Chelan County Natural Resources Department & WRIA 40A Planning Unit

WRIA 40A Storage Assessment Phase 2 Report June 2010

Prepared by RH2 Engineering, Inc.

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Prepared for: WRIA 40A Planning Unit

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WRIA 40A Storage Assessment Phase 2 Report

Table of Contents

FIGURES

Table of Contents (Continued)

DRAWINGS

TABLES

APPENDICES

Chelan County Natural Resources Department

& WRIA 40A Planning Unit

WRIA 40A Storage Assessment Phase 2 Report

INTRODUCTION

Purpose and Objectives

The Chelan County Natural Resources Department (County) is the Lead Agency for watershed planning in Water Resources Inventory Area (WRIA) 40A (Squilchuck/Stemilt). The WRIA 40A Planning Unit was awarded Watershed Planning and Implementation Grant G-0800519 from the Washington State Department of Ecology (Ecology) to conduct a storage feasibility assessment of five sites/alternatives selected by the Planning Unit. The County is designated as Grant Manager.

The objective of the storage feasibility assessment is to help the Planning Unit assess the technical and regulatory feasibility of creating or increasing water storage at five off-channel sites identified in the WRIA 40A Watershed Plan. The first phase of this study was completed in 2009 (RH2, 2009) and identified two sites for further study. The second phase (this report) includes conceptual designs and preliminary cost estimates for three preferred priority sites and identification of a preferred site for engineering design. It is anticipated that these results will be used to secure funding for design and construction of the preferred storage site. The scope of work and budget to accomplish this objective is outlined in Phases 1 through 3 below.

WRIA 40A Site Characteristics

The area occupied by WRIA 40A comprises over 49,000 acres (76.6 square miles). WRIA 40A is bounded by the Columbia River to the north, sub-basins of the Wenatchee and Columbia Rivers to the west (Mission Creek, Number 2 Canyon, Dry Gulch), Naneum Ridge to the south and Jumpoff Ridge to the east. The two primary streams in WRIA 40A, Squilchuck and Stemilt Creeks, are tributaries to the Columbia River. The management area consists of four sub-basins: Stemilt (21,430 acres); Squilchuck (17,600 acres); Malaga (8,490 acres); and Wenatchee Heights (2,200 acres) (**Figure 1**). Approximately 8 percent of WRIA 40A lies within Kittitas County and the remainder lies in Chelan County.

Most of the water in the basin originates as snow that melts off by mid-summer. Summer stream flow is low and useable groundwater resources are limited by geologic conditions. An elaborate irrigation infrastructure dating to the 1870s was created to sustain tree crops that require water through the entire dry summer. To meet demand, water is diverted from streams to off-channel reservoirs and pumped into the basin from the Columbia River.

Twelve irrigation water purveyors and numerous private irrigators divert, store and/or use water in WRIA 40A. Irrigators that would be affected by the findings of this study primarily include the Beehive Irrigation District and the Stemilt Irrigation District, and secondarily include irrigators downstream of the diversion for these two districts. The increased efficiency of reservoir storage could result in greater stream flow during the spring/summer runoff season, which would benefit instream flow conditions and potentially support additional out of stream uses of water.

WRIA 40A Planning Efforts

Watershed planning in WRIA 40A consists of the following three phases.

Phase 1: The organization phase, in which the initiating governments, including the County, the City of Wenatchee and the Stemilt Irrigation District, established a Planning Unit. The scope of watershed planning was determined, including the establishment of procedures to be employed during the planning process. The County is the lead agency for WRIA 40A watershed planning. Phase 1 was completed in 2006.

Phase 2: The watershed assessment phase included a water quantity assessment to enhance local knowledge about water resource issues and concerns. Tools necessary to support decision-making regarding management recommendations were also developed. The water quantity assessment comprised the first comprehensive characterization of water resources in WRIA 40A. The key findings of the water quantity assessment report that relate to water storage include the following.

- Preliminary water balance estimates indicate that most of the physically available water (runoff of precipitation, shallow groundwater and imported water) entering WRIA 40A is withdrawn or diverted for beneficial uses.
- A portion of winter and spring runoff, return flow from irrigation and base flow may be available for diversion to new or additional storage.
- The lack of stream flow and groundwater data results in large variation in water balance estimates. The availability of water for new storage is uncertain and will require additional data and analysis to quantify. New gauging data on Squilchuck and Stemilt Creeks will improve watershed hydrology.
- Irrigation water use is very efficient and incremental improvements in irrigation efficiency are unlikely to significantly increase water availability in the basin.
- Annual paper water rights are about 50 percent greater than the estimated quantity of physically available water. Water diverted for new storage may potentially impair senior rights and/or require mitigation of impacts to senior rights.

The Phase 2 Multi-Purpose Water Storage Assessment identified and evaluated opportunities to improve the beneficial use and/or increase the amount and/or reliability of water used in storage projects in WRIA 40A. The potential opportunities included improving irrigation infrastructure operations and efficiency, and increasing above and below-ground storage capacity.

Phase 3: This phase developed a watershed plan that recommended potential actions for the planning unit and stakeholders, including strategies and projects to achieve the goals of the plan. The watershed plan was developed from the Phase 1 discussions and the Phase 2 assessment work and led to three principal recommendations, which are listed in the general order of the Planning Unit's priority.

A. **Increase the availability of water, the reliability of the water supply, and/or increase water use efficiency.**
B. **Improve the management of water and related land resources in WRIA 40A.**
C. **Improve the understanding of the hydrology of WRIA 40A.**

Subcategories of recommendations, identified as opportunities, were established by the Planning Unit to achieve each recommendation. In particular, two opportunities identified to advance Recommendation A, directly related to the storage assessment objectives.

Opportunity A.1: Improve the existing infrastructure to minimize the loss of water.
This opportunity includes securing funding and implementing needed system improvements to minimize water losses due to leakage from existing and active reservoirs, estimated at approximately 1,800 acre-feet (AF) of water per year. Reservoir lining will directly reduce seepage loss.

Opportunity A.2: Expand existing storage capacity.
The expansion of storage capacity involves changes to active and inactive storage facilities, including structural modifications such as raising dam height, reactivating inactive facilities and constructing new facilities.

Regulating Authorities

In WRIA 40A, reservoirs and dams are regulated by several agencies, each with their specific concerns. These agencies jointly manage and protect water and land resources, and human and environmental health. The DSO is the regulatory authority for the construction, modification and operation of storage reservoirs with greater than 10 AF of volume (Chapter 173-175 WAC). Additional information to identify the requirements for reservoir improvements are available in the DSO Dam Safety Guidelines for: Owner Responsibilities (2004); Planning for Dam Construction or Modification (2008); and Design and Construction (1993).

Water rights for the diversion of water and the storage of water in reservoirs are regulated by Chapter 90.03 RCW and managed by the Ecology Water Resources Program.

Chelan County and the Washington State Department of Natural Resources (DNR) regulate land use, critical areas and environmental impact studies related to reservoir construction and modification, depending on land jurisdiction.

The Army Corps of Engineers (Corps), under the Clean Water Act, regulates activities that occur in fresh water, including shorelines and wetlands. The Corps is the permitting agency for construction of reservoirs that would occupy or disturb streams and wetlands.

Prioritized Storage Enhancement Projects

The following potential storage enhancement projects were selected by the WRIA 40A Planning Unit at the January 2008 meeting to be evaluated during the Storage Feasibility Study. The Phase 1 report identified the following projects in order of feasibility (RH2, 2009):

1. Reactivate, enlarge and line Rose Lake
2. Fully Line Clear Lake
3. Construct a new reservoir near Stemilt Loop Road
4. Enlarge Beehive Reservoir
5. Partially Line Lily Lake
6. Raise Beehive Reservoir Dam
7. Partially Lily Lake

PHASE 2 INTRODUCTION

This phase developed the conceptual plans for three reservoir sites identified as priority sites by the WRIA 40A Planning Unit meetings in 2009 and 2010 based on the results of the Phase 1 study. The three sites are informally named the Upper Stemilt Loop Road site, the Lower Stemilt Loop Road site, and the Lower Beehive site. **Figure 1** identifies the locations of the three sites. **Table 1** summarizes the site details of each of the WRIA 40A Storage Assessment Sites, and **Table 2** summarizes the land use surrounding each of the assessment sites.

The Phase 1 report identified reconstructing Rose Lake as the highest feasibility storage projects in WRIA 40A from a construction standpoint. However, there was little interest in investing effort into the Rose Lake site due to limitations of property ownership and water rights. Fully lining Clear Lake and constructing a new reservoir at Stemilt Loop Road were identified as the next highest feasibility storage projects in WRIA 40A. However, the Stemilt Irrigation District concluded that Clear Lake could not go offline during the period of diversion and storage or during irrigation season, and so the Upper Stemilt Loop Road site was identified as the highest priority project in Stemilt Creek basin. Lining Clear Lake would be considered after completion of a new reservoir, which would allow Clear Lake to go offline. During subsequent meetings in 2009, Planning Unit considered and approved the evaluation of a new reservoir near the existing Beehive Reservoir site to provide a Squilchuck Creek option. This option appeared feasible based on the evaluation of enlarging the existing Beehive Reservoir. Subsequent meetings in late 2009 and early 2010 lead to the Planning Unit to also consider a reservoir site near the Upper Stemilt Loop Road site. This alternate site was identified late in the 2009, when the property owner became willing to consider this alternative. The Lower Stemilt Loop Reservoir site offered advantages to the Upper Stemilt Loop Road site, which would require re-routing Stemilt Loop Road and extensive wetland filling, and presented a greater risk from extreme flooding events than the Lower Stemilt Loop Reservoir site.

Phase 2 included additional field and analytical tasks to improve the understanding of conditions at the sites. RH2 Engineering, Inc. (RH2) conducted an additional review of geologic, geotechnical and wetlands conditions at the sites and a review of water rights was completed to update the information requirements supporting preliminary designs and cost estimates. Review of the available topographic data indicated that greater topographic precision was necessary to estimate the grading quantities, liner dimensions and costs for the Lower Beehive Reservoir and Lower Stemilt Loop Road site. Topographic surveys of these two sites were completed in 2010. The available topographic data for the Upper Stemilt Loop Road site was considered adequate for conceptual design. Because the Upper Stemilt Loop Road site is within a large basin, a hydraulic analysis of this site was conducted by a subconsultant to estimate potential extreme flooding risk in order to estimate emergency overflow spillway requirements.

Phase 2 entails compiling this new information, preparing preliminary reservoir configuration alternatives which were reviewed by the Planning Unit, and preparing advanced conceptual designs for three sites.

Additional Site Assessment for Phase 2

Geologic Reconnaissance

RH2 reviewed available soil map and geologic maps for the area and reviewed boring data for the original Stemilt Loop Reservoir site. On several site visits, RH2 inspected natural outcrops and roadcuts, and examined shallow soil for compositional and structural features. The field inspection confirmed the mapped soil and geology at all three potential sites, which are generally underlain by Stemilt silt loam (Stemilt Loop Road sites) and Loneridge stony loam (Beehive Reservoir site) derived from weathered rubbly basalt mapped as ancient landslide deposits (Stemilt Loop Road sites) or diamictite, a rubbly unsorted conglomerate (Beehive Reservoir site). The rubbly basalt appears at the surface as talus slopes or colluvium, and is frequently observed to be loosely bound by silt or clay. At all three sites, seepage was observed emanating from slopes, primarily at the Upper Stemilt Loop Road and Lower Beehive Reservoir sites, and only minor seeps were observed at the Lower Stemilt Loop Road site within lower portions of the narrow channel. Persistently wet areas at the sites promoted dense vegetation and wetland areas, which are presumably underlain by less permeable bedrock zones that retain moisture in overlying soil. **Appendix A** contains photographs for each of the reservoir sites.

Wetlands Reconnaissance

RH2 inspected the three sites for wetland and vegetation characteristics during both Phases of the project, and made a more detailed reconnaissance of the Upper Stemilt Loop Road and Lower Stemilt Loop Reservoir sites on September 30, 2009. The Lower Beehive Reservoir site was inaccessible due to road closure during prescribed burning in Fall 2009 and inaccessible due to snow cover in Winter and Spring 2010. A summary of the inspection is contained in **Appendix B**. Inspection of the wetlands at the three locations identified approximately 1 acre of pond and Category 2 or 3 wetlands at Upper Stemilt Loop Road site, approximately 0.5 acres of Category 2 or 3 wetlands at the Lower Stemilt Loop Road site, and approximately 1 acre of Category 3 wetlands at the Lower Beehive Reservoir site. The wetland area for the Beehive Reservoir site was evaluated using site photos and aerial photos and comparing these images with findings at the Stemilt Loop Road sites.

Topographic Surveying

Preliminary results of Phase 1 delineation using available 10-meter topographic data were too coarse to accurately assess requirements for grading and volume estimation. RH2 contracted NCW Land Surveying LLC (NCW) in Omak, Washington, to provide topographic elevation data for the perimeter and interior of the Lower Stemilt Loop Road and Lower Beehive Reservoir sites. NWC used a combination of GPS and level surveying methods to obtain evaluate general perimeter and internal topography and develop a contour map with 5-foot intervals for the two sites. The resolution of the topographic data greatly improved the estimation of the reservoir perimeter and volume, and grading and liner requirements. These data would be included as part of high precision survey necessary for design and construction. The survey data are attached in **Appendix C**.

Evaluation of Flood Characteristics to Support Hydraulic Control

RH2 contracted Northwest Hydraulic Consultants (NHC) of Seattle, Washington, to evaluate the peak storm runoff at the Upper Stemilt Loop Road site to estimate the emergency spillway design discharge. The findings are included in **Appendix D**. NHC concluded that a conservative estimate of runoff would require a spillway flow design capable of a peak flow of 2,000 to 2,500 cubic feet per second (cfs). NHC did not evaluate the Lower Stemilt Loop Road site, but results are expected to be comparable, as .the Lower Stemilt Loop basin area is approximately the same as the Upper Stemilt Loop basin area (763 acres). No evaluation of the Lower Beehive Reservoir site was conducted, as the basin above this site is significantly smaller, and would be readily evaluated during engineering design.

Revise Preliminary Design to Conceptual Design

RH2 prepared preliminary designs with basic topography data to identify general positions of the three reservoir sites. Schematic drawings were prepared and submitted for review to the Planning Unit meetings. It was apparent that detailed survey would be necessary, which was obtained with the services of NCW. RH2 incorporated the new survey data into the preliminary designs and prepared conceptual designs for each reservoir, which are presented as Drawings 1, 2 and 3 in the plans. The conceptual designs all incorporated a liner in the design, which is considered the most straightforward approach for construction and design without extensive geotechnical engineering and construction to create reservoirs that would rely upon low permeability clay liners. The source of material for clay, the quality control for clay liners, and the underlying fractured basalt and landslide-derived bedrock with groundwater seepage were deemed a higher risk approach than an underlying flexible high-density polyethylene (HDPE) liner. The liner approach, however, limits the maximum filling depth to approximately 30 feet, which also potentially reduces the reservoir storage volume. Should greater volumes be required for storage, further evaluation of the reservoir sites would significantly increase the necessary geotechnical assessment.

LOWER STEMILT LOOP ROAD CONCEPTUAL DESIGN

Site Summary

The proposed reservoir site is in an undeveloped area approximately 8 miles from the City of Wenatchee in a natural depression in the Stemilt Creek watershed. The reservoir would be used to store and convey water as part of the Stemilt Irrigation District system that includes Clear and Lily Lakes (**Figure 1 and Drawing 1**).

The property is owned by a private landowner that has connections to members of the Stemilt Irrigation District and immediately accessible by Stemilt Loop Road. Easement access would be required to convey irrigation water across adjacent properties.

The land and surrounding area is zoned Commercial Forest. No Chelan County Critical Areas are established adjacent to the reservoir site other than wetlands mapped under a designation as "Emergent; Temporarily Flooded; Impounded" (Cowardin, 1979). Constructing a new reservoir at the site would permanently inundate these wetlands and likely create new seasonal wetland areas along the reservoir shoreline. Permanently inundated land would be created in the reservoir.

Vegetation at the site consists of open, mixed pine-fir forest. The proposed reservoir area is undeveloped and is used by the general public for winter recreation. The reservoir site exists within an approximately 700-acre basin, which supports perennial stream flow and springs originating from the Jumpoff Ridge. The basin is upstream of and tributary to Stemilt Creek and the reservoir and dam would be classified as in-channel structures.

Site Layout and Reservoir Operation

The reservoir site lies within an open bowl and channel of a minor tributary to Stemilt Creek (**Figure 1**). Constructing the reservoir would not require re-routing of Stemilt Loop Road and would be setback at least 100 feet from the road.

The total reservoir depth would be 17 feet, assuming that the lower portions of the reservoir would be filled and underlain with a drainage layer. This design depth is intended to maximize the storage volume without placing excessive hydraulic pressure on a flexible liner. A liner is recommended due to the relatively low cost compared to importing and placing a clay liner. The 30 mil to 60 mil polyvinyl chloride (PVC) liner would be underlain by a porous granular drain layer with perforated pipe to convey seepage beneath the liner to discharge downstream of the earth embankment. The simplest design would not include a liner cover comprised of soil and quarry spalls, which is more costly to construct and maintain. However, a liner cover may provide greater security against punctures or vandalism. A liner cover would consist of a 12-inch soil layer, covered with quarry spalls. Without a liner, a security fence would substantially improve security.

The embankment would be constructed of native soil and bedrock excavated from the interior of the reservoir perimeter and may include imported select fill. Fill would be compacted to 95 percent of relative compaction density. Subsequent geotechnical investigation of the embankment area would assess the need for additional key design or structures to strengthen the embankment.

Based on the size and location of the 550-foot-long embankment, the total storage volume is approximately 200 AF. The reservoir surface area would be approximately 13.2 acres.

The reservoir would be filled from the source and conveyance that currently fills Clear Lake via extension of the same pipeline. Operation would be similar to Clear Lake operation, but could potentially store water over the winter due to presence of liner. However, permitting requirements of the DSO will include estimating the effects for extreme winter storm flow into the reservoir as part of evaluating any risks related to winter storage.

Permitting Issues

General permitting issues and requirements were summarized in Phase 1 report. For this reservoir site, the critical permits and regulations will include water rights, wetlands mitigation, and dam safety.

The current plan for use of the reservoir would not change the timing or quantity of diversion or changing the place or type of water use of the existing Stemilt Irrigation District water rights. The right to store diverted water into the Stemilt Irrigation District reservoirs (Clear Lake and Lily Lake) would remain intact and a new reservoir right to store a portion the existing storage right would need to be obtained from Ecology. The new reservoir right would specify the purpose of storage and the timing and source of diversion as the same as the right to divert water into Clear or Lily Lake. Water rights permitting to obtain a new reservoir right under this scenario is expected to be straightforward. However, any changes in timing of diversion or quantity of water or changes in location or use of water would require modification of existing rights or acquiring new water rights. Simultaneous use of Clear or Lily Lake with the new reservoir could not result in diversion of water greater than current allowable diversion under the Stemilt Irrigation District water rights without a legal change in the water rights. Additional counsel from a water rights attorney is recommended to evaluate opportunities to re-allocate water within the current water right portfolio or identify the potential to acquire new rights from existing sources.

The construction and operation of the reservoir would occur within a perennial stream channel and would modify existing riparian zones and wetlands. Based on the estimated wetland size and mitigation ratios, creating additional storage at this site will likely require creation of 1 to 1.5 acres of additional wetland habitat, preferably on-site and within the drainage basin. The Upper Stemilt Loop Road site would be a prime candidate for a mitigation site, as it has undulating topography readily amenable to expanding the existing wetland area, a persistent source of seepage to maintain the enlarged wetland, and similar wetland characteristics.

The Phase 1 report and the findings of the wetlands reconnaissance conclude that construction in wetland and stream would require multiple agency permits that will involve the Corps as the lead agency and with Ecology, Washington Department of Fish and Wildlife (WDFW) and the County as participants.

Creation of new wetland habitat or restoration of existing wetland habitat presents the most viable option for mitigation in this area. Creation and restoration are preferred on-site or at least in the same drainage basin as the wetland being impacted. Often times, mitigation ratios will increase for mitigation completed off-site; however, this is typically at the discretion of the regulatory agencies (i.e. the Corps and Ecology). The mitigation ratios for creation of wetland habitat are less than those for restoration of habitat although restoration is preferred by the regulatory agencies because of its viability. Enhancement or preservation of existing wetland habitat is also options for mitigation although these typically require the highest ratios.

Development of a storage reservoir at this site would need to include provisions for an outflow to continue feeding downstream wetland habitat. Otherwise, additional wetland impacts would be incurred indirectly from reservoir construction. The reservoir underdrain would facilitate some of the re-routing of flow within the channel.

Dam safety would require full engineering analysis to extend the advanced conceptual design to actual design. As stated in Phase 1 report, the design of the reservoir would require additional geotechnical assessment of the embankment location and the type and availability of soil and rock for constructing the embankment. The Dam Safety permit would require specific design analysis to determine the potential quantities of seepage into the underdrain beneath the liner and the routing of water around the embankment to maintain stream flow. The emergency spillway structure would need to be calculated based on the basin area contributing to the stream channel at the reservoir site. These additional tasks are considered straightforward and could be undertaken as an interim step towards engineering design. Previous discussion with (DSO) regarding the Upper Stemilt Loop Road site identified wetlands and seepage as critical issues for the site, but other issues such as embankment and control structure design were seen as straightforward. Consequently, the design of the Lower Stemilt Loop Road site to meet DSO standards is expected to require less effort than for the Upper Stemilt Loop Road site. A meeting with DSO representatives is warranted to discuss the site characteristics, reservoir operation, and engineering design elements before further continuing with site analysis.

Control structures and pipelines would be sized based on final determination of the storage volume and irrigation requirements and storage operation. However, the location of the structures would not likely change from the conceptual design as shown in **Drawing 1**.

Costs and Construction

Costs are based on volumes and areas of the reservoir and a straightforward earth embankment design with a liner. The grading requirements would include clearing of vegetation, stripping of organic soil and re-grading the existing topography to accommodate the liner and drain, and stockpiling suitable soil to construct the embankment. The conceptual design indicates that 120,000 yards of earth materials would be required for re-grading and embankment construction. The maximum excavation depth is approximately 10 to 15 feet into native earth and no special excavation is anticipated; excavating some areas of resistant bedrock may require large rock excavators capable of ripping bouldery basalt.

Schedule

Engineering and design timeline, including additional engineering and geotechnical design tasks is approximately 1 year. Some of the permitting tasks could be completed simultaneously, including detailed assessment for wetlands at the reservoir site and wetland mitigation site. Permitting tasks including DSO review would likely require 2 years. Construction could occur during a single summer season for completing the earthwork. Wetland mitigation would likely extend from 5 to 10 years beyond the construction of new wetland areas to monitor and manage the wetland until fully established.

Cost summary and funding sources

Table 3 summarizes the estimated costs to construct the Lower Stemilt Loop Road reservoir. These costs include contingencies for additional detailed assessment and for final design, permitting and construction. An analysis of funding sources is beyond the scope of this Phase. Sources of State funding are limited, but combinations of private and public funding, particularly from the Office of Columbia River that may partner with the Stemilt Irrigation District with funding and use of the reservoir for water storage in the Columbia River or its tributaries, specifically, Stemilt Creek.

UPPER STEMILT LOOP ROAD CONCEPTUAL DESIGN

Site Summary

The proposed reservoir site is approximately 8 miles from the City of Wenatchee in a natural depression in the Stemilt Creek watershed as shown in **Figure 1** and **Drawing 2**. The reservoir was originally considered a dam site by the United States Department of Agriculture Soil Conservation Service (SCS) in 1958, and in the Stemilt Irrigation District Comprehensive Water Conservation Plan (CWCP) (HCWL, 2003). The reservoir would be used to store and convey water as part of the Stemilt Irrigation District system that includes Clear and Lily Lakes.

The property is owned by the Stemilt Irrigation District and immediately accessible by Stemilt Loop Road. Easement access would be required to convey irrigation water across adjacent properties.

The land and surrounding area is zoned Commercial Forest. No Chelan County Critical Areas are established adjacent to the reservoir site other than wetlands mapped under a designation as "Emergent; Temporarily Flooded; Impounded" (Cowardin, 1979). Constructing a new reservoir at the site would permanently inundate these wetlands and likely create new seasonal wetland areas along the reservoir shoreline. Permanently inundated land would be created in the reservoir.

Water collects seasonally in the topographic depression of the reservoir site from ephemeral and perennial springs and ephemeral runoff. Vegetation at the site consists of open, mixed pine-fir forest. The proposed reservoir area is undeveloped and not used by the general public for recreation. The reservoir site exists within a 750-acre basin that supports ephemeral stream flow and springs originating from the Jumpoff Ridge. The basin also includes Clear Lake. The basin is upstream of, and may be considered a tributary to, Stemilt Creek. Therefore, the reservoir potentially may be classified as an in-channel structure.

<u>Site Layout and Reservoir Operation</u>

The reservoir site lies within an open bowl and channel of a minor tributary to Stemilt Creek (**Figure 1**). Constructing the reservoir would require re-routing of Stemilt Loop Road to create maximum storage volume, and the road would traverse the reservoir embankment.

The maximum reservoir depth at the base of the embankment would be 37 feet assuming that the lower portions of the reservoir would be filled and underlain with a drainage layer. This design depth is intended to maximize the storage volume but is at the limit of excessive hydraulic pressure on the flexible liner. A liner is recommended due to the relatively low cost compared to importing and placing a clay liner. The 30 mil to 60 mil PVC liner would be underlain by a porous granular drain layer with perforated pipe to convey seepage beneath the liner to discharge downstream of the earth embankment. The liner would either be covered with a sand and quarry spall cover, or the reservoir would be surrounded by a fence for security.

The embankment would be constructed of native soil and bedrock excavated from the interior of the reservoir perimeter and may include imported select fill. Fill would be compacted to 95 percent of relative compaction density. Subsequent geotechnical investigation of the embankment area would assess the need for additional key design or structures to strengthen the embankment.

Based on the size and location of the 625-foot-long embankment, the total storage volume assuming a minimum excavation volume is estimated at approximately 185 AF. The reservoir surface area would be approximately 12.6 acres. An option to excavate additional soil to maximize the storage volume and reduce the depth by distributing excavation soil was evaluated, and the resulting storage would be 245 AF with a maximum depth of approximately 30 feet. This alternative would be much more costly, similar to the Lower Stemilt Loop, and would require re-routing of the Stemilt Loop Road.

The reservoir would be filled from the source and conveyance that currently fills Clear Lake via extension of the same pipeline. Operation would be similar to Clear Lake operation, but could potentially store water over the winter due to presence of liner. However, dam safety permitting would evaluate the potential for extreme winter storm flow into the reservoir to evaluate any risk of winter storage.

Permitting issues

General permitting issues and requirements were summarized in Phase 1 report. For this reservoir site, the critical permits and regulations will include water rights, wetlands mitigation and dam safety.

The current plan for use of the reservoir would not change the timing or quantity of diversion or changing the place or type of water use of the existing Stemilt Irrigation District water rights. The right to store diverted water into the Stemilt Irrigation District reservoirs (Clear Lake and Lily Lake) would remain intact and a new reservoir right to store a portion the existing storage right would need to be obtained from Ecology. The new reservoir right would specify the purpose of storage and the timing and source of diversion as the same as the right to divert water into Clear or Lily Lake. Water rights permitting to obtain a new reservoir right under this scenario is expected to be straightforward. However, any changes in timing of diversion or quantity of water or changes in location or use of water would require modification of existing rights or acquiring new water rights. Simultaneous use of Clear or Lily Lake with the new reservoir could not result in diversion of water greater than current allowable diversion under the Stemilt Irrigation District water rights without a legal change in the water rights. Additional counsel from a water rights attorney is recommended to evaluate opportunities to re-allocate water within the current water right portfolio or identify the potential to acquire new rights from existing sources.

The construction and operation of the reservoir would occur within a perennial stream channel and would modify existing riparian zones and wetlands. Based on the estimated wetland size and mitigation ratios, creating additional storage at this site will likely require creation of 2 to 3 acres of additional wetland habitat, preferably on-site and within the drainage basin. The Lower Stemilt Loop Road reservoir site may offer sufficient area as a mitigation site; a portion of the site has undulating topography readily amenable to expanding the existing wetland area, a persistent source of seepage to maintain the enlarged wetland, and similar wetland characteristics. However, the Lower Stemilt Loop Road site is privately owned and may not be available for mitigation. Other sites would have to be identified in the Stemilt basin that would suffice as a mitigation site. Potentially, Chelan County may have established a Fee-in-Lieu program for mitigation that would allow financial contribution towards a mitigation program instead of actual mitigation to replace inundated wetlands. However, a formal fee in-lieu program or certified bank is not currently established in the basin and thus this option is not presently available.

The Phase 1 report and the findings of the wetlands reconnaissance conclude that construction in wetland and stream would require multiple agency permits that would likely involve the Army Corps of Engineers as the lead agency and with the WDFW and the County.

Creation of new wetland habitat or restoration of existing wetland habitat presents the most viable option for mitigation in this area. Creation and restoration are preferred on-site or at least in the same drainage basin as the wetland being impacted. Often times, mitigation ratios will increase for mitigation completed off-site; however, this is typically at the discretion of the regulatory agencies (i.e. the Corps and Ecology). The mitigation ratios for creation of wetland habitat are less than those for restoration of habitat although restoration is preferred by the regulatory agencies because of its viability. Enhancement or preservation of existing wetland habitat is a possible mitigation alternative, although this alternative typically requires the highest mitigation ratio.

Development of a storage reservoir at this site would need to include provisions for an outflow to continue feeding downstream wetland habitat; otherwise, additional wetland impacts would be incurred indirectly from reservoir construction. The reservoir underdrain would facilitate some of the re-routing of flow within the channel.

Dam safety would require full engineering analysis to extend the advanced conceptual design to actual design. As stated in Phase 1 report, the design of the reservoir would require additional geotechnical assessment of the embankment location and the type and availability of soil and rock for constructing the embankment. The Dam Safety permit would require specific design analysis to determine the potential quantities of seepage into the underdrain beneath the liner and the routing of water around the embankment to maintain stream flow. The size of the emergency spillway structure has been determined through hydraulic analysis based on the basin area contributing to the stream channel at the reservoir site. These additional tasks are considered straightforward and could be undertaken as an interim step towards engineering design. Previous discussion with DSO regarding the Upper Stemilt Loop Road site identified wetlands and seepage as critical issues for the site, but other issues such as embankment and control structure design were seen as straightforward. A meeting with DSO representatives is warranted to discuss the site characteristics, reservoir operation, and engineering design elements before further continuing with site analysis.

Control structures and pipelines would be sized based on final determination of the storage volume and irrigation requirements and storage operation. However, the location and size of the structures would not likely change from the conceptual design as shown in **Drawing 2**.

<u>Costs and Construction</u>

Costs are based on volumes and areas of the reservoir and a straightforward earth embankment design with a liner. The grading requirements would include clearing of vegetation, stripping of organic soil and re-grading the existing topography to accommodate the liner and drain, and stockpiling suitable soil to construct the embankment. The conceptual design indicates that 20,000 yards of earth materials would be required for re-grading and embankment construction for the lower volume alternative and 120,000 yards of earth materials would be re-graded for the higher volume alternative. The maximum excavation depth is approximately 10 to 15 feet into native earth and no special excavation is anticipated; excavating some areas of resistant bedrock may require large rock excavators capable of ripping bouldery basalt.

<u>Schedule</u>

Engineering and design timeline, including additional engineering and geotechnical design tasks is approximately 1 year. Some of the permitting tasks could be completed simultaneously, including detailed assessment for wetlands at the reservoir site and wetland mitigation site. Permitting tasks including DSO review would likely require 2 years. Construction could occur during a single summer season for completing the earthwork. Wetland mitigation would likely extend from 5 to 10 years beyond the construction of new wetland areas to monitor and manage the wetland until fully established. Additional time for road reconstruction and permitting under the larger storage volume alternative would likely add 2 to 3 years of time.

<u>Cost summary and funding sources</u>

Table 4 summarizes the estimated costs to construct the Upper Stemilt Loop Road reservoir. These costs include contingencies for additional detailed assessment and for final design, permitting and

construction. An analysis of funding sources is beyond the scope of this phase of work. Sources of State funding are limited, but combinations of private and public funding, particularly from the Office of Columbia River that may partner with the Stemilt Irrigation District with funding and use of the reservoir for water storage in the Columbia River or its tributaries, specifically, Stemilt Creek. The cost evaluation indicates that the maximum volume alternative would cost an additional $1,000,000 to gain 60 AF of storage, and does not include additional cost to re-route the Stemilt Loop Road.

LOWER BEEHIVE RESERVOIR CONCEPTUAL DESIGN

Site Summary

The proposed reservoir site is approximately 7.5 miles from The City of Wenatchee in a natural depression in the Squilchuck Creek watershed near the Beehive Reservoir as shown in **Drawing 3**. The reservoir would be used to store and convey water for the Beehive Irrigation District system that includes Beehive Reservoir.

The property is owned by the US Forest Service (USFS) and immediately accessible by Beehive Road. Easement access would be required to convey irrigation water across adjacent properties and a special use permit would need to be issued by USFS.

The land and surrounding area is zoned Commercial Forest. No Chelan County Critical Areas are established adjacent to the reservoir site other than wetlands mapped under a designation as "Emergent; Temporarily Flooded; Impounded" (Cowardin, 1979). Constructing a new reservoir at the site would permanently inundate these wetlands and likely create new seasonal wetland areas along the reservoir shoreline. Permanently inundated land would be created in the reservoir.

Water collects seasonally in the topographic depression of the reservoir site from ephemeral and perennial springs and ephemeral runoff. Vegetation at the site consists of open, mixed pine-fir forest. The proposed reservoir area is undeveloped and has limited use by the general public for recreation. The reservoir site exists within a 50-acre basin that supports ephemeral stream flow and springs originating from the slopes above the site. The basin is upstream of, and may be considered a tributary to, Lake Creek. The reservoir would be classified as an out-of-channel structure.

<u>Site Layout and Reservoir Operation</u>

The reservoir site lies within a broad depression above a minor tributary to Squilchuck Creek (**Figure 1**). Constructing the reservoir may require re-routing of Beehive Road to create maximum storage volume, and the road would traverse above the reservoir.

The total reservoir depth would be 30 feet, assuming that the lower portions of the reservoir would be filled and underlain with a drainage layer. This design depth is intended to maximize the storage volume without placing excessive hydraulic pressure on a flexible liner. A liner is recommended due to the relatively low cost compared to importing and placing a clay liner. The 30 mil to 60 mil PVC liner would be underlain by a porous granular drain layer with perforated pipe to convey seepage beneath the liner to discharge downstream of the earth embankment. The liner would either be covered with a sand and quarry spall cover, or the reservoir would be surrounded by a fence for security.

The embankment would be constructed of native soil and bedrock excavated from the interior of the reservoir perimeter and may include imported select fill. Fill would be compacted to 95 percent of relative compaction density. Subsequent geotechnical investigation of the embankment area would assess the need for additional key design or structures to strengthen the embankment.

Based on the size and location of the 2,500-foot-long embankment which completely surrounds the reservoir, the total storage volume would be approximately 200 AF. The reservoir surface area would be approximately 10 acres.

The reservoir would be filled from the source and conveyance that currently fills Beehive Reservoir via a side lateral from the main pipeline. Operation would be similar to Beehive Reservoir, but could potentially store water over the winter due to presence of liner. Permitting with DSO will evaluate any risk of winter storage.

Permitting Issues

General permitting issues and requirements were summarized in Phase 1 report. For this reservoir site, the critical permits and regulations will include water rights, wetlands mitigation, and dam safety.

The current plan for use of the reservoir would not change the timing or quantity of diversion or changing the place or type of water use of the existing Beehive Irrigation District water rights. The right to store diverted water into the Beehive Reservoir would remain intact and a new reservoir right to store a portion the existing storage right would need to be obtained from Ecology. The new reservoir right would specify the purpose of storage and the timing and source of diversion as the same as the right to divert water into Beehive Reservoir. Water rights permitting to obtain a new reservoir right under this scenario is expected to be challenging, as a new source of water would be required to fill the reservoir above the total amount currently authorized for the Beehive Irrigation District. Simultaneous use of the existing and new Beehive Reservoirs could not result in diversion of water greater than current allowable diversion under the Beehive Irrigation District water rights without a legal change in the water rights. Additional counsel from a water rights attorney is recommended to evaluate opportunities to re-allocate water within the current water right portfolio and identify the potential to acquire new rights from existing sources.

The construction and operation of the reservoir would occur within a perennial stream channel and would modify existing riparian zones and wetlands. Based on the estimated wetland size and mitigation ratios, creating additional storage at this site will likely require creation of 2 to 3 acres of additional wetland habitat, preferably on-site and within the drainage basin. No sites have been identified that could represent a mitigation site; a portion of the site has undulating topography readily amenable to expanding the existing wetland area, a persistent source of seepage to maintain the enlarged wetland, and similar wetland characteristics. It is worth noting that the current wetland conditions are degraded by livestock grazing, which has trampled and muddied the wetland areas. Other sites would have to be identified in the Squilchuck basin that would suffice as a mitigation site. Potentially, Chelan County may have established a Fee-in-Lieu program for mitigation that would allow financial contribution towards a mitigation program instead of actual mitigation to replace inundated wetlands. However, a formal fee in-lieu program or certified bank is not currently established in the basin and thus this option is not presently available.

The Phase 1 report and the findings of the wetlands reconnaissance conclude that construction in wetland and stream would require multiple agency permits that would likely involve the Corps as the lead agency and with WDWF and the County.

Creation of new wetland habitat or restoration of existing wetland habitat presents the most viable option for mitigation in this area. Creation and restoration are preferred on-site or at least in the same drainage basin as the wetland being impacted. Often times, mitigation ratios will increase for mitigation completed off-site; however, this is typically at the discretion of the regulatory agencies (i.e. the Corps and Ecology). The mitigation ratios for creation of wetland habitat are less than those for restoration of habitat although restoration is preferred by the regulatory agencies because of its viability.

Development of a storage reservoir at this site would need to include provisions for an outflow to continue feeding downstream wetland habitat. Otherwise, additional wetland impacts would be incurred indirectly from reservoir construction. The reservoir underdrain would facilitate some of the re-routing of flow within the channel.

Dam safety would require full engineering analysis to extend the advanced conceptual design to actual design. As stated in Phase 1 report, the design of the reservoir would require additional geotechnical assessment of the embankment location and the type and availability of soil and rock for constructing the embankment. The Dam Safety permit would require specific design analysis to determine the potential quantities of seepage into the underdrain beneath the liner and the routing of water around the embankment to maintain stream flow. The size of the emergency spillway structure has been determined through hydraulic analysis based on the basin area contributing to the stream channel at the reservoir site. These additional tasks are considered straightforward and could be undertaken as an interim step towards engineering design. Previous discussion with DSO regarding the Upper Stemilt Loop Road site identified wetlands and seepage as critical issues for the site, but other issues such as embankment and control structure design were seen as straightforward. A meeting with DSO representatives is warranted to discuss the site characteristics, reservoir operation, and engineering design elements before further continuing with site analysis.

The USFS would required substantial environmental and economic analysis of the proposed reservoir project and would need to be consulted early in the subsequent planning phases.

Control structures and pipelines would be sized based on final determination of the storage volume and irrigation requirements and storage operation. However, the location and size of the structures would not likely change from the conceptual design as shown in **Drawing 3**.

<u>Costs and Construction</u>
Costs are based on volumes and areas of the reservoir and a straightforward earth embankment design with a liner. The grading requirements would include clearing of vegetation, stripping of organic soil and re-grading the existing topography to accommodate the liner and drain, and stockpiling suitable soil to construct the embankment. The conceptual design indicates that 110,000 yards of earth materials would be required for re-grading and embankment construction. The maximum excavation depth is approximately 10 to 15 feet into native earth and no special excavation is anticipated; excavating some areas of resistant bedrock may require large rock excavators capable of ripping bouldery basalt.

<u>Schedule</u>
Engineering and design timeline, including the estimated time to conduct additional engineering and geotechnical design tasks, is approximately 1 year. Some of the permitting tasks could be completed simultaneously, including detailed assessment for wetlands at the reservoir site and wetland mitigation site. Permitting tasks including USFS and DSO review would likely require 2 to 3 years due a significant public comment period. Construction could occur during a single summer season for completing the earthwork. Wetland mitigation would likely extend from 5 to 10 years beyond the construction of new wetland areas to monitor and manage the wetland until fully established.

<u>Cost Summary and Funding Sources</u>
Table 5 summarizes the estimated costs to construct the Lower Beehive Reservoir. These costs include contingencies for additional detailed assessment and for final design, permitting and construction. An analysis of funding sources is beyond the scope of this phase of work. Sources of State funding are limited, but combinations of private and public funding, particularly from the Office of Columbia River that may partner with the Beehive Irrigation District with funding and use of the reservoir for water storage in the Columbia River or its tributaries, specifically, Squilchuck Creek.

CONCLUSIONS AND RECOMMENDATIONS

The three reservoir sites offer advantages, disadvantages and uncertainties that have been identified in the Phase 2 Assessment; the Lower Stemilt Loop Road site offers superior advantages to the Upper site, but the land is privately owned and may not become available for the project. Negotiating the land use for the Lower Stemilt Loop Road site therefore, is a critical step. In this case, it is likely that a mitigation plan may provide additional challenges to permitting, including identifying a suitable location and negotiating and designing the mitigation.

The Lower Beehive Reservoir site offers a significant storage opportunity in the Squilchuck Creek basin and would be able to rely on existing infrastructure for supply. The USFS and the public has accepted the use and operation of the existing Beehive Reservoir and may find a second reservoir equally acceptable, if the new reservoir provided similar benefits with acceptable impacts. In addition to public and federal agency acceptance, the issue of transferring or modifying existing water rights or obtaining new rights to fill the new reservoir is the second significant critical step to developing this site.

The Upper Stemilt Loop Road site would become the priority site if the Lower Stemilt Loop Road site is not available. The site presents additional challenges in wetland permitting and re-routing the Stemilt Loop Road.

Table 6 summarizes the likely approach for the design, permitting and construction for each reservoir site. Critical steps for each site are identified.

REFERENCES

Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm.

RH2 Engineering, Inc. 2009. *WRIA 40A Storage Assessment Phase 1 Report*. Prepared for Chelan County Natural Resources and WRIA 40A Planning Unit. April 2009.

FIGURES

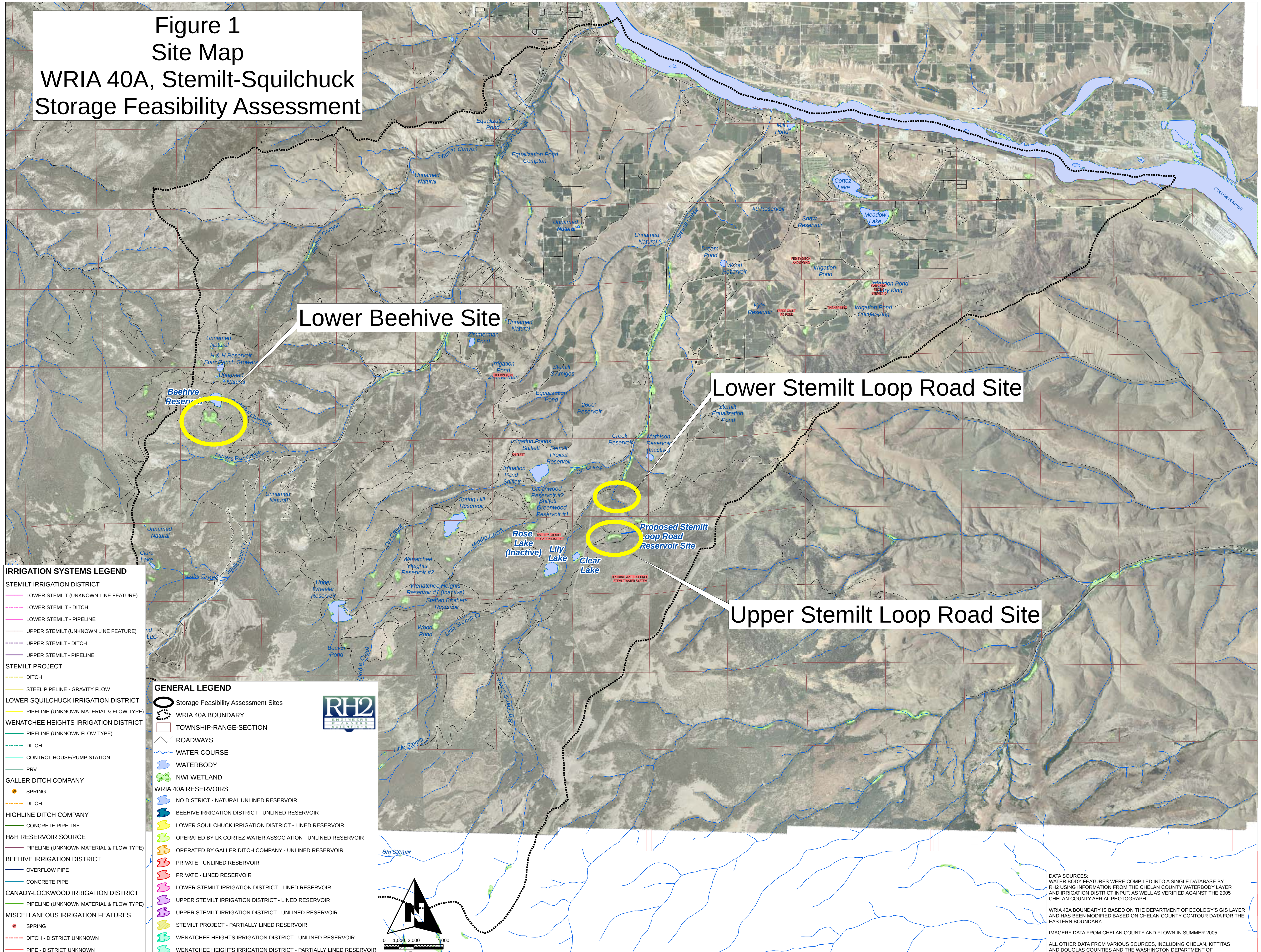
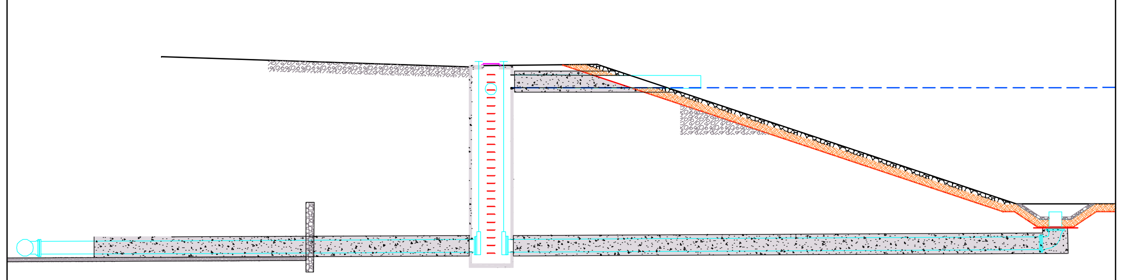


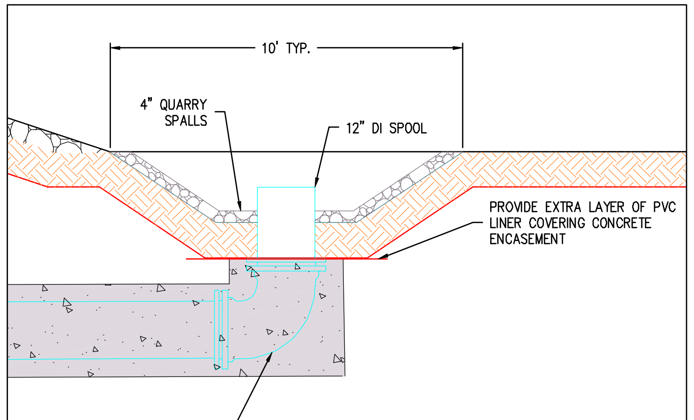
Figure 1
Site Map
WRIA 40A, Stemilt-Squilchuck
Storage Feasibility Assessment

DRAWINGS



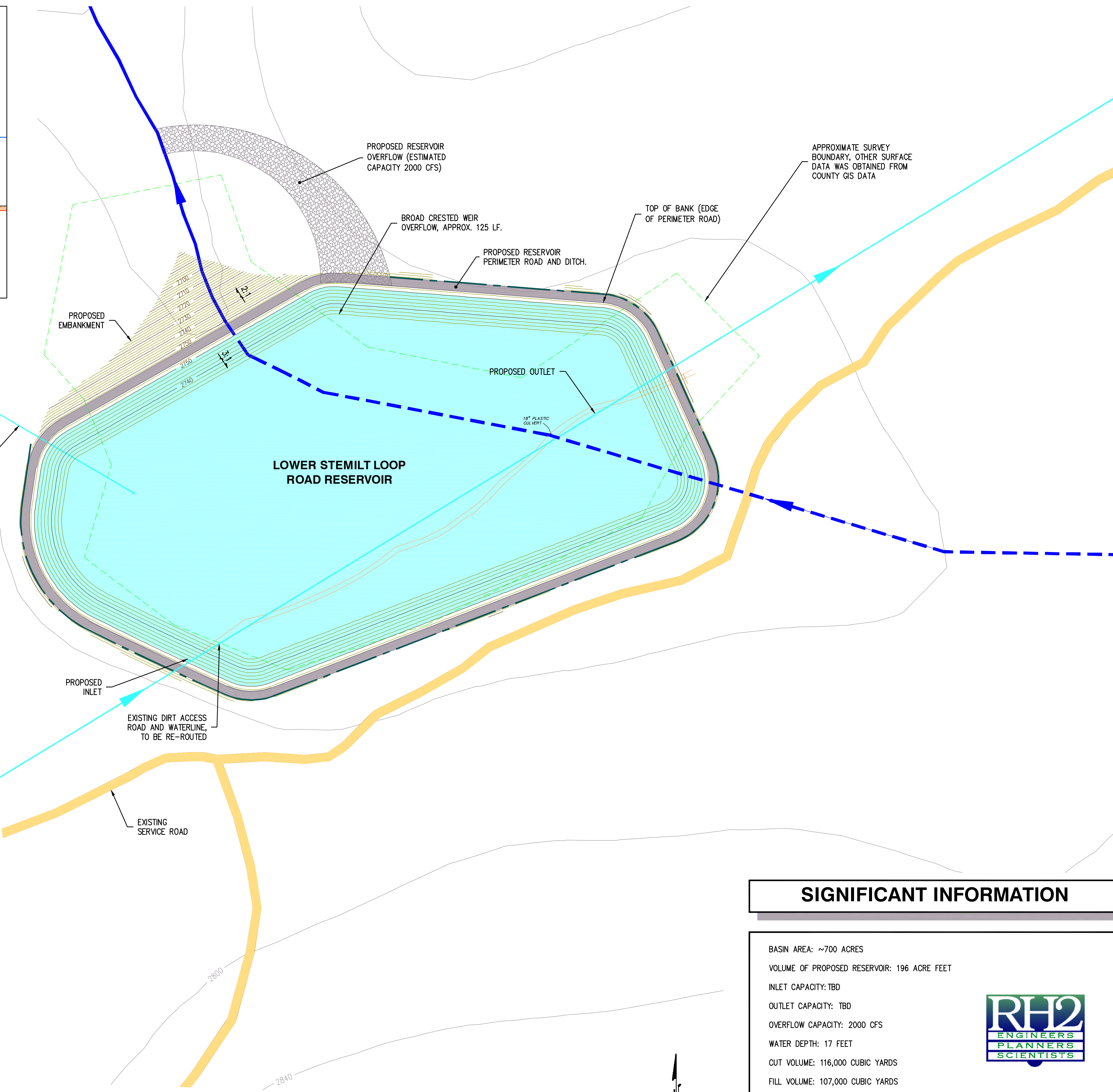
INLET STRUCTURE SECTION

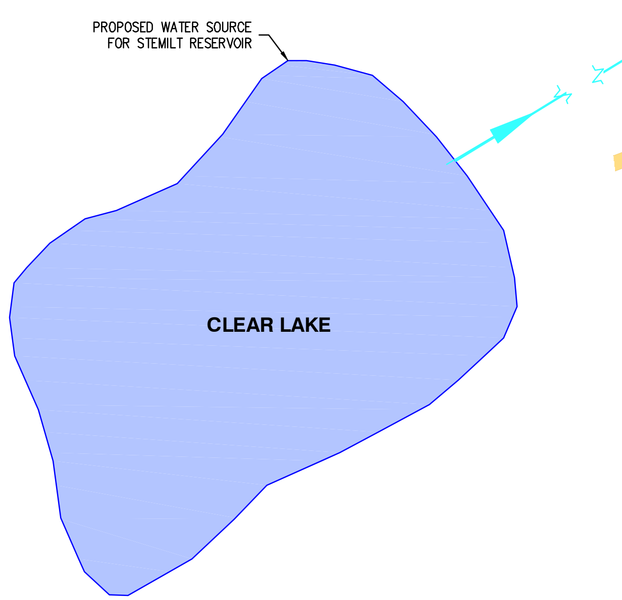
NTS



OUTLET DETAIL

NTS





SIGNIFICANT INFORMATION

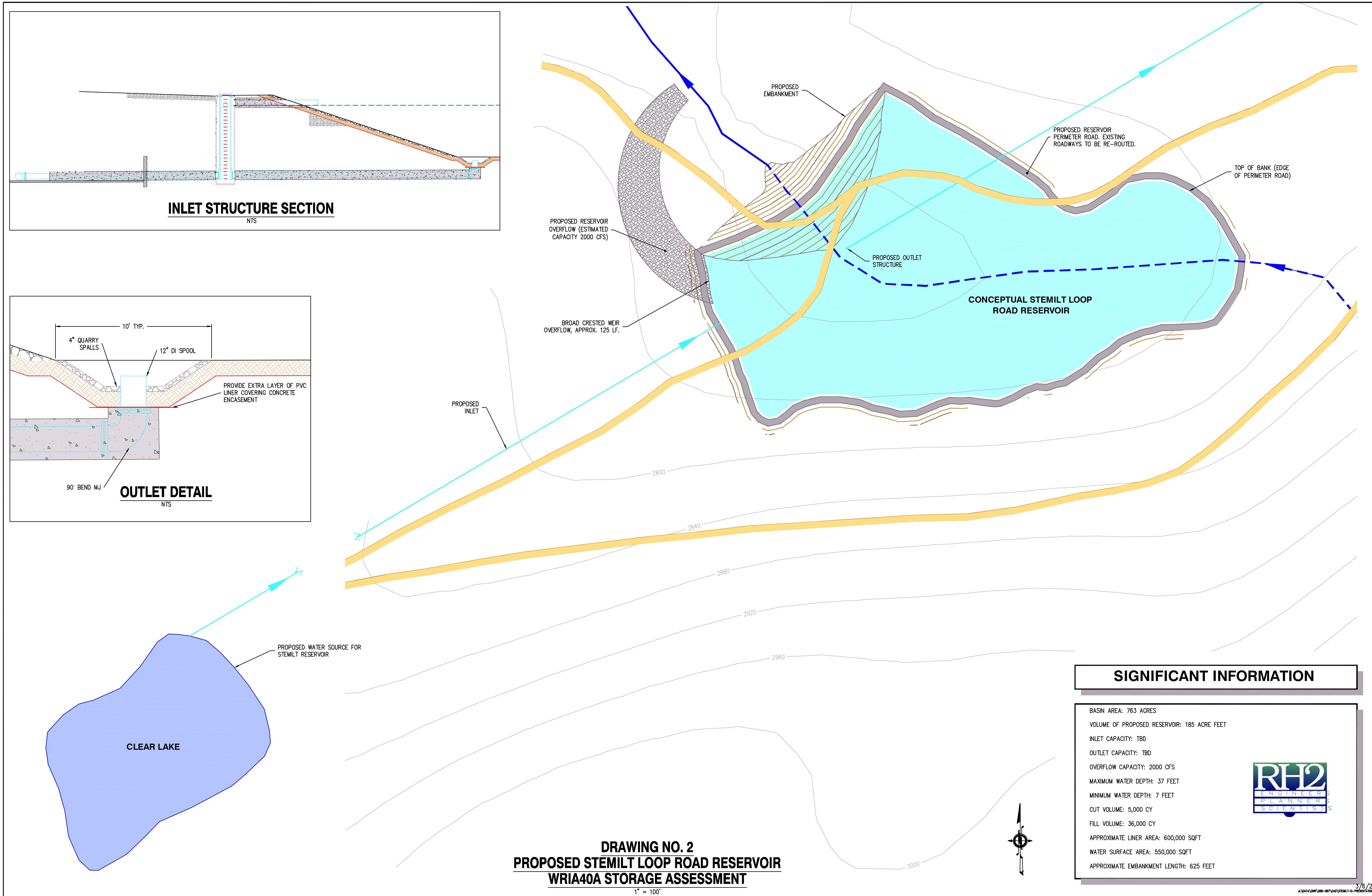
BASIN AREA: ~700 ACRES
VOLUME OF PROPOSED RESERVOIR: 196 ACRE FEET
INLET CAPACITY: TBD
OUTLET CAPACITY: TBD
OVERFLOW CAPACITY: 2000 CFS
WATER DEPTH: 17 FEET
CUT VOLUME: 116,000 CUBIC YARDS
FILL VOLUME: 107,000 CUBIC YARDS
APPROXIMATE LINER AREA: 610,000 SQFT
WATER SURFACE AREA: 575,000 SQFT
APPROXIMATE EMBANKMENT LENGTH: 550 FEET

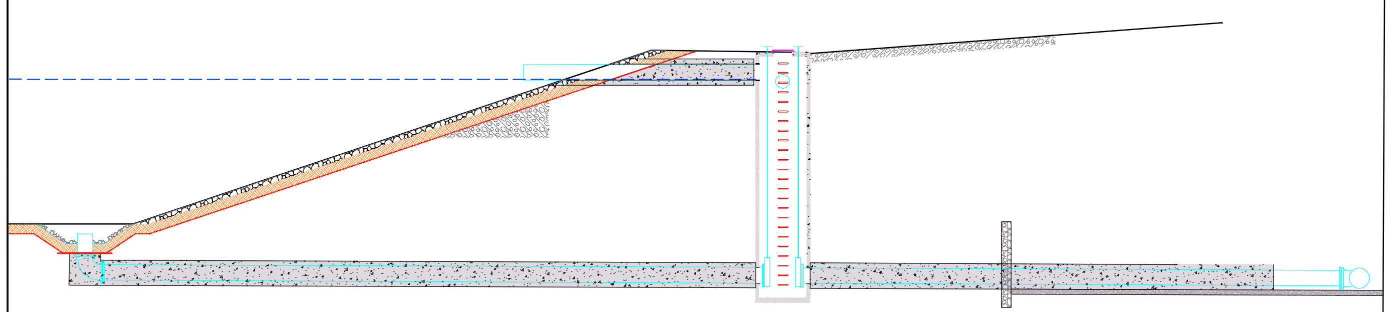
RH2 ENGINEERS PLANNERS SCIENTISTS

DRAWING NO. 1
CONCEPTUAL LOWER STEMILT LOOP ROAD RESERVOIR
WRIA40A STORAGE ASSESSMENT

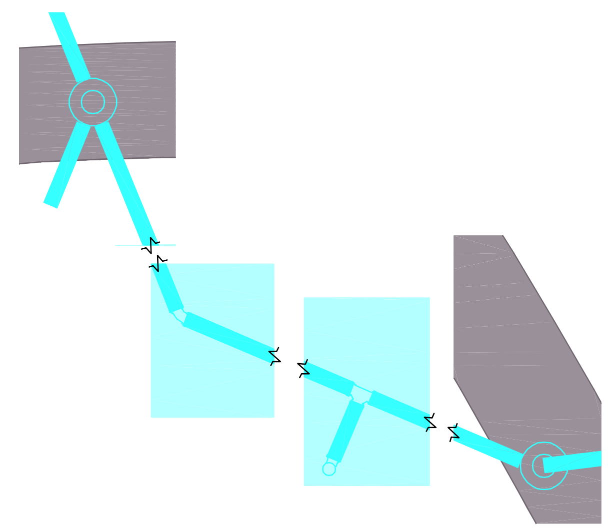
1" = 100'

3/6/2009

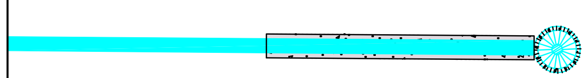

INLET STRUCTURE SECTION
NTS
4" QUARRY SPALLS
10' TYP.
12" DI SPOOL
PROVIDE EXTRA LAYER OF PVC LINER COVERING CONCRETE ENCASEMENT
90° BEND MJ
OUTLET DETAIL
NTS
PROPOSED EMBANKMENT
PROPOSED RESERVOIR PERIMETER ROAD. EXISTING ROADWAYS TO BE RE-ROUTED.
TOP OF BANK (EDGE OF PERIMETER ROAD)
PROPOSED RESERVOIR OVERFLOW (ESTIMATED CAPACITY 2000 CFS)
PROPOSED OUTLET STRUCTURE
BROAD CRESTED WEIR OVERFLOW, APPROX. 125 LF.
CONCEPTUAL STEMILT LOOP ROAD RESERVOIR
PROPOSED INLET
2800
2840
2880
2920
2960
3000
PROPOSED WATER SOURCE FOR STEMILT RESERVOIR
CLEAR LAKE
SIGNIFICANT INFORMATION
BASIN AREA: 763 ACRES
VOLUME OF PROPOSED RESERVOIR: 185 ACRE FEET
INLET CAPACITY: TBD
OUTLET CAPACITY: TBD
OVERFLOW CAPACITY: 2000 CFS
MAXIMUM WATER DEPTH: 37 FEET
MINIMUM WATER DEPTH: 7 FEET
CUT VOLUME: 5,000 CY
FILL VOLUME: 36,000 CY
APPROXIMATE LINER AREA: 600,000 SQFT
WATER SURFACE AREA: 550,000 SQFT
APPROXIMATE EMBANKMENT LENGTH: 625 FEET
RH2 ENGINEERS PLANNERS SCIENTISTS
DRAWING NO. 2
PROPOSED STEMILT LOOP ROAD RESERVOIR
WRIA40A STORAGE ASSESSMENT
1" = 100'
3/6/2009



INLET/OUTLET STRUCTURE SECTION
NOT TO SCALE



INLET STRUCTURE PLAN
NOT TO SCALE



OVERFLOW STRUCTURE PLAN
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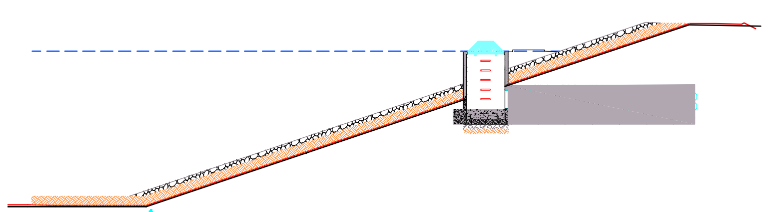

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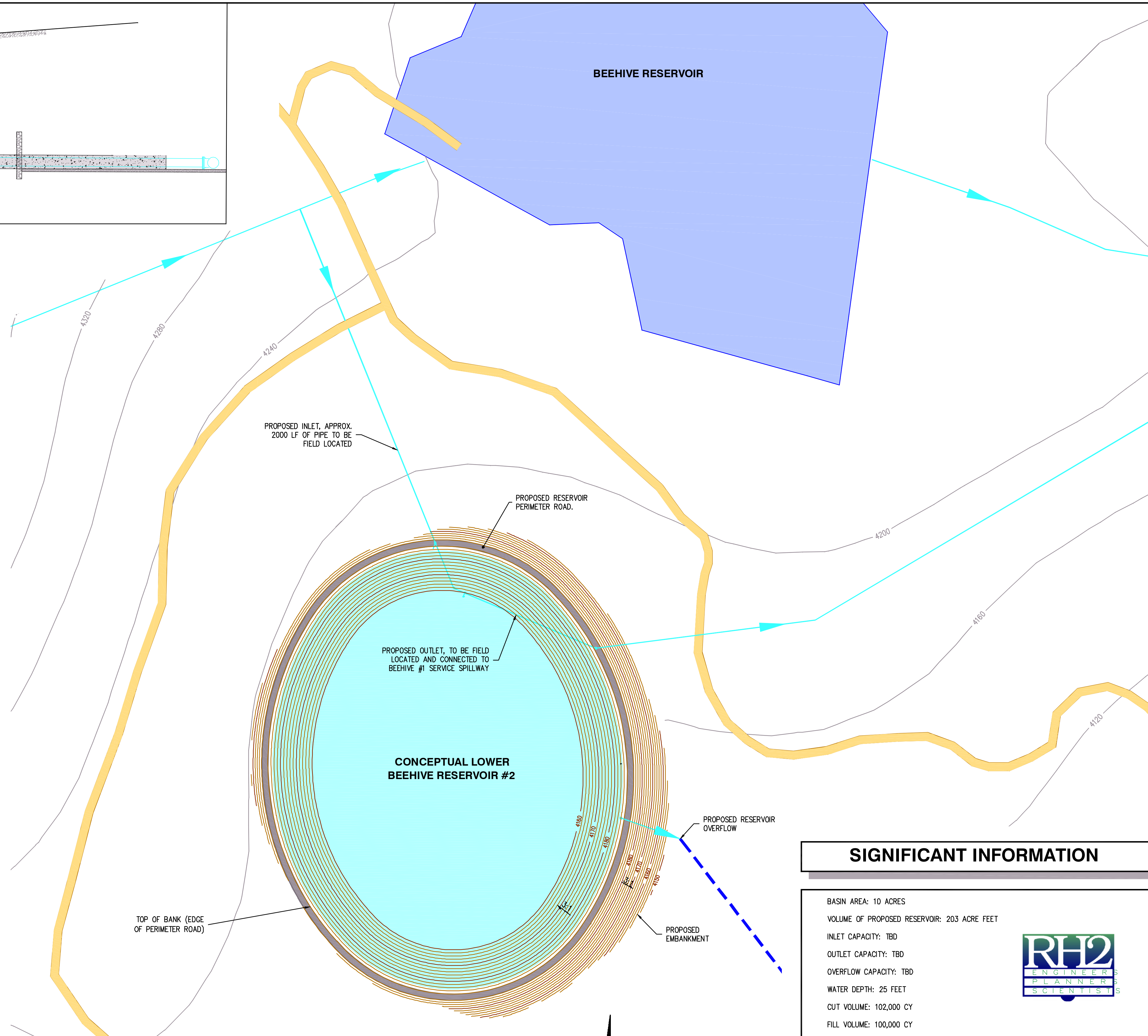


SIGNIFICANT INFORMATION

- BASIN AREA: 10 ACRES
- VOLUME OF PROPOSED RESERVOIR: 203 ACRE FEET
- INLET CAPACITY: TBD
- OUTLET CAPACITY: TBD
- OVERFLOW CAPACITY: TBD
- WATER DEPTH: 25 FEET
- CUT VOLUME: 102,000 CY
- FILL VOLUME: 100,000 CY
- APPROXIMATE LINER AREA: 470,000 SQFT
- WATER SURFACE AREA: 433,000 SQFT
- ARRPOXIMATE EMBANKMENT LENGTH: 2,500 FEET

RH2 ENGINEERS PLANNERS SCIENTISTS

DRAWING NO. 3
CONCEPTUAL LOWER BEEHIVE RESERVOIR #2
WRIA40A STORAGE ASSESSMENT

1" = 100'

3/6/2009

TABLES

Table 1
Summary of WRIA 40A Storage Assessment Sites – Site Details

Reservoir	Operator	Estimated Total Volume at Spillway Crest	Estimated Live Volume	Surface Area	Dam Height	Dam Length	Spillway Max	Source Stream	DSO Hazard Class
		(ac-ft)	(ac-ft)	(acres)	(ft)	(ft)	(cfs)		
Lower Stemilt Loop Road	Stemilt ID	195	190	20	50	120	2,500	Stemilt Cr	High
Upper Stemilt Loop Road	Stemilt ID	200	195	20	40	150	2,500	Stemilt Cr	High
Lower Beehive	Beehive ID	165	160	20	25	200	100	Squilchuck Cr Lake Cr	High

Table 2
Summary of WRIA 40A Storage Assessment Sites – Land Use

Reservoir	Operator	Land Owner	Parcels	Parcel Area	Access	Easement issues?	Water Source	Water Right Requirement	Wetland	Land Zoning	Extreme Flooding Risk
Lower Stemilt Loop Road	Stemilt ID	Private	20000000	80	Stemilt Loop Road	Private	Stemilt Creek	New Reservoir Right Transfer Existing SID Right	1 to 1.5 acres of Mitigation using Upper Stemilt site	Non-Commercial Forest	Moderate
Upper Stemilt Loop Road	Stemilt ID	Stemilt ID	21202200000 (entire section)	9.49	Stemilt Loop Road	None	Stemilt Creek	Transfer Existing SID Right	2 to 3 acres of Mitigation using Lower Stemilt site	Commercial	Moderate to High
Lower Beehive	Beehive ID	USFS	211912000000 (entire section)	640	Beehive Road	USFS	Squilchuck and Lake Creek	New Reservoir Right New Water Right (Share BID Right)	2 to 3 acres of Mitigation – unknown site or potential mitigation bank	Commercial	Low

SID – Stemilt Irrigation District
BID – Beehive Irrigation District

Table 3
Summary of Estimated Costs – Lower Stemilt Loop Road Reservoir Site

Item Description	Quantity	Units	Unit Price	Total Price
Mob/Demob and Miscellaneous Site Work	1	Lump Sum	$176,900	$ 176,900
Clearing and Grubbing, Tree Removal	14	Acre	$40,000	$ 560,000
Site Grading and Earthwork	120,000	CY	$6	$ 720,000
Intake/Outlet Control Structure	1	Lump Sum	$20,000	$ 20,000
Emergency Spill Way	450	cy	$500	$ 225,000
15" PVC	0	LF	$46	$ -
60 millimeter PVC liner	610,000	SF	$0.40	$ 244,000
Fencing and gates	3,000	LF	$20	$ 60,000
Construction Subtotal				$ 2,005,900

Cost Summary	
Construction Sub Total	$ 2,005,900
Sales Tax (8.1%)	$ 162,478
Contingency (15%)	$ 300,885
Construction Total	$ 2,469,263
Engineering (10%)	$ 246,926
Construction Support (10%)	$ 246,926
Permitting and Wetland Mitigation	$ 300,000
Project Total	**$ 3,263,115**

Table 4
Summary of Estimated Costs – Upper Stemilt Loop Road Reservoir Site

Limited Excavation – 185 AF Storage Volume

Item Description	Quantity	Units	Unit Price	Total Price
Mob/Demob and Miscellaneous Site Work	1	Lump Sum	$129,000	$ 129,000
Clearing and Grubbing, Tree Removal	13	Acre	$50,000	$ 650,000
Site Grading and Earthwork	20,000	CY	$8	$ 160,000
Intake/Outlet Control Structure	1	Lump Sum	$20,000	$ 20,000
Emergency Spill Way	500	cy	$500	$ 250,000
15" PVC Pipe	0	LF	$46	$ -
60 millimeter PVC liner	600,000	SF	$0.35	$ 210,000
Fencing and gates				
Construction Subtotal				$ 1,369,000

Cost Summary	
Construction Sub Total	$ 1,369,000
Sales Tax (8.1%)	$ 110,889
Contingency (15%)	$ 205,350
Construction Total	$ 1,685,239
Engineering (10%)	$ 168,524
Construction Support (10%)	$ 168,524
Permitting and Wetland Mitigation	$ 400,000
Project Total	**$ 2,422,287**

Maximum Excavation – 245 AF Storage Volume

Item Description	Quantity	Units	Unit Price	Total Price
Mob/Demob and Miscellaneous Site Work	1	Lump Sum	$175,000	$ 175,000
Clearing and Grubbing, Tree Removal	13	Acre	$40,000	$ 520,000
Site Grading and Earthwork	120,000	CY	$6	$ 720,000
Intake/Outlet Control Structure	1	Lump Sum	$20,000	$ 20,000
Emergency Spill Way	500	cy	$500	$ 250,000
15" Ductile Iron Pipe	0	LF	$46	$ -
60 millimeter PVC liner and underdrain	600,000	SF	$0.40	$ 240,000
Fencing and gates	3,000	LF	$20	$ 60,000
Construction Subtotal				$ 1,985,000

Cost Summary	
Construction Sub Total	$ 1,985,000
Sales Tax (8.1%)	$ 160,785
Contingency (15%)	$ 297,750
Construction Total	$ 2,443,535
Engineering (10%)	$ 244,354
Construction Support (10%)	$ 244,354
Permitting and Wetland Mitigation	$ 400,000
Project Total	**$ 3,332,242**

Table 5
Summary of Estimated Costs – Lower Stemilt Loop Road Reservoir Site

Item Description	Quantity	Units	Unit Price	Total Price
Mob/Demob and Miscellaneous Site Work	1	Lump Sum	$161,900	$ 161,900
Clearing and Grubbing, Tree Removal	12	Acre	$40,000	$ 480,000
Site Grading and Earthwork	110,000	CY	$6	$ 660,000
Intake/Outlet Control Structure	1	Lump Sum	$20,000	$ 20,000
Emergency Spill Way	450	cy	$500	$ 225,000
15" Ductile Iron Pipe	1,000	LF	$46	$ 46,000
60 millimeter PVC liner and underdrain	470,000	SF	$0.40	$ 188,000
Fencing and gates	3,000	LF	20	$ 60,000
Construction Subtotal				$ 1,840,900

Cost Summary	
Construction Sub Total	$ 1,840,900
Sales Tax (8.1%)	$ 149,113
Contingency (15%)	$ 276,135
Construction Total	$ 2,266,148
Engineering (10%)	$ 226,615
Construction Support (10%)	$ 226,615
Permitting and Wetland Mitigation	$ 400,000
Project Total	**$ 3,119,377**

Table 6
Approach for Design, Permitting, and Construction

Reservoir	Operator	Actions
Lower Stemilt Loop Road	Stemilt ID	1. **Negotiate lease or purchase of property with property owner**. 2. Identify and secure funding for design and construction. 3. Negotiate with DSO and permitting agencies to confirm permits to construct new reservoir and permit over-winter storage. 4. Establish wetland mitigation requirements and prepare mitigation plan. 5. Obtain reservoir right from Ecology. 6. Geotechnical assessment of bottom and slope sediment to accommodate liner and drain; assessment of embankment site. 7. Engineering design and cost of installation and underdrain for seepage and vapor venting. 8. Engineering design of embankment and control structures. 9. Re-route existing pipelines and construct reservoir.
Upper Stemilt Loop Road	Stemilt ID	1. Identify and secure funding for design and construction. 2. Negotiate with DSO and permitting agencies to confirm permits to construct new reservoir and permit over-winter storage. **3. Negotiate Chelan County road re-alignment and reconstruction.** 4. Establish wetland mitigation requirements and prepare mitigation plan. 5. Obtain reservoir right from Ecology. 6. Geotechnical assessment of bottom and slope sediment to accommodate liner and drain; assessment of embankment site. 7. Engineering design and cost of installation and underdrain for seepage and vapor venting. 8. Engineering design of embankment and control structures. 9. Re-route existing pipelines and construct reservoir.
Lower Beehive	Beehive ID	1. **Establish water right strategy for storage and use of existing right and/or obtain new/transfer existing rights, if necessary.** 2. **Negotiate with USFS for special use permit; public meetings and planning.** 3. Identify and secure funding for design and construction. 4. Negotiate with DSO and permitting agencies to confirm permits to construct new reservoir and permit over-winter storage. 5. Negotiate with USFS for road re-alignment and reconstruction. 6. Establish wetland mitigation requirements and prepare mitigation plan. 7. Obtain reservoir right from Ecology. 8. Geotechnical assessment of bottom and slope sediment to accommodate liner; assessment of embankment site. 9. Engineering design and cost of installation and underdrain for seepage and vapor venting. 10. Engineering design of embankment and control structures. 11. Re-route existing pipelines and construct reservoir.

Bold = Critical step

APPENDIX A

SITE PHOTOGRAPHS

Lower Stemilt Loop Road Reservoir Site – General Area

Lower Stemilt Loop Reservoir Site – General Area

Lower Stemilt Loop Road Reservoir Site – Embankment Area

Lower Stemilt Loop Reservoir Site – Embankment Area

Upper Stemilt Loop Road Reservoir Site - Panorama

Upper Stemilt Loop Road Reservoir Site – Embankment Area

Upper Stemilt Loop Road Reservoir Site – General Area

Lower Beehive Reservoir Site – General Area

Lower Beehive Reservoir Site – General Area

Lower Beehive Reservoir Site – Wetlands

Lower Beehive Reservoir Site – Typical Outcrop Geology

APPENDIX B

WETLANDS RECONNAISSANCE SUMMARY

CNR 208.087.01.102

STORAGE SITE VISIT SUMMARY – SEPTEMBER 30, 2009

WETLAND CONDITIONS AND RESERVOIR CONSTRUCTABILITY FROM AN ENVIRONMENTAL PERMITTING PERSPECTIVE

Alicia Sundown, RH2 Engineering, Inc.

Upper Stemilt Site:

The Upper Stemilt site is largely undeveloped upland. Terrain generally slopes to the northwest and the overall layout of the site resembles an oval bowl. At the low-point, the site contains a vegetated pond with aquatic, emergent, forested and scrub-shrub wetland vegetation. The hydrology source for the pond is presumably a number of groundwater seeps originating just south of the Upper Basin Road. The pond outlets to a surface water channel that flows northwest and crosses under Stemilt Loop Road. The estimated size of the pond and associated wetland habitat is one (1) acre. In some upland areas of the site, water drift was evidenced indicating that drainage may extend beyond the pond boundaries at certain times of the year. These areas did not contain wetland soils and are still presumed to be upland habitat.

Upland vegetation on the site consists of a Ponderosa pine (*Pinus ponderosa*) over-story, with a limited shrub-layer consisting of blue and red elderberry (*Sambuscus caerulea* and *S. racemosa*, respectively), Snowberry (*Symphoricarpos albus*), and thimbleberry (*Rubus parviflorus*). The upland forb layer consists of bedstraws (*Galium* sp.), Pearly everlasting (*Anaphalis margaritacea*), Common mullein (*Verbascum thapsus*), as well as some upland grasses and thistles.

Wetland vegetation includes an over-story dominated by Quaking aspen (*Populus tremuloides*), alder (*Alnus* sp.), and some maple (*Acer* sp.). The shrub layer is predominantly willows (*Salix* sp.), Snowberry, thimbleberry and dogwood (*Cornus* sp.). Emergent vegetation is young willows, cattails (*Typha latifolia*), and sedges (*Carex* sp.), which are growing along the pond edge and on hummocks within the inundated areas. Floating aquatic vegetation covers a large majority of the pond surface.

The wetland area was not formally characterized during the site visit; however, based on vegetation, size and habitat types, the wetland category is anticipated as either a Category 2 or 3. In Chelan County, wetland characterization is based on the Washington State Department of Ecology (Ecology) *Eastern Washington Wetland Rating System*. Wetland buffer widths are defined under the Chelan County Zoning Code (Title 11) and range depending on the level of development planned adjacent to the wetland habitat. For Category 2 wetlands, the recommended buffer is 100-feet for a low intensity land use and 200-feet for a high intensity land use. The low intensity buffer for Category 3 wetlands is 75-feet and 150-feet for a high intensity land use.

From a topography perspective, this site lends itself well to creating additional storage as the site already forms a bowl and presumably grading could be minimized as a result. From a wetland perspective though, creating additional storage at this site would likely involve permanent inundation of the existing wetland habitat. Additional wetland habitat and shoreline would undoubtedly be created along the shoreline of the proposed reservoir. Mitigation to compensate for unavoidable loss of the existing wetland habitat would need to be consistent with the Ecology and U.S. Army Corps of Engineers (Corps) guidance, *Wetland Mitigation in Washington State*. For creation of Category 3 wetlands, this guidance document recommends a 2:1 ratio, and a 3:1 ratio for creation of Category 2 wetlands. Based on the estimated wetland size and these ratios, creating additional storage at this site will likely require creation of 2 to 3 acres of additional wetland habitat, preferably on-site and within the drainage basin.

Lower Stemilt Site:

The Lower Stemilt site is also largely undeveloped upland. The pond feature on the Upper Stemilt site drains to a channel which crosses Stemilt Loop Road and then continues to flow on the Lower Stemilt site. Adjacent to the road, this channel is relatively unconfined and shallow and more closely resembles wetland characteristics than stream habitat. In the interior of the site, the grade drops dramatically and the drainage is more confined in a steep ravine. The riparian corridor measures approximately 25 to 100 feet wide and at its steepest location, the ravine is roughly 25 to 35 feet deep.

Upland vegetation on the site is similar to the Upper Stemilt site with a dominance of Ponderosa pine in the over story, and grasses and upland herbs in the understory.

Riparian vegetation consists of a Quaking aspen and alder over story with Vine maple (*Acer circinatum*) and Snowberry in the shrub layer. The channel contains cattails in the upper portion (adjacent to the road) and smartweeds (*Polygonum* sp.) indicating that the flow is not heavy or quick-moving.

Topographically, this site poses more issues for additional storage creation as it will require significantly more grading that the Upper Stemilt site. From a wetland perspective though, this site poses the least issue because wetland habitat is significantly reduced, thus mitigation will be less extensive. This site is still expected to require mitigation; however, wetland habitat will likely be created along the shoreline of the proposed reservoir and there is an opportunity to mitigate on-site wetland impacts at the adjacent Upper Stemilt site. Development of a storage reservoir at this site would need to include provisions for an outflow to continue feeding downstream wetland habitat though; otherwise, additional wetland impacts would be incurred indirectly as a result of the proposal.

Beehive Site:

The Forest Service was completing controlled burning on the day of the site visit, thus the below notes are based on an aerial reconnaissance and review of previous site inspection photographs and other environmental data.

The existing Beehive Reservoir spillway crosses Beehive Road and supplies hydrology for emergent, scrub-shrub and forested wetlands. Wetland habitat covers a little over one (1) acre. This site contains the most extensive of the wetland habitat compared with the Stemilt sites, both in acreage and function/classification. Wetland habitat has not been formally classified; however, the likely category of these wetland is Category 2.

Over story vegetation consists of Ponderosa pine in the upland areas, Quaking aspen, alder and fir. In the understory, shrub vegetation consists of tree saplings of the above-listed species, as well as Snowberry, dogwood and willow. In the wetland areas, the herb layer contains sedges (both *Carex* sp. and *Scirpus* sp.), grasses, cattails, smartweeds and Large-leaf avens (*Geum macrophyllum*).

Hoof prints were observed in wetland habitat, thus active livestock grazing is presumed to occur in this area.

Development of additional storage at this site will require significantly more permanent loss of wetland habitat and thus, significantly more mitigation to compensate for this loss [in comparison to the other sites that were evaluated]. The amount of wetland habitat that will be created along the shoreline of the proposed reservoir will likely not alone compensate for the lost wetland acreage, thus additional off-site area will be needed for mitigation purposes. An estimated total 2 to 3 acres of mitigation is anticipated to be needed to construct additional storage at this site.

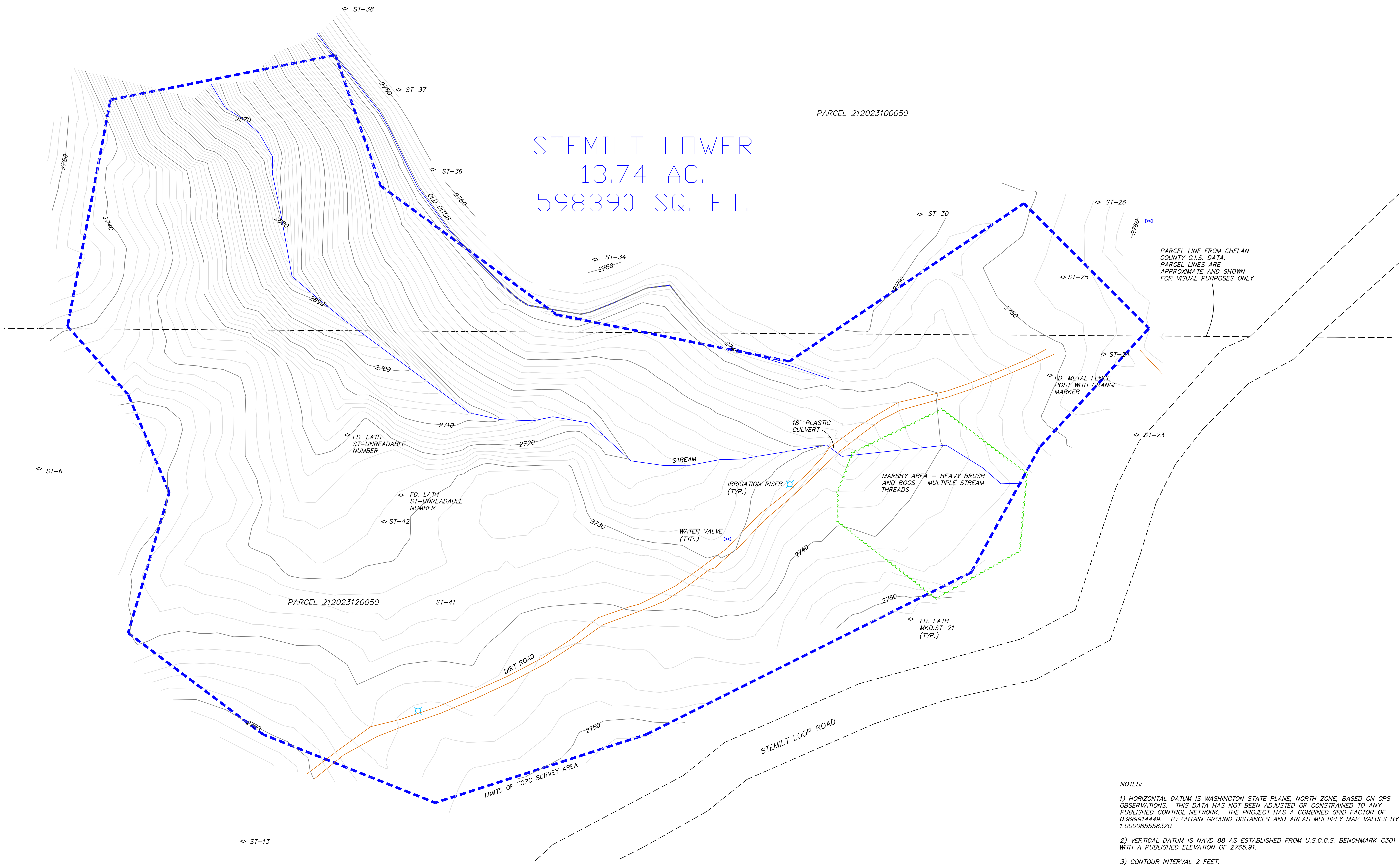
Mitigation Options:

Mitigation banking or fee in-lieu mitigation would present good opportunities for mitigating large areas off-site; however, there are no formal fee in-lieu programs or certified banks in this region, thus this option is not presently available.

Creation of new wetland habitat or restoration of existing wetland habitat presents the most viable option for mitigation in this area. Creation and restoration are preferred on-site or at least in the same drainage basin as the wetland being impacted. Often times, mitigation ratios will increase for mitigation completed off-site; however, this is typically at the discretion of the regulatory agencies (i.e. the Corps and Ecology). The mitigation ratios for creation of wetland habitat are less than those for restoration of habitat although restoration is preferred by the regulatory agencies because of its viability. Enhancement or preservation of existing wetland habitat are also options for mitigation although these typically require the highest ratios.

APPENDIX C

NCW SURVEYING TOPOGRAPHIC DATA

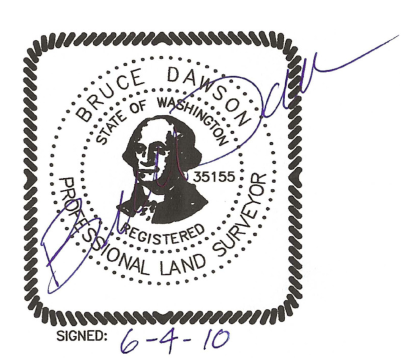


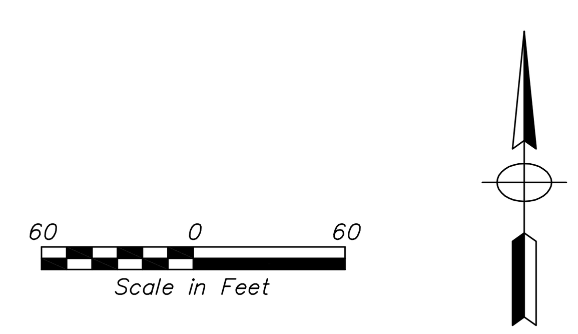
NOTES:

1) HORIZONTAL DATUM IS WASHINGTON STATE PLANE, NORTH ZONE, BASED ON GPS OBSERVATIONS. THIS DATA HAS NOT BEEN ADJUSTED OR CONSTRAINED TO ANY PUBLISHED CONTROL NETWORK. THE PROJECT HAS A COMBINED GRID FACTOR OF 0.999914449. TO OBTAIN GROUND DISTANCES AND AREAS MULTIPLY MAP VALUES BY 1.000085558320.

2) VERTICAL DATUM IS NAVD 88 AS ESTABLISHED FROM U.S.C.G.S. BENCHMARK C301 WITH A PUBLISHED ELEVATION OF 2765.91.

3) CONTOUR INTERVAL 2 FEET.





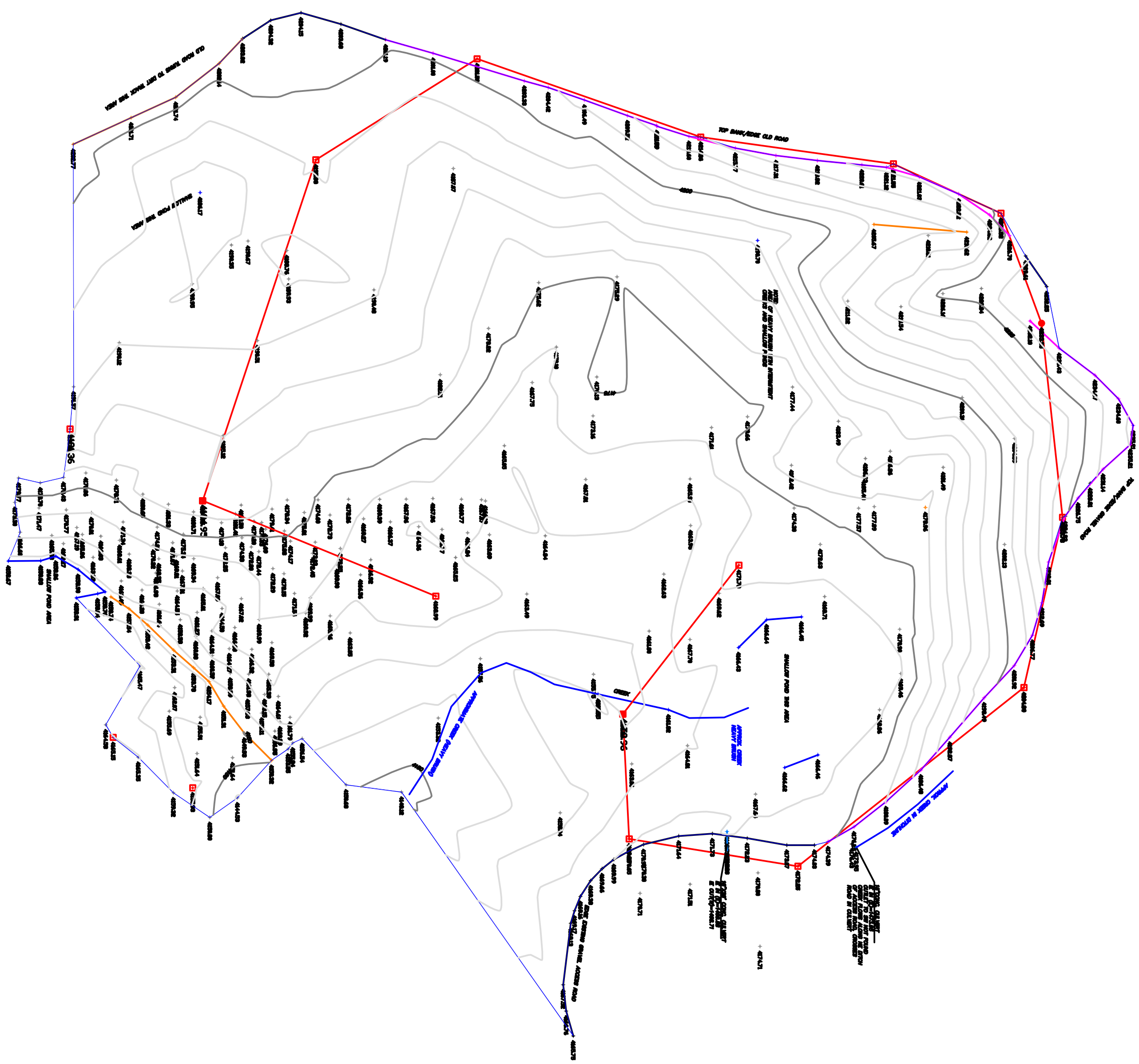
LOWER STEMILT SITE
TOPOGRAPHIC SURVEY
RH2 ENGINNERING
SECTION 12, T.21N., R.23E.W.M.
CHELAN COUNTY, WASHINGTON

NCW Land Surveying, LLC

1105 KOALA DR.
OMAK, WA
(509) 826-1763

101 E. LOCUST ST.
WATERVILLE, WA
(509) 745-8530

DATE:	06-04-10	DWG NAME:	10510.DWG
DRAWN BY:	BWD	JOB NO.:	10510
SCALE:	1"=60'	SHEET 1 OF 1	


TOP BANK/EDGE OLD ROAD
4800

APPENDIX D

NHC EMERGENCY SPILLWAY DESIGN FLOW ANALYSIS

Draft Memorandum

northwest hydraulic consultants
16300 Christensen Road, Suite 350
Seattle, WA 98188-3418
Phone: 206-241-6000
Fax: 206-439-2420

Date: March 25, 2009

To: Rick Ballard, RH2

From: David Hartley, **nhc**

Subject: Stemilt-Squilchuck Emergency Spillway Preliminary Design Flow

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Problem: Determine Emergency Spillway design discharge for the proposed Stemilt-Squilchuck dam.

Approach

Washington State Dam Safety Guidelines were applied to determine the 2-hr design storm amounts for Climatic Region 1 at the location of the watershed delineated by RH2. The total amount was embedded in a short duration, 6-hr storm hyetograph. The hyetograph was used as input to the SBUH-SCS runoff and routing procedure (as programmed by the King County HYD program). The procedure generated runoff hydrographs to the proposed reservoir that correspond to three "design step" (risk levels) defined by WA-DOE. NHC assumes RH2 will choose the appropriate "design step" level based on its knowledge of local conditions downstream of the dam with respect to consequences of dam failure. It is NHC's opinion that the computed design discharge values corresponding to each step are conservative estimates of peak discharge.

Table 1. Storm and Peak Flow Results Amount Results

DOE Design Step	Estimated DOE AEP*	DOE Design Step Risk Level	2-hr Storm Amount at Watershed (in)	Emergency Spillway Design Discharge (cfs)
2	1/ in 1,000	"Low" Hazard, See attached Table 2 from DOE	1.93	1100
3	1 in 3,000	"Significant" Hazard See attached Table 2 from DOE	2.39	1500
4	1 in 10,000	See attached Table 2 from DOE	2.95	2000
*Annual Exceedance Probability				

Discussion

Comparison of Precipitation Amount with NWS PMP

Precipitation amounts shown in Table 1 for all three design steps are considerably less than the PMP amount for a basin of this size. The PMP is approximately 8.25 inches for a 2-hour storm (HMR 57, Figure 11.19 and Table 11.4) at the study location. This exceeds DOE Dam Safety Design Step 8.

Hyetograph Development

A design hyetograph for a six hour storm was developed for each storm amount in Table 1 using procedures for a short duration storm described in WA-DOE's Dam Safety Guidelines, Technical Note 3. A short duration storm is considered to be appropriate for the locale of the proposed dam and reservoir. The storm rises and falls very fast, compressing 89% of the total storm amount within a 30-minute period.

Backup calculations and notes for both storm amounts and design hyetographs are provided in the attached spreadsheet file STEMELT.XLS.

Peak Flow Simulation Procedure

A runoff hydrograph was computed using the SBUH-SCS method as programmed by King County's HYD program. The following inputs and assumptions were incorporated into the runoff and routing calculation:

1. Basin Pervious
    a. 98% of total area of 763 acres = 748 acres
    b. Curve Number = 83 corresponding to forest cover, D type SCS soil (low permeability), poor condition
2. Basin impervious
    a. 2% of total area = 15 acres
    b. CN = 98
3. Basin Time of Concentration
    a. Velocity = 1.5 ft/s (nomograph, Barfield et al, 1983)
    b. Length assumed = 3000 feet (estimated from topo map provided by RH2)
    c. Tc = 33 minutes directly from length and velocity.

Discussion: Runoff hydrographs and peak flow estimates based on these assumptions and methods should be judged as conservative as the lowest permeability soil type was selected. No effort was made to research the permeability of basin soils which may be more pervious. Also, it was assumed that forest condition was poor. These two assumptions resulted in selection of a high curve number for basin pervious surfaces.

Comparison of SBUH-SCS Peak Flow Rational Method Peak Flow

Peak flow results shown in Table 1 were compared with results using the Rational Method with a time of concentration of 33 minutes. The peak discharge results in Table 1 were used to back-calculate Rational Method C factors for the study basin for each Design Step. Resultant C factors range from 0.4 to 0.5 which is approximately 67% to 83% of the C-factor value estimated as a function of topography, soil drainage, vegetation cover, and watershed storage (see http://onlinemanuals.txdot.gov/txdotmanuals/hyd/the_rational_method.htm).

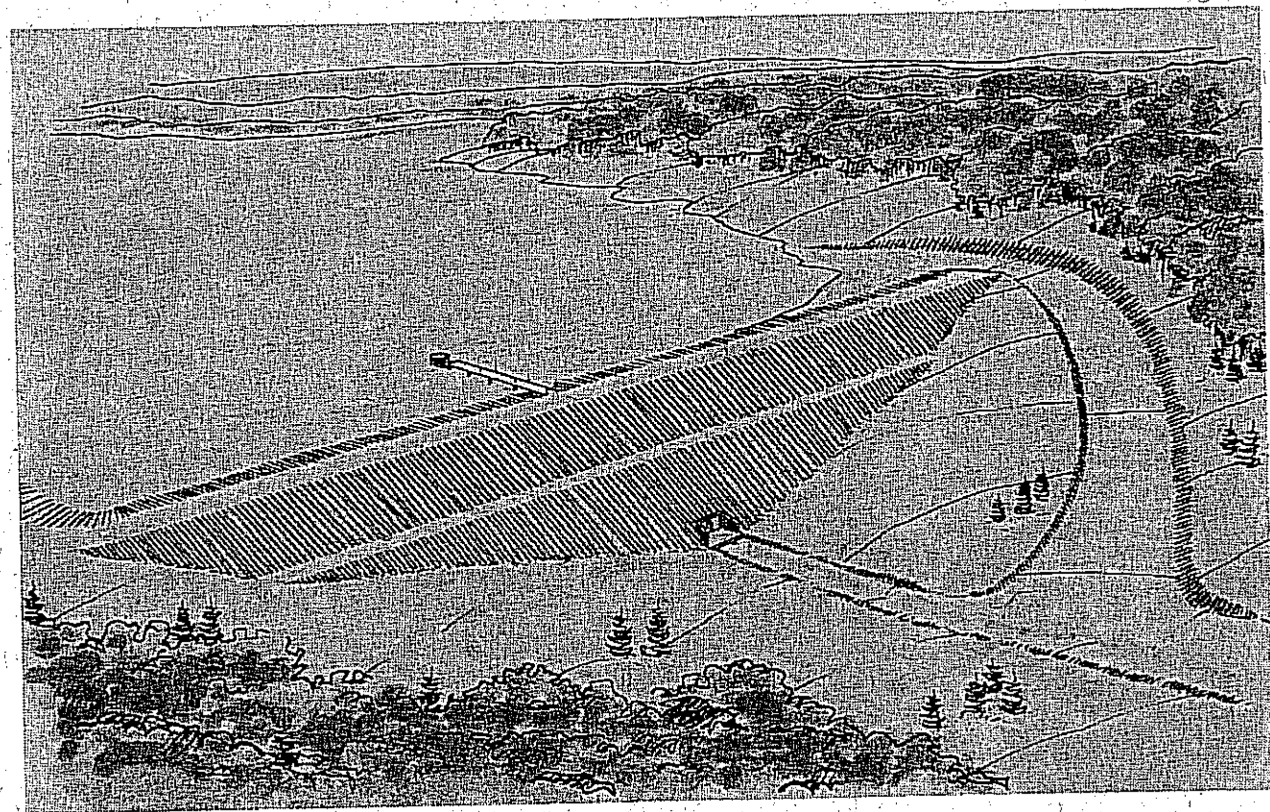
The Rational Method is generally considered to be a conservative methodology; this calculation confirms that the SBUH-SCS results approach the conservatism implicit in the Rational Method.

<u>Comparison with HSPF-based Peak Flow</u>
An HSPF model was developed to represent the basin using USGS regional parameters for till soils (i.e. low permeability) and effective impervious area. The HSPF model was run for a range of antecedent soil conditions. HSPF peak flow results for the design storms range widely from much less than the SBUH-SCS results to substantially more depending on antecedent soil moisture conditions. HSPF peak flows generally match the SBHU-SCS results for moderately high initial soil moisture.

Conclusion
The peak flows provided are considered to be conservative for the DOE hazard categories specified. The peak flows represent inflows and reflect no reservoir routing through an assumed spillway. Peak flows reflect an intense, small, thunderstorm type rainfall event that occurs on a very wet basin in the study area. RH2 should select the Design Step and corresponding peak flow estimate that best reflects the potential failure hazards downstream of the proposed facility. The estimates in this memo are suitable for cost estimating purposes. NHC recommends a review of the approach, methods, and assumptions prior to their application for design purposes.

Attachments:

1. Washington Design Step-Hazard Correlation Table
2. Design Storm and Hyetograph Calculations (Digital EXCEL file)



Dam Safety Guidelines

Part IV:
Dam Design and Construction

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

July 1993
92-55D

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Additive-Weighting Scheme - Selection of the Design Step and corresponding design/performance goal is accomplished using an additive-weighting scheme[2,3] to incorporate all of the consequence information into a numerical format (consequence rating points) to provide guidance in decision-making. The design/performance goal is determined based on the magnitude of the consequence rating points (Figure 1).

Application of the selected design/performance goal is accomplished through a Design Step Format incorporating 8 design steps (Figure 1). The selected design step is used as an index for specific design levels, design events and design loading conditions for the various critical project elements.

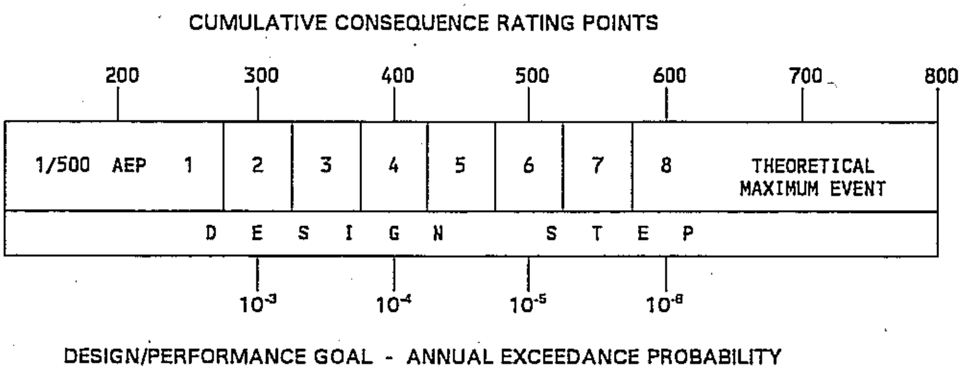

FIGURE 1. DESIGN STEP FORMAT AND CONSEQUENCE RATING POINTS

The approach taken here is to use the broad spectrum of engineering design practice as a reference for setting benchmarks for design levels. While direct situational comparisons are few, there are enough similarities to provide sound guidance[1]. This approach provides a means of setting design levels which are consistent with levels of safety provided by other engineering disciplines and by existing government regulation in other engineering and product safety areas.

Often during the preliminary stages of project planning, there is a need to make a quick assessment of the Design Step. This can usually be accomplished by use of Table 2 which shows the general relationship between the Design Step and the commonly used Downstream Hazard Classification.

TABLE 2 - RELATIONSHIP OF DESIGN STEP TO DOWNSTREAM HAZARD CLASSIFICATION

DOWNSTREAM HAZARD POTENTIAL	DOWNSTREAM HAZARD CLASSIFICATION	POPULATION AT RISK	ECONOMIC LOSS GENERIC DESCRIPTIONS	ENVIRONMENTAL DAMAGES	TYPICAL DESIGN STEP
LOW	3	0	Minimal. No inhabited structures. Limited agriculture development.	No deleterious materials in reservoir	1 - 2
SIGNIFICANT	2	1 to 6	Appreciable. 1 or 2 inhabited structures. Notable agriculture or work sites. Secondary highway and/or rail lines.	Limited water quality degradation from reservoir contents and only short term consequences	3 - 4
HIGH	1C	7 to 30	Major. 3 to 10 inhabited structures. Low density suburban area with some industry and work sites. Primary highways and rail lines.	Severe water quality degradation potential from reservoir contents and long term effects on aquatic and human life	3 - 6
HIGH	1B	31-300	Extreme. 11 to 100 inhabited structures. Medium density suburban or urban area with associated industry, property and transportation features.		4 - 8
HIGH	1A	More than 300	Extreme. More than 100 inhabited structures. Highly developed, densely populated suburban or urban area with associated industry, property, transportation and community life line features.		8

2.1.5 REFERENCES:

1. Schaefer, M.G., Selection of Design/Performance Goals for Critical Project Elements, Technical Note 2, Dam Safety Guidelines, Washington State Department of Ecology, Olympia, WA., July, 1992.

2. Hayes J.B., The Complete Problem Solver, Lawrence Erlbaum Associates Publishers, Hillsdale, N.J., 1989.

3. Keeney, R.L., Raiffa, H., Decisions With Multiple Objectives: Preferences and Value Tradeoffs, John Wiley and Sons, 1976.