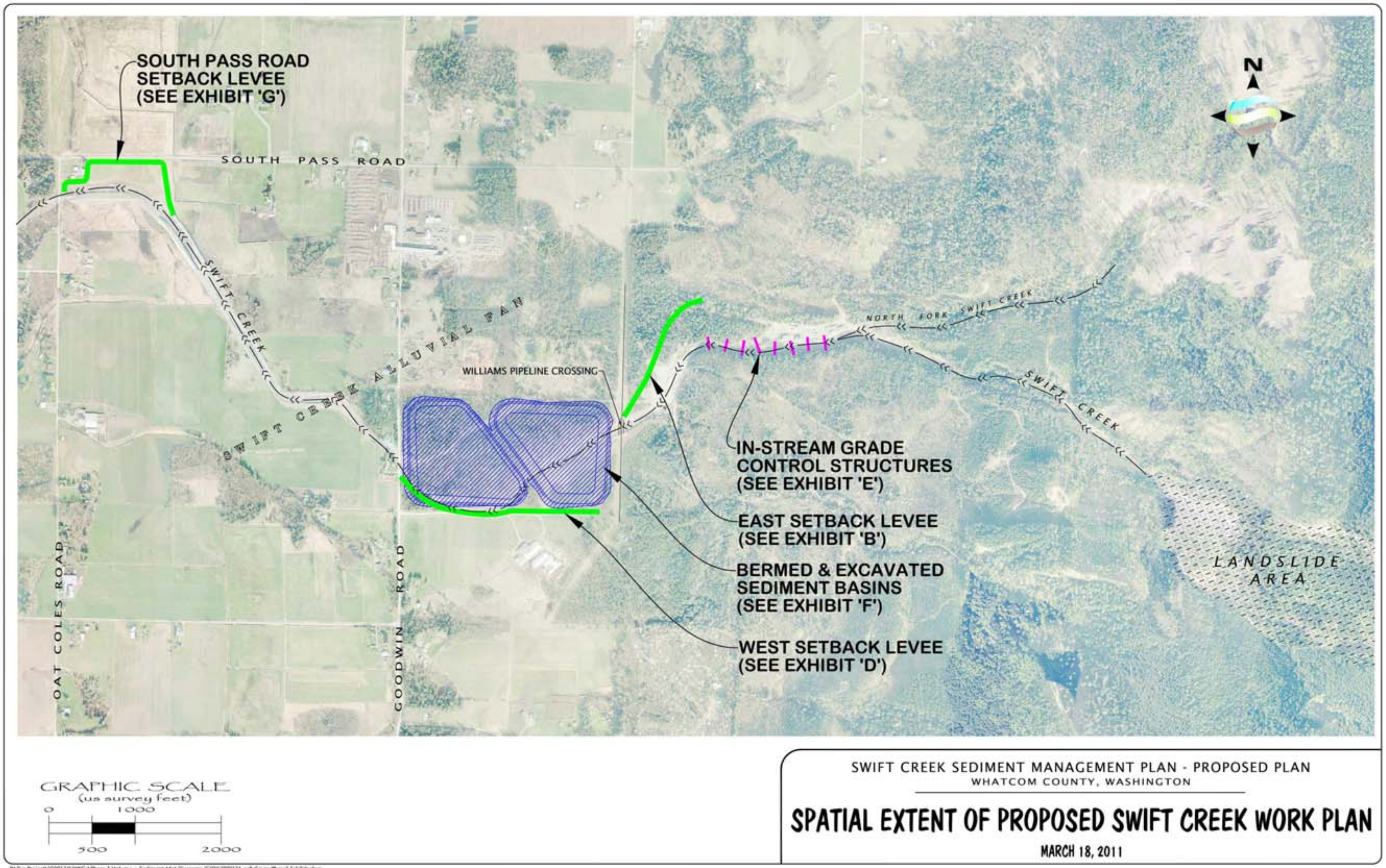

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5.1.1 Bedload Management – In-stream Grade Control Structures (See Exhibit E)

Objectives

The purpose of the grade control structures is to retard or arrest the downstream migration of bedload sediment and accomplish meeting the management objectives of:

- flood control to reduce the potential for future uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage,
- and reduce potential private property impacts.

For this analysis, grade control structures refer to structures placed across the stream channel that modifies the stream profile to capture and store bedload sediment, ranging from fine sand and silts to boulders, upstream of the structure. Another advantage of grade control structures is that the sediment captured behind the structures could be used to construct on-site facilities such as levees or berms. At some point in the future, if resolution for off-site uses of the aggregate occurs, the material stored by the grade control structures could offer a renewable product source.

The grade control structures are proposed to be located through the Swift Creek Canyon section to utilize the relatively narrow and steep side slope of the natural canyon wall terrain to contain sediment beyond the sides of the soldier pile walls. '*Exhibit 'A' – Overall Site and Sheet Key Diagram,* and *'Exhibit 'E' - Grade Control Structure Plan & Profile & Containment Volume Estimate Diagram'*. Based on the proposed conceptual design, bedload storage of approximately 50,000 cubic yards would be provided over about 1800 lineal feet of Swift Creek channel starting at the upper end of the Swift Creek Canyon just below the confluence of the North Fork Swift Creek. Bedload sediment arriving to the alluvial fan was measured for several years by Whatcom County. Maximum annual bedload sediment deposition approached 50,000 cubic yards, but averages were less. The 1971 event deposited an estimated 150,000 cubic yards in a single event. The average bedload deposition at the apex of the fan between 2006 and 2010 is pending analysis upon receipt and processing of the 2011 LiDAR topographic survey data. The structures are designed to capture average annual bedload volumes and to allow large debris flow events to pass over the structures with little to no downstream impacts. As designed, maintenance of the structures (sediment removals) would be required at an interval of approximately 2 to 5-years.

Additional detailed description of this management alternative strategy is found in the Section 2.1A of the *Sumas Mountain Naturally–Occurring Asbestos Interim Alternatives Analysis*.

Concept Design

The grade control structures may be constructed using a soldier pile wall consisting of steel H-beams embedded in the ground with timber lagging. Use of these materials allows for an adaptable design and allows for varying heights of the grade control structure. Additional timbers can be stockpiled on site for quick deployment to meet current site conditions. Building the grade control structures in height as needed over time to provides a safety mechanism and will help avoid failure of the structures via a large gradient difference between upstream and immediately downstream of the structures.

The current conceptual design consists of grade control structures, made up of eight soldier-pile walls, placed on approximately 200-feet on-center through the Swift Creek Canyon section. Final design parameters will need to be developed based upon geotechnical information and structural engineering calculations. Conceptually, soldier piles could be constructed from 40-feet long steel H-beams with approximately 25-ft of embedment in existing ground, resulting in up to 15-feet of available lagging height. The solider pile walls vary in length from 85-feet to 200-feet, with soldier piles 10-feet on-center. The height of the grade control structures can be gradually built-up to an elevation of approximately 10 to 14 feet above existing ground by adding levels of timber lagging. It is assumed the bedload deposition finished grade shall follow approximately the same longitudinal grade of the existing streambed.

A design alternative that could be constructed in conjunction with this design element is the re-routing of the North Fork Swift Creek (or Gold Creek) from the current confluence at the apex of the alluvial fan to a point downstream east of the Williams pipeline crossing and within the proposed East Levee Setback (described below). There would be some hydraulic and fish habitat benefits to this alternative, but is not an essential design element. It is estimated that this work could be accomplished for approximately $200,000.

Status: 30% Design

5.1.2 Fine (Suspended Load) Sediment Management – Bermed and Excavated Basins (See Exhibit F)

Objectives

The sediment basins will provide sediment, flooding, and NOA management benefits by slowing down runoff velocities to allow deposition and removal of fine suspended load sediments from creek waters. Capture of this suspended load sediment addresses the problem of exacerbated flooding downstream as a result of decreased channel capacity from sedimentation. Decreased sediment in the floodwater is also a benefit in that it reduces the health and environmental risks associated with sediment entering into the community. The following management objectives are realized by implementing sediment basins for removal of suspended load sediments:

- flooding control to reduce the potential for future uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage,
- and reduce potential private property impacts.
-

Additional detailed description of this sediment basin management alternative strategy is available in the Section 2.1B of the *Sumas Mountain Naturally–Occurring Asbestos Interim Alternatives Analysis*.

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Concept Design

The facility, as conceptually designed, consists of two large basins on a 70-acre site located in the existing Swift Creek alluvial fan east of Goodwin Road and west of the Williams Gas Pipeline corridor. Sediment storage volume capacity on the magnitude of 1,963,000 cubic yards would be provided in the basins with the use of excavation into native material and embankment construction around the perimeter of the basins. The western and eastern basin storage volume capacities are 758,000 cubic yards, and 1,205,000 cubic yards respectively. Two basins would allow for phased construction and better management of residency times to maximize suspended sediment settling. The suspended sediment associated with the Swift Creek landslide has unique properties in that it has very rapid settling rates, therefore making benefiting the feasibility of this design element. *'Exhibit 'F' - Fine Sediment Basin Plan Diagram'* and *'Cross Section A-A Find Sediment Basin Plan Diagram'.*

Due to the large impoundment volumes the Washington State Department of Ecology Dam Safety Guidelines considerations shall be incorporated into the final engineer certified sediment basin designs. Future design refinements shall include inlet spillway and energy dissipation mechanisms to promote sediment deposition, outlet structures, and emergency by-pass or overflow structures.

The conceptual embankments are designed with a maximum depth of 15-feet from existing ground to top of berm. The berm top is designed at 20-feet wide and will have a gravel access road. The west basin top of embankment elevation is at 155-feet and the top of sediment storage would be limited to an elevation of 153-feet resulting in 2-feet of freeboard. The west basin top of embankment elevation is at 180-feet and the top of sediment storage would be limited to an elevation of 178-feet resulting in 2-feet of freeboard. Embankment side slopes are designed at a slope of 3H:1V. All grading daylight geometry in this preliminary basin design is based on 2006 USGS North Puget Sound LiDAR survey surface data (with a vertical datum of NAVD 88).

A large portion of the native material excavated to construct the sediment basins can be used as fill for construction of the basin embankments. The conceptual design estimates earthwork volumes for construction of both sediment basins on the order of 1,728,000 cubic yards of cut material and 132,000 cubic yards of fill material. In addition, preliminary geotechnical borings and evaluation of subgrade determined that a significant quantity of sediment underlying the proposed basins consists of non-asbestos bearing aggregates that likely have a market value, and thus could offset construction costs. Preliminary estimates are that a net value of $2 per Cubic Yard could be realized. Refinement of these numbers and collection of more geotechnical information will be needed for the subsequent final design phase.

Ground water elevations in the vicinity of the sediment basins were generated from groundwater conditions as measured during the 2010 geotechnical borings and per a March 2010 survey. Four ground water monitoring wells were installed and surveyed following the geotechnical borings in anticipation of further designs and environmental permitting. The finished grade of the preliminary sediment basin bottom maintain approximately 5-feet of cover above assumed ground water elevation. A preliminary study of heavy metal leaching was

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performed by Whatcom County west of Goodwin Road. The results found that leaching of these metals was minor. Leaching of the metals is exacerbated in acid conditions. The pH of sediment at the apex of the alluvial fan is alkaline and was measured at greater than 9 (Whatcom County, 2004).

The inlet and outlet structures of the sediment basin will take additional analysis. In particular, the inlet control structure lies adjacent to and immediately downstream of the three Williams high-pressure gas pipelines (36-inch, 30-inch, and inactive 26-inch). Design coordination with Williams will be required. In addition, clear-water hydraulic events were modeled; however dam outburst floods and debris flows have historically occurred in Swift Creek and these events were not modeled. The final design will have to take into account these larger potential discharges.

Status: 10% Design

5.1.3 Flood Control Management – Debris Flow Deflection and Setback Levees

1. East Setback (Deflection) Levee (see Exhibits B and C)

Objectives
The objective of this management strategy includes the use of a containment (or set back) levee offset from the banks of Swift Creek channel with the intended purpose to arrest and contain larger debris flows and sediment from flooding events. The setback levees will decrease the potential NOA impact area for a portion of the alluvial fan and store sediment on the floodplain, thus decreasing the downstream transport of some sediment. Management objectives achieved by implementing the setback levee include:

- flooding control to reduce the potential for future uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage,
- and reduce potential private property impacts.

The conceptual debris flow deflection levee for Swift Creek is proposed on the north side of Swift Creek immediately downstream of the canyon section, See *'Exhibit 'A' – Overall Site and Sheet Key Diagram*, *'Exhibit 'B' – East Setback Levee Plan & Profile Diagram'*, and *'Exhibit 'C' – East Setback Levee Containment Volume Estimate Diagram'*. Additional detailed description of this sediment basin management alternative strategy is available in the Section 3.4 of the *Sumas Mountain Naturally–Occurring Asbestos Interim Alternatives Analysis*.

Concept Design
The setback levee design consists of a constructed embankment approximately 1700-lineal feel long and varying in height from 2-feet to 15-feet in height. The berm top is designed at 20-feet wide and embankment side slopes are designed at a slope of 2H:1V on the containment side (east), and 3H:1V on the back-slope side (west). All grading daylight geometry in this preliminary basin design is based on 2006 USGS North Puget Sound LiDAR survey surface data.

HEC-RAS modeling, prepared by Northwest Hydraulic Consultants, October 2010 (Appendix E), determined clear-water flow velocities. Bruce Geotechnical Consulting (BGC) estimated a possible large debris flow possibility in the order of 300,000 cubic yards (Appendix A). The debris flow setback levee was designed to accommodate the estimated volume with an additional safety factor to provide debris flow storage volume capacity on the magnitude of 400,000 cubic yards. This volume capacity assumes that the containment of materials will fill to the top of the embankment, that all 400,000 cubic yards will be deposited upstream of the Williams pipelines, and that the surface of the debris flow deposit shall follow approximately the same longitudinal grade of the existing streambed (Appendix E).

Existing stockpiles of dredged sediments are located at the apex of the alluvial fan as short distance away from the proposed East Setback Levee. There are sufficient quantities of material in these piles to construct the East Setback Levee, therefore reducing the quantities of fill import and project cost (Appendix E). Work would occur outside of the OHWM and there are no wetlands within the proposed project footprint, therefore permitting for this structure should be straightforward and this project could be constructed in a short period of time. In the sequencing of project elements, the East Setback Levee would proceed the Grade Control Structures, Sediment Basin, or West Setback Levee. The South Pass Road Setback Levee could be constructed first since it is unrelated to this overall upper alluvial fan strategy.

Status: 50% Design

2. West Setback Levee (see Exhibit D)

Objectives

The conceptual setback levee is proposed on the south side of Swift Creek immediately upstream from the Goodwin Road Bridge, see '*Exhibit 'A' – Overall Site and Sheet Key Diagram,* and '*Exhibit 'D' – West Setback Levee Plan & Profile Diagram*'. The advantage of this setback levee would be to decrease the potential NOA impact area for a portion of the alluvial fan and store sediment on the floodplain in the reach immediately upstream of the Goodwin Road Bridge, thus decreasing the downstream transport of some sediment and provides protection to more than 50% of the houses on the Swift Creek alluvial fan. Management objectives realized by implementing the setback levee include:

- flooding control to reduce the potential for future uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage,
- and reduce potential private property impacts.

Additional detailed description of this setback levee management alternative strategy is available in the Section 3.3 of the *Sumas Mountain Naturally–Occurring Asbestos Interim Alternatives Analysis*.

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This management strategy is in the same location as the Sediment Basin alternative described above, and could be utilized in an interim manner prior to and during construction of the sediment basins.

Concept Design

The setback levee design consists of a constructed embankment approximately 2500-lineal feel long and varying in height with an average height of 4-feet. The berm top is designed at 6-feet wide and embankment side slopes are designed at a slope of 2H:1V on the containment side (north), and 3H:1V on the back-slope side (south). All grading daylight geometry in this preliminary design is based on 2006 USGS North Puget Sound LiDAR survey surface data.

Status: 50% Design

3. South Pass Road Setback Levee (see Exhibit G)

Objectives

The setback levee shall create a sediment containment area to assist in the management of flooding in the Sumas River and Swift Creek systems, and provide containment of sediment from Swift Creek floodwater laden with naturally-occurring asbestos and heavy metals. Management objectives achieved by implementing the setback levee include:

- flooding control to reduce the potential for future uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage,
- and reduce potential private property impacts.

The setback levee is proposed south of South Pass Road, bound on the west end by Oat-Coles Road, and bound on the east end by WSDOT unimproved Highway 9 right of way and agricultural drainage ditch, Appendix '*Exhibit 'G' – South Pass Rd. Setback Levee & Sediment Containment Area Conceptual Design Diagram'*. The advantage of this setback levee would be to decrease the potential NOA impact area for a portion of the alluvial fan, minimize environmental impacts to Breckenridge Creek and its associated wetland, maintain high-priority transportation infrastructure (South Pass Road), and store sediment on the floodplain in the reach immediately upstream of the Oat-Coles Road Bridge, thus decreasing the downstream transport of some sediment and reducing some of the on-going repair and maintenance needs at the bridge.

Concept Design

The first phase of project construction includes stripping topsoil north of the existing dredging stockpiles adjacent to the right bank of the Swift Creek channel. Approximately 16,000 to 19,000 cubic yards of topsoil shall be stripped to an elevation of 91-feet within the proposed sediment containment area, and windrowed along the west, north, and east edges of the project site and shall constitute the setback levee. The setback levee shall be approximately 2200 LF in length, with a top width of 30-feet and a top elevation of 98-ft, and varying in height with an average height of 6-feet. The windrow topsoil embankment side slopes are designed at a slope of 2H:1V on the containment side (south), and 3H:1V on the back-slope side (north). All grading volumes estimates and daylight geometry in this preliminary design are based on 2006 USGS North Puget Sound LiDAR survey surface data.

The resulting stripped area shall be used for sediment containment area with an anticipated design capacity of approximately 50,000 cubic yards of asbestos laden sediment stored to an elevation of 95-feet. Vertical storage capacity is limited by the existing Oat Coles Roadway elevation of approximately 95-feet in the vicinity of the Swift Creek bridge. After the proposed setback levee construction is completed, the existing dredging stockpile adjacent to the right bank of Swift Creek shall be breached near the west and east ends of the proposed setback levee to allow sediment laden runoff to be diverted into the containment area.
The second phase of the project shall be completed, at an undetermined future time, when the containment area is filled up with sediment from runoff. At that time the topsoil windrow setback levee material shall be utilized as a cap and spread over the contained sediment, and final site stabilized with vegetation will be completed.

A wetland delineation was performed at the proposed South Pass Levee Setback site. Some Category 4 wetlands were identified at the far east portion of the site. A JARPA is currently being developed for this project component.

Status: 50% Design

5.2 Anticipated Data Gaps for Final Design and Environmental Permitting

The following is a list of anticipated data gaps associated with final design development, environmental permitting, and connected to EIS scoping currently being developed:

- Geotechnical analysis
- Landslide hazards and debris flow/dam outburst modeling and hydraulic analysis
- Suspended load and sediment yield
- Suspended sediment settling rate analysis
- Hydro-geology (groundwater depths, flow, presence and movements of metals, pH)
- Wind and dust transport modeling
- Biologic information (avian and aquatic primarily)
- Williams Pipeline impacts
- Visual impacts
- Noise impacts
- Transportation impacts
- Archaeological survey
- Economic analysis
- Land use impacts
- A repair and maintenance program for implemented sediment management works

Appendix F – EIS Scoping Document – *IN PROGRESS*

5.3 Planning Level Costs

Table 3

Project Element	*Estimated Costs **
Grade Control Structures (upper alluvial fan)	$800,000
East Deflection Levee	$754,000
West Setback Levee	$325,000
South Pass Setback Levee (excludes wetland mitigation costs if necessary)	$345,000
Sediment Basin	$4,600,000
Repair and Maintenance**	$1,500,000
TOTAL	$8,324,000

*Estimated costs include construction, permitting, data gaps, and final design. Permitting and final design assumed at 25% of construction costs.
** Repair and maintenance costs assume 6 year cost horizon.

A compilation of planning level cost estimates is provided in Appendix G – Planning Level Costs

5.4 Repair and Maintenance Program for Sediment Management Works

A frequent and on-going repair and maintenance (R & M) program that manages bedload deposited throughout the Swift Creek channel will be needed until such time that the Sediment Management Works Plan is implemented and fully functioning, at which time channel maintenance should reduce in frequency. It is anticipated that this frequent R & M effort will be needed for, at best, several years. Without adequate funding, this effort could be indefinite. The R & M program will never be an effective tool to comprehensively manage the risks and at some point R & M costs will continue to rise, and the effectiveness of the works will continue to fall. The R & M program is not sustainable beyond the short-term, therefore it is imperative that the proposed Sediment Management Works be implemented as soon as possible.

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6 Findings and Conclusions

This Swift Creek Sediment Management Plan provides a means by which sediment from the Swift Creek landslide, containing asbestos and heavy metals, can be controlled in close proximity to the landslide with a system of engineered civil works structures located in Swift Creek alluvial area. Implementation of these civil works will meet the following management objectives by controlling sediment before it can be transported downstream and impact the built environment:

- flood control to reduce the potential for uncontrolled releases of asbestos and associated health risks,
- reduce public infrastructure damages,
- minimize environmental damage,
- reduce private property impacts.

Several key limiting factors need to be resolved before implementation of the designed sediment management works plan can occur. These limiting factors include:

- liability associated with management of the asbestos-containing sediment
- project financing and appropriate funding authority

Liability remains the preeminent limiting factor, followed closely by the inability to secure funding through an existing agency's authority. In addition to these limiting factors, several data gaps need to be filled prior to finalizing the designs or addressing some of the anticipated environmental concerns. The known data gaps are itemized in Section 5 above, and these shall be considered in the forthcoming EIS process.

Subsequent Swift Creek Management Plan efforts and steps toward implementation include:

- environmental review and disclosure,
- permitting,
- secure funding,
- finalize the sediment management works engineering designs,
- construction,
- establish a repair and maintenance program for the works.

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This report submitted by:

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Statement of Limitations

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This document represents PSE's best professional judgment based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the geologic engineering profession currently practicing under similar conditions. No warranty, expressed or implied, is made.

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APPENDIX A

Swift Creek Background and Alternatives Identification (KWL, 2008)

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APPENDIX B

APPENDIX B: Health Information (US EPA, 2006 and WA Dept. of Health, 2008)

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APPENDIX C

APPENDIX C: Regulatory Perspectives (US EPA, 2007 and WA Ecology 2007)

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APPENDIX D

Sumas Mountain NOA Short to Mid-term Alternatives Analysis (PSE, 2010)

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APPENDIX E

Supporting Technical Information
(PSE, 2011; 2011 LiDAR survey; NHC, 2010; GeoEngineers, 2010)

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APPENDIX F

Environmental Permitting
(PSE, 2011; Whatcom County SEPA MDNS, 2005;
DRAFT-Swift Creek Mangemetn Plan Scoping Document, 2011)

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APPENDIX G

Planning Level Cost Estimates (PSE, 2010; Hart Crowser, 2007; E&E 2007)

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APPENDIX H

Summary Presentation

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