FINAL DRAFT
MAY CREEK DRAINAGE AND RESTORATION PLAN
KING COUNTY, WASHINGTON
DECEMBER 19, 2008

FOR
KING COUNTY
WATER AND LAND RESOURCES DIVISION

MID-PUGET SOUND FISHERIES
ENHANCEMENT GROUP

GeoEngineers

File No. 10791-005-00

Final Draft
May Creek Drainage and Restoration Plan
King County, Washington
File No. 10791- 005-00

December 19, 2008

Prepared for:

King County Water and Land Resources Division

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KING COUNTY, WASHINGTON
FOR
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AND
MID-PUGET SOUND FISHERIES ENHANCEMENT GROUP

INTRODUCTION

GeoEngineers, Inc (GeoEngineers) was contracted by the Mid-Puget Sound Fisheries Enhancement Group (MPSFEG) to develop a Conceptual Restoration Plan (CRP) for the May Valley Subarea, located within the May Creek Basin, near Renton, Washington (Figure 1, Appendix A). King County funded the development of this CRP. GeoEngineers and OTAK of Kirkland (the project team) worked with MPSFEG to develop this plan.

The May Valley Subarea consists of a relatively long, narrow low-relief floodplain bounded on three sides by upland slopes. The floodplain, which is zoned for rural/agricultural use with accompanying residential and farm related structures, has a long history of flooding and is subject to multiple episodes of flooding every year. Although a natural function of the valley is to temporarily store floodwater, it is clear that storage periods have increased considerably over the past few decades, rendering valley properties virtually inaccessible and unusable until mid-summer. The extended duration is one result of the combined effects of alterations to the stream channel, riparian vegetation, floodplain wetlands and upland drainage basins, all of which have exacerbated the frequency and duration of valley flooding.

This Conceptual Restoration Plan summarizes past, current, and projected future conditions in the May Creek Basin and provides an overview of proposed actions planned in the May Creek Basin. Based on this information, a suite of 33 conceptual projects are recommended for consideration. If constructed, these projects will begin to address local flood control issues, degraded aquatic habitat, and other associated issues in the May Valley.

King County, the City of Renton, the City of Newcastle, the State of Washington and the May Creek Citizens Advisory Committee invested personal time and energy identifying and prioritizing problems within the Basin and developing recommendations to resolve those problems. These efforts culminated in the production of the May Creek Basin Action Plan (Action Plan), finalized and adopted in April of 2001 (King County 2001). Recommendations provided in this CRP were guided by technical information contained in the May Creek Current and Future Conditions Report (King County 1995), and on the expertise and experience of natural resource professionals and the citizens in the May Creek basin.

PROJECT BACKGROUND

The May Creek drainage basin is situated on the east side of Lake Washington in King County, Washington (Figure 1, Appendix A). Over the past several decades the May Creek Basin has been subject to numerous flooding issues related to urban and rural development. For example, the May Valley area is presently subject to frequent episodes of long duration flooding, the Canyon section (downstream from May Valley) is subject to increased erosion, and the entire length of the stream has experienced reduced usage by salmonids and wildlife. In order to address the many issues and problems facing the May Creek basin, King County developed the Action Plan (King County 2001). The Plan was based on several supporting studies that reflected conditions documented in 1995.

We understand that earlier flood control planning efforts were attempted in the 1960s and 1970s. In the 1960s, a Flood Control Zone District drainage plan bond was proposed and failed due to issues regarding fees on new development, dredging, and fears that flood-proofing would increase development in the valley. In the 1970s, May Creek residents approved plans to deepen the May Creek channel and control runoff from new development onsite; however, the group had no authority to implement these proposals and no actions were taken. During this period valley residents urged King County to acknowledge that portions of the creek have been ditched, and thus mechanically created to convey both low flows and periodic flooding out of the valley. In 1980, King County prepared a drainage basin plan for the May Creek Basin in cooperation with the City of Newcastle Community Plan (King County 1980). Following completion of the Newcastle Plan, the County completed the "May Creek Current and Future Conditions Report," dated August 1995 and the "May Creek Basin Action Plan," dated April 2001 (King County 2001). We also understand that some landowners maintained some portions of the channel until the 1990s, after which regulations limited their ability to do so.

PROBLEM STATEMENT AND PROJECT OBJECTIVES

The CRP addresses Recommendation 5 in the May Creek Basin Action Plan (Action Plan, King County 2001), which focuses on reducing the duration of flood in the May Valley. Recommendation 5 states that successful projects must be allowable under current regulations and permitting requirements, and, to the extent possible, be implemented and maintained by valley residents. However, projects must also comply with King County Critical Areas Ordinance (CAO) codes, which specify that projects must be designed primarily to provide significant habitat elements (channel meanders, buffer plantings and in-channel wood). Projects meeting these requirements may include flood reduction measures such as channel clearing; however, flood reduction can not be the primary purpose of the project.

Based on directives posed by the King County Action Plan and CAO, the intent of this CRP is to provide a suite of projects that 1) help reduce the duration of local flooding, 2) enhance fish habitat, and 3) can be implemented and/or maintained by local residents. The development of measures to eliminate or reduce, the frequency of significant flood events within the Valley is beyond the scope of this CRP. Individual projects are intended to reduce the duration of flooding from flows ranging from the 2- to 5-year recurrence interval storms.

Based on information derived from the Basin Current and Future Conditions Report (King County 1995) and May Creek Basin Action Plan (King County 2001), observed increases in both the frequency and duration of flooding are the end result of several factors, all of which are related to increases in stormwater runoff, valley topography/gradient, and sediment supply. In general, the increased runoff results in increased rates of hillslope sediment production and delivery to drainage channels, and increased rates of water and sediment transport through upper basin channels to the valley, where most of the sediment is deposited in the mainstem channel. Once there, the sediment tends to accumulate in low gradient portions of the mainstem channel, filling portions of the channel, obstructing flow, and thus reducing the conveyance capacity of the creek. Infilled portions of the creek have become susceptible to the growth of invasive aquatic vegetation which capture more sediment and further restrict channel conveyance. Significant reductions in conveyance capacity have resulted in a significant reduction of in-channel flow storage, loss of aquatic habitat, more frequent flooding, and longer periods of post-flood recession and recovery. This condition has been further exacerbated by construction of bridge crossings, culverts and beaver dams, which impede all but the lowest flows.

The primary objectives of the projects described in this Plan are provided below:

- Reduce the duration of flood events in May Valley,
- Increase conveyance of surface water out of May Valley,
- Reduce erosion and sedimentation impacts in the Valley,

- Reduce the effects of hydraulic barriers created by culverts, bridges, and other obstructions,
- Avoid impacts to downstream landowners, particularly those in the canyon section of May Creek,
- Improve fish passage and habitat along May Creek and priority tributaries, and
- Enhance the riparian and wetland functions along May Creek.

PROJECT APPROACH

Our approach to achieving the objectives described above includes three principle phases: 1) identify and evaluate the relationship (and importance) of physical in-channel and floodplain conditions and processes to local flood duration problems, 2) develop conceptual projects designed to reestablish the dynamic equilibrium of the stream and address specific factors contributing to local flood duration problems, and 3) evaluate the expected benefits of projects to reduce flood duration, to improve habitat or to address other restoration priorities identified in Recommendation 5 of the Action Plan (King County 2001).

The initial phase of this project included a review of available existing documents and studies for both the May Creek Basin and May Valley. Although this CRP focuses on projects in May Valley, all available information regarding May Creek Basin conditions were reviewed to gain an understanding of basin-scale controls on valley flooding. Information specific to geologic, geomorphic, and hydraulic processes in the upper basin and valley were reviewed to provide a more complete picture of the processes that are contributing to the observed increases in flood frequency and duration periods in the Valley. This information was also used to help identify specific problem areas in the May Valley and in the design and analysis of each project.

With an understanding of Basin and May Valley conditions, the team identified projects with potential for achieving two objectives: 1) improving in-channel processes and aquatic habitat, and 2) reducing flood duration periods resulting from high frequency events. All identified projects were further evaluated with respect to flood control effectiveness, implementation feasibility, permit requirements, water quality issues, landowner cooperation, cost and probability of success.

Projects 1 through 29 described in this CRP were developed using well-established principles of ecosystem restoration, most of which are based on the premise that hydrologic, hydraulic, and geomorphic processes control stream channel form and function, as well as the development of aquatic habitat features. These projects focus on restoring key fluvial and biological processes and reconnecting habitat features within the watershed as a means of achieving, over the long term, greater flood conveyance and recovery of the ecosystem (Ehrenfeld 2000, Bates 2003). However, existing land use and infrastructure access issues within the May Valley demand more immediate solutions than can be achieved through process-based projects alone (Projects 1 through 29). Therefore, four projects (IFP 1 through IFP 4) were developed to address ineffective flow areas known to exist in the Valley. These projects focus on mechanical alteration of the channel cross section, and are intended to reduce flood duration periods and improve fish passage. It is important to understand that while these projects offer immediate benefits to flood-prone properties, the life span, (the period of effective project performance) will likely be short, given the ambient basin and reach scale conditions, unless implemented in concert with more process-based projects 1 through 29.

The final list of feasible projects was selected and prioritized based on 1) proximity to areas with critical issues and 2) the ability of the projects to address CRP project objectives, including: flooding, fish habitat, erosion water quality, and sedimentation. The prioritization offers a sequencing of project implementation intended to incrementally improve conditions in the May Valley.

TECHNICAL INFORMATION UPDATES

The project team reviewed available information provided by the Mid-Puget Sound Fisheries Enhancement Group (MPSFEG), King County, local community resources, Washington State agencies, Federal Agencies, and GeoEngineers. Where access was granted and landowners were available, the project team conducted site visits and met with landowners through the May Valley Subarea. New information was added, as necessary, to the existing project data base compiled by King County. New information included geomorphic, hydrologic, hydraulic and biologic characterizations provided in the May Creek Current and Future Conditions Report (King County 1995) and the May Creek Basin Action Plan (King County 2001). Where new information was not available, the Conditions Report (1995) and Action Plan (King County 2001) were used as primary references, supplemented with other available data. The information reviewed and used to characterize the basin, valley, and reach conditions included:

- FEMA flood maps,
- Geologic, soils and topographic maps,
- Current road and parcel boundary maps.
- Recent aerial black/white and infrared photography
- Current critical/sensitive areas maps,
- August 2007 Priority Habitat and Species (PHS) maps by Washington State Department of Fish and Wildlife (WDFW), and
- Light Detection and Ranging (LiDAR) data and maps.

The project team created a GIS data base and developed a LiDAR based floodplain surface topography model to update geomorphic, biologic and flooding conditions described in the May Creek Basin Action Plan. The GIS data base and LiDAR provides a basis for assessing the following:

- Changes in conditions since publication of the Conditions Report (King County 1995).
- Cause/effect relationships controlling flooding and ecological conditions throughout the May Valley.
- Identification of channel constrictions, flow obstructions, topographic lows on the floodplains, and possible wetlands and near shore features that may represent possible project sites.

The adequacy of existing data and basin information presented in the Basin Action Plan and appendices was reviewed for applicability to the objectives of the CRP. The reviewed data included assumptions and input parameters used in the HSPF and HEC-2 computer analyses. The model evaluated the area between 148th Avenue SE and 164th Avenue SE. The models were reviewed to:

- assess how storage in the wetlands, overbank, and channel were modeled,
- assess how well these natural storage areas simulate the attenuation of flood flows at various locations in the May Valley reach, and
- evaluate how cross sections have changed, and whether there is sufficient existing information throughout the May Valley to evaluate alternatives.

All collected data were reviewed with respect to important information gaps and/or inaccuracies. The evaluation focused on assessing whether the description of May Creek conditions offered in the Current and Future Conditions Report provides an accurate reflection of current basin conditions. As a result of the evaluation, the existing HSPF and HEC-2 model analyses were modified to more accurately reflect current conditions using site-specific surveying. The HEC-2 model was converted to a HEC-RAS model, which is a more accurate model for establishing flow rates, depths, durations, velocities and the time required for floodwaters to drain from the May Valley reach. The HEC-RAS model was also used to evaluate areas of ineffective flow and their respective water surface elevations for specific high frequency recurrence interval

storm events. Additional survey was conducted to provide site specific topographic information for use in the HEC-RAS computer model. The models and GIS database were used to evaluate the following:

- Channel sections affected by constrictions, such as pinch points caused by bridges, and flow obstructions such as beaver dams and undersized culverts.
- Channel sections determined to have ineffective flow during high frequency (2-year recurrence) events.
- Potential flood-prone areas.
- Factors contributing to prolonged duration of local flooding.
- Potential flood reduction sites.
- Potential habitat restoration sites.
- Selection of sites requiring additional engineering analysis.

Field reconnaissance and data verification site visits were conducted throughout the basin and at possible project sites in the Valley. The reconnaissance included investigation of wetland and riparian conditions, channel erosion and deposition and floodplain features. Field data was added to the GIS data base and the results were used to develop project concepts included in this Plan.

ENVIRONMENTAL SETTING

This section generally describes the geologic processes that formed the current structure of the May Creek Basin. It is these processes that established the current drainage pattern in the area and set the basic geologic and fluvial geomorphic structure within which each of the proposed projects for the Valley must function.

The following background information was derived from the May Creek Current and Future Conditions Report dated August 1995 and the May Creek Basin Action Plan dated April 2001.

REGIONAL SETTING

The May Creek drainage basin is part of the Lake Washington Watershed. The May Creek drainage system (main stem and tributaries) encompasses a 14-square mile (8,960 acre) area located on the east side of the Lake. Basin headwaters originate at about Elevation 1,600 feet, in the rugged foothills of Cougar and Squak Mountains. The basin is situated between the Cedar River, Coal Creek, and Issaquah Creek drainages. It serves a diverse mix of land uses ranging from planned urban communities to more sparsely settled rural residences and small farms.

The Basin consists of four distinct topographic sections; from upstream to downstream these sections are 1) the steep upper foothills section, 2) the May Valley, 3) May Creek Canyon, and 4) the delta and eastern shoreline of Lake Washington.

The **upper foothills section** is drained by several branching tributaries which join to form a single main stem channel where the steep terrain transitions to the low gradient topography of May Valley. The **May Valley** is situated between Elevations 550 and 660. The valley consists of a long, narrow relatively flat, floodplain oriented from southeast to northwest and bounded on the northeast and southwest by moderately inclined valley slopes. The valley slopes are drained by numerous tributaries that flow across the floodplain to join with the mainstem channel. The **May Creek Canyon** is a steep, narrow ravine deeply incised in the face of shoreline bluffs adjacent to Lake Washington. The Creek descends through the canyon from about elevation 550 feet mean sea level (MSL) to approximately elevation 20 feet MSL. The **Delta** section extends from the

mouth of the canyon where the creek flows across the low gradient landform of the Lake Washington shoreline and onto a small delta formed from May Creek sediment deposits

Geologic History and Topography

The current shape and topography of the May Creek Basin were determined primarily by large scale geologic events that took place from roughly 35 million to about 1 million years ago. These events included upward folding associated with tectonic uplift and mountain-building that formed the Cascade and Olympic Mountain Ranges. These same events included a west-northwest trending fold that formed Newcastle Hills, Cougar Mountain, and Squak Mountain. The May Creek basin lies on the southwest side of this fold.

The topography of greater Puget Sound area and, in particular, Lake Washington, was further defined by the advance and retreat of numerous episodes of continental glaciation. Approximately 16,500 years ago advancing glacial ice flowed south into the greater Puget Sound area. As the glacial ice advanced, lowland areas were scoured to form Puget Sound, numerous adjacent lakes, and upland flat-topped plateaus. In the Lake Washington/May Creek area, the advance and retreat of the glacier resulted in the formation of an ice-scoured platform surrounded by the west and south flanks of Cougar Mountain. The scoured platform, which formed May Valley, is situated at Elevation 600 feet and drops away abruptly at the western edge to form a portion of the eastern lake bluff.

During the final episodes of glacial advance and retreat, May Creek became a major meltwater drainage channel, and developed a conveyance corridor wide enough to accommodate the large volume of glacial runoff flowing into what is now Lake Washington. This ancestral stream eroded glacial deposits to a base level that forms the present-day elevation of the May Valley.

The Vashon glacier continued to melt and had receded as far north as the Strait of Juan de Fuca by about 13,600 years ago. As the ice receded from more areas, drainages began to flow north out to the Strait of Juan de Fuca, lowering Puget Sound to its approximate present-day elevation. This initiated a second phase of erosion in the May Creek Basin. As water levels in Puget Sound and Lake Washington continued to lower, the mouth of May Creek eroded down to a new base elevation, exposing bedrock in the May Creek Canyon section and lower portion of the Valley.

The receding glacier and meltwater erosion of the May Creek Basin created a well defined valley with steep sidewalls. The steep walls and multiple layers of glacial deposits on the valley walls were susceptible to landsliding and erosion, especially where the sandy deposits are exposed. As a result, both the valley-slopes and stream channel have been highly sensitive to erosion since the retreat of the glacial ice.

With the on-set of human activity over the last 100 years, surface water runoff and stream discharge generated from within the basin has increased significantly, subsequently, increasing post-glacial erosion rates and the supply of fine sediments to the May Creek valley.

Geology

Three major geologic units underlie the May Creek Basin

- Bedrock, comprising Cougar Mountain, Squak Mountain, Newcastle Hills and uplands in the immediate vicinity of May Valley.
- Glacial-consolidated sediment deposits that form the gentle rolling plateau south of May Valley.
- Unconsolidated sediments derived from the upper May Creek Basin and uplands surrounding the May Valley.

The **bedrock** includes two formations: The Renton Formation, which consists of non-marine sandstone and claystone containing numerous coal beds, and the Tukwila Formation, consisting of andesitic volcanic sandstone, tuff, mudflow breccia and minor lava flows. Bedrock is primarily exposed at the surface in the uplands north of the valley; and at a few sites on the south and west sides of the valley.

The **glacial-consolidated sediments** include advance outwash deposits, till and recessional outwash deposits. The advance outwash deposits were deposited in May Valley about 15,000 years ago by rivers of meltwater and in lakes that formed along the margins of the glacier as it moved to the south. The advance outwash deposits generally consist of well-bedded sand and gravel, with almost no silt or clay. These sediments are exposed along much of the May Valley sidewalls. The sediments are susceptible to water erosion, resulting in ravines and gullies.

The till was deposited from the base of the glacial ice as it moved over the advance outwash deposits. The till is composed mainly of a dense, highly compacted, poorly sorted mix of clay, silt and gravel. These deposits are typically 5 to 30 feet thick within the May Creek Basin. The till has very low infiltration and relatively high runoff rates.

The recessional outwash consists of moderately to well sorted sand and gravel with little silt and sand deposited by meltwater flow of the receding glacier. Recessional outwash is exposed on the upland plateau in the southern part of the basin and along the south-trending outwash channels. These deposits vary from 0 to about 33 feet in thickness, and have moderate infiltration and runoff rates.

The unconsolidated sediments composed of sand, gravel, and boulders in the basin and valley are derived from post-glacial processes including gravel mining, stream erosion as May Creek began to incise through glacial and non-glacial deposits; landsliding of glacial sediments from basin walls, weathering processes, stream erosion; and alluvial fan and debris fan development. These sediments are abundant throughout the May Valley and along the inner canyon walls of tributary creeks.

In the May Creek Basin, the Valley is comprised mostly of alluvial deposits (water deposited sediment) up to 500 feet thick overlying bedrock. The west end of the valley is confined by a small notch in the bedrock where the alluvium thins out to exposed bedrock where the channel drops into the high gradient May Creek Canyon. The upper most section of the canyon (RM 0.6 to 3.9) is composed of compact advance outwash and possible bedrock. The lower portions of the canyon section are composed of sand and gravel outwash and alluvium and till. The May Creek channel has incised through the outwash and till. Further up channel erosion is slowed by the more compact outwash and possible bedrock.

Basin Hydrology

The May Creek drainage system includes approximately 26 miles of mapped streams, two small lakes and over 400 acres of wetlands. The mainstem of May Creek flows nearly 9 miles from its headwaters to Lake Washington. Major tributaries include the North, East, and South Forks of May Creek, Honey Creek, Indian Meadow Creek, Long Marsh Creek and Boren Creek. Two lakes, Lake Kathleen in the southeast and Lake Boren in the northwest, are also located within the Basin.

The majority of the water entering the streams and lakes originates from stormwater runoff and limited groundwater springs and seeps. The storms are typically of long-duration and low-intensity. Average annual precipitation levels range from 44 to 49 inches. Snow occasionally falls at the higher elevations, but the snowfall has no significant impact on the hydrology of the basin. However, it should be noted that over the last several years, the occurrence of several rain-on-snow events has generated high volumes of stormwater run-off.

Increases in stormwater run-off may be occurring for a number of reasons, including:

- increased impervious and semi-impervious area (bedrock, glacial till, , roof tops, pavement, and compacted soils such as lawns);
- possible increase in the intensity of storm events which exceed the infiltration capacity of the soil; and ,
- Lack of soil storage capacity due to saturated soil conditions.

Estimated changes in runoff are presented in the Conditions Report (King County 1995), and is further evaluated later in this report. Modeling results presented in the Conditions Report predicted that the change from predominately forested land cover to more commercial and agricultural land use would effectively increase the basin-wide average of effective impervious area from 0 to 7 percent. The models also estimated that, without any changes in zoning or development regulations, the total future impervious area would likely increase to 12 percent. The increase in impervious area, as well as high ground water levels, were predicted to increase peak flows and flood durations in the valley from 15 to 20 percent, as compared to predevelopment conditions post-dicted for the 2-, 25- and 100-year events. In addition to these changes in landuse in the uplands of the basin, changes to the natural stream channels through dredge and fill activities and the removal of streamside vegetation have also changed runoff patterns, flood attenuation, nutrient assimilation, stream channel morphology and flow conveyance capabilities.

GeoEngineers performed hydrologic analyses to evaluate whether run-off changes since 1990 predicted in the Conditions Report (King County 1995) have been realized as a result of development over the past 10 to 15 years. The analyses required developing two streamflow hydrographs to evaluate actual runoff before and after 1990. A streamflow hydrograph represents the changes in streamflow as measured over time.

Streamflow data from two gage stations on May Creek were used for hydrographic input. Gauge station 37A is located near the mouth of May Creek downstream of Lake Washington Boulevard. The project team was able to acquire intermittent flow data from this station. The U.S. Geological Survey (USGS) maintained the station from September 1964 to July 1972, producing hourly flow data (USGS Gauge #12119600). King County maintained this station from November 1983 through April 1993, producing data at 15-minute intervals. Flow data from gauge 37A from September 1964 to July 1972 was used to represent conditions prior to the year 1990, as modeled in the Conditions Report (King County 1995). The average daily discharge in cubic feet per second (cfs) at Gage 37A from September 1964 to July 1972 is shown below in Figure 2.

Gage station 37B is located near the Coal Creek Parkway SE crossing of May Creek. This station has been maintained by King County from November 1988 to present, producing flow data on 15 minute increments. Flow data from gage 37B from March 1999 to January 2007 was used to represent conditions between 1990 and the present. The average daily discharge in cfs at Gage 37B from March 1999 to January 2007 is also shown below in Figure 2 below.

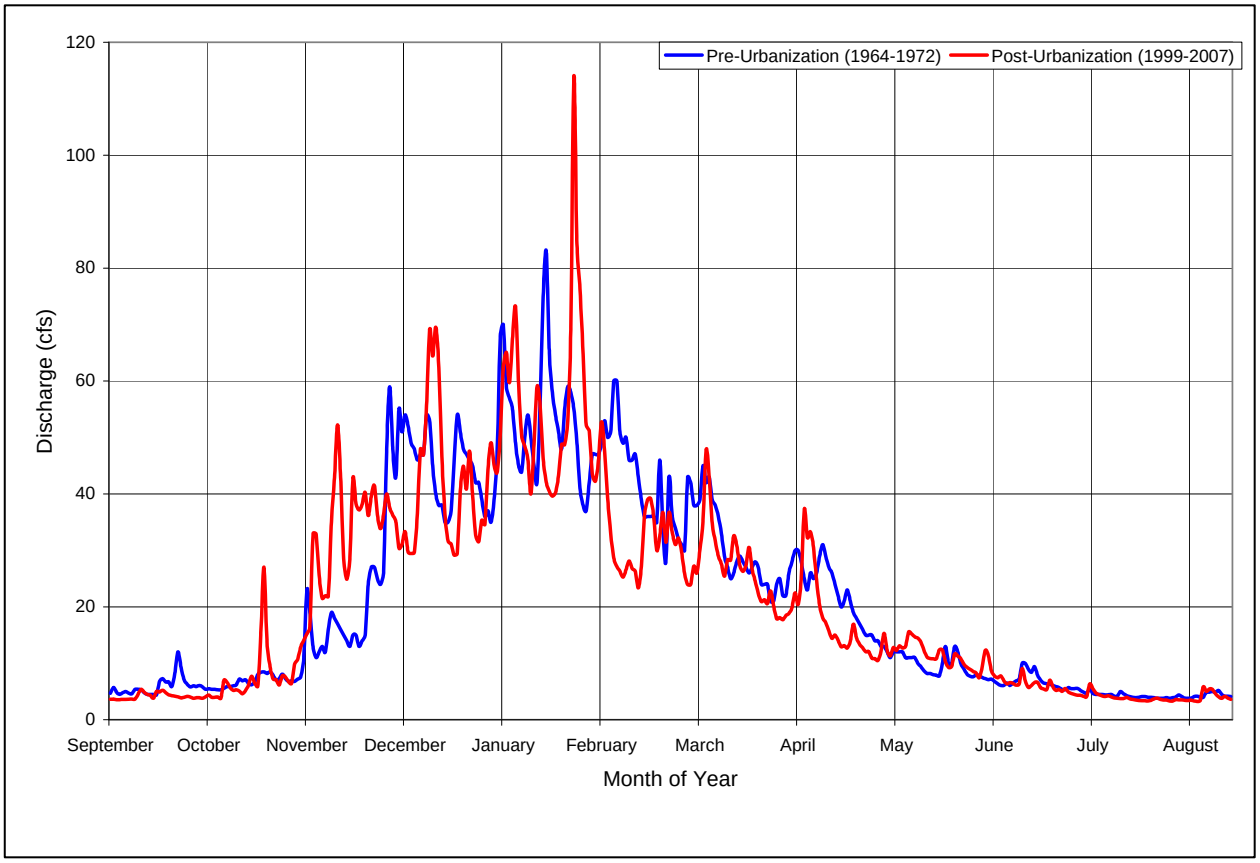


Figure 2. Average daily streamflow hydrographs for May Creek, USGS Gauge Station 12119600 depicting pre (1964-1972) and post (1999-2007) urbanization periods.

To further compare average annual flows an average monthly discharge hydrograph was developed for both the pre and post-urbanized period of record. To determine if there are any significant deviations from pre-urbanized condition the 95 percent Confidence Intervals were plotted for the pre-urbanized record. The 95 percent confidence intervals show a range of values where there is a 90 percent chance that the average monthly discharge will fall within that estimated range. This allows us to see if there are any statistical differences between both periods of record. Figure 3 shows the average monthly discharge graph for both the pre and post-urbanized conditions.

Flow data from the two gauges were compared to evaluate whether expected changes in flow since 1990 have been realized. To compare the data, average daily discharges were compared for each pre and post-urbanized period of record. The post-urbanized period shows a 12 percent increase in average daily discharge during the runoff months of November through March. During the low flow months from April through October the post-urbanized period of record shows a 6 percent decrease in average daily discharge. When summarized throughout the year there is only estimated to be a 2 percent increase in average daily discharge.

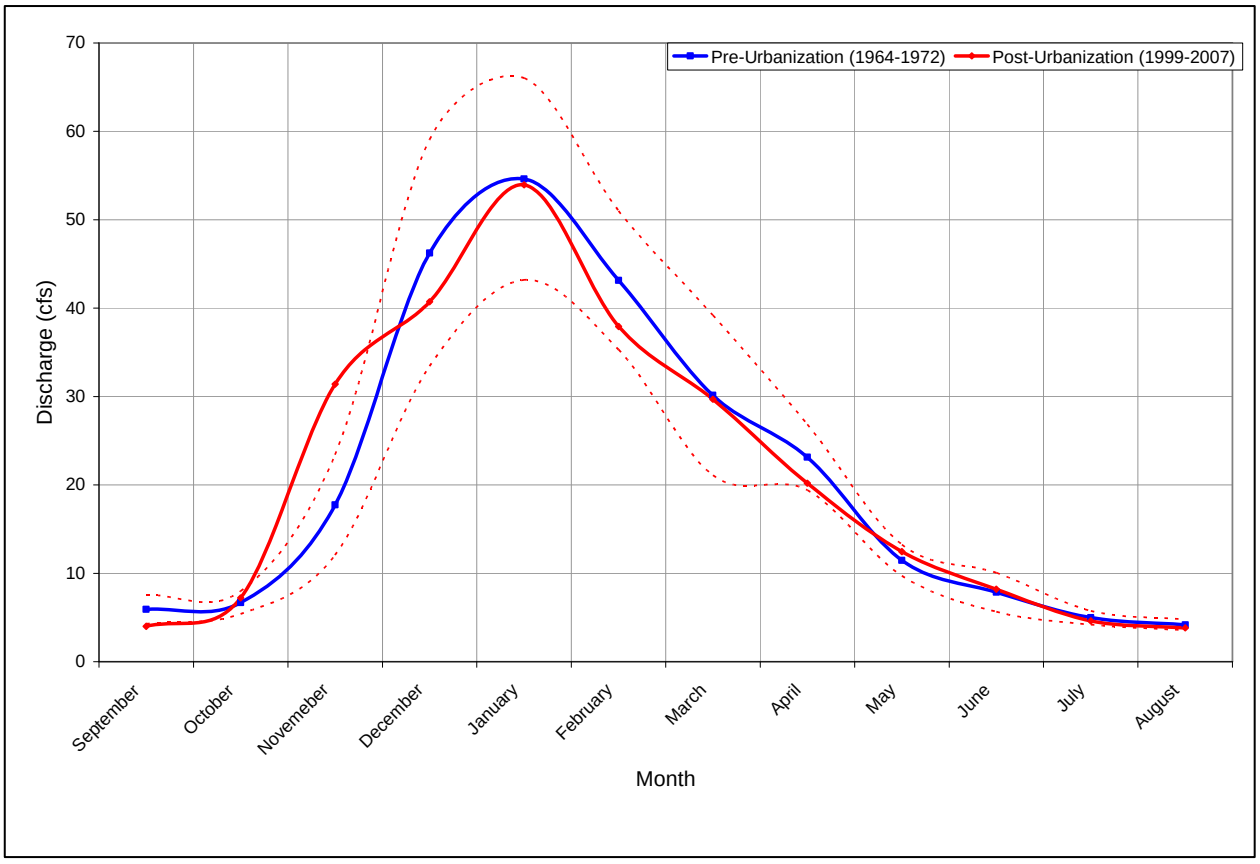


Figure 3. Average daily streamflow hydrographs for May Creek, USGS Gauge Station 12119600 depicting pre (1964-1972) and post (1999-2007) urbanization periods.

The average monthly discharge graph shows that the yearly hydrograph, post-urbanized condition (1999-2007) has a steeper rising limb. The steeper limb indicates that urban runoff reaches the basin outlet faster than runoff from the forested condition (pre-urbanized), probably in response to the presence of impervious surfaces. The post-urban hydrograph appears to peak in January, approximately the same time as for pre-urbanized conditions. August and September base flow conditions show relatively low base flows, which were also indicated by the average daily discharge analysis. There appear no significant differences between average monthly flows, however, this could be a result of individual storm events being washed out by low and base flow averages. Based on these observations, the stream flow hydrographs shown in Figure 2 appears to better portray individual storm events and was therefore used in the analysis of discharge differences between pre and post-urbanized conditions.

It is important to consider that each average day and average month hydrograph has been developed using only 8 years of data, which is a relatively short period of time to perform any type of hydrologic analysis. Results for such small datasets should be construed as provisional and interpretation of results should recognize the potential for error.

Figure 2 demonstrates that stream flows between 1964 and 1972 were generally higher than those measured between 1999 and 2007 during low flow events and were generally lower than post-urbanized flows during the peak runoff season. The flows for the high flow events have increased approximately 12 percent. This is slightly less of an increase than predicted in the Conditions Report (King County 1995). This increase in flow can be attributed to the lack of interception caused by the removal of forested cover as well as the

increase of impervious area. Conversely, the low-flow events were found to be less frequent after 1990 (1999 to 2007) as compared with events prior to 1990 (1964 to 1972). Such results are not unusual in an urbanized basin where development leads to a significant increase in the percentage of impervious surfaces. As impervious surface area increases, a greater percentage of rainfall in the basin leaves the basin as stormwater shortly after the storm event, resulting in a decrease in infiltration of precipitation and subsequently, the groundwater table. These conditions have led to a decrease in groundwater discharge to the stream during low-flow periods of the year, resulting in lower discharges during base flow events.

In summary, the May Valley basin shows evidence of urbanization as indicated by changes in the peak and timing of high and low flow events throughout the year.

MAY CREEK BASIN SUBAREAS

In previous studies the basin was divided into four regional subareas (Figure 4) for discussion and analysis. The four subareas are the:

- Lower Basin Subarea, which extends from the mouth of May Creek at Lake Washington upstream to River Mile 3.9 (RM 3.9), above the Coal Creek Parkway S.E. crossing;
- May Valley Subarea, which includes the upper May Valley floodplain and adjacent lower valley areas from RM 3.9 to the hydrologic divide to the east;
- Highlands Subarea, which includes the area lying north of May Valley and east of the Lower Basin, including the steep southern slopes of Cougar Mountain and the southwest portion of Squak Mountain; and
- East Renton Plateau Subarea, which includes the area south of May Valley and east of the Lower Basin Subarea.

Detailed descriptions for each of the sub-areas are provided in the Action Plan (King County 2001).

MAY VALLEY SUBAREA CONDITIONS

The May Creek basin continues to experience growth in urban and suburban development. The May Valley Subarea, however, still remains mostly rural with landuses such as livestock management and quarry mining. Although the western portion of the subarea continues to experience more residential and commercial growth, the eastern portion of the basin will likely be preserved as a rural area, based on the location of the Urban Growth Area Boundary, which bisects the basin at 148th Avenue SE.

The following basin and valley conditions were discussed in the Action Plan (King County 2001):

- The dominant hydraulic function of the May Valley is to store floodwaters. The Valley is subject to long-duration flooding, likely in response to an increase in high-flow stormwater run-off events throughout the basin.
- The most extensive flooding in the basin occurs within May Valley. Development, dredging and filling in the floodplain have altered natural drainage patterns, reduced natural storage areas, and placed structures in the path of drainage. Longer duration floods are projected in concert with predicted increases in storm water runoff.
- Deposition of sediment derived from natural erosion occurred even before human development began to alter natural processes within the Basin. Sediment deposition has been accelerated by development because of increased stormwater flows and changes in local land cover and increased impervious surfaces. Sediment deposition is slowly reducing the capacity of May Creek in the valley, worsening flooding and degrading fish habitat. Sediment escaping the May Valley is transported as far downstream as Lake Washington.

- Nonpoint pollution from roads, quarries, developing sites and commercial operations, animal-keeping practices and grazing in riparian areas and failing septic systems are negatively effecting water quality and aquatic habitat in May Creek.
- Development activities in the basin, including filling wetlands, increased stormwater runoff and peak flows, increased sediment and pollution in the water, and removal of coniferous forest cover, have historically degraded stream and wetland habitats.

The following summaries of historic and existing valley conditions are provided to illustrate changes that have occurred in the May Valley Subarea.

Historic Valley Condition

May Valley is historically a natural floodplain and, as a result has historically experienced frequent and sometimes extensive flooding, even before humans began altering natural processes through the active use of the valley. The natural flooding events were altered with the advent of activities such as logging, coal mining, and agriculture. Prior to the onset of basin development, the May Valley floodplain was likely a predominately coniferous forested wetland that periodically filled with floodwaters as described in the Current and Future Conditions Report (King County 1995). May Valley was cleared and drained in the late 1800's to support agricultural and residential uses that persist to this day. The woodland area in May Valley today consists mainly of thin stands of deciduous trees and scrubs occurring at irregular intervals along May Creek, as compared to a more diverse mixture of deciduous and coniferous trees and shrubs that would have occupied the entire valley bottom prior to development.

These and other practices led to the loss of vegetation, channelization of the streams, and further development onto the floodplains. These processes resulted in locally accelerated erosion, sediment deposition in stream channels, flooding of manmade structures, and loss of fish habitat. Through the years, flooding problems in the valley have worsened as a result of ongoing construction in the floodplain and development in upland areas, which have increased storm water runoff to the mainstem and tributary creeks and, subsequently, the May Valley. Sediment deposition in the valley has continued to reduce the conveyance capacity of the May Creek channel, in spite of past creek dredging conducted in attempts to temporarily improve conveyance and flood relief within the valley.

The Conditions Report (King County 1995) suggests that, historically, the May Valley Subarea was drained by several well to poorly defined channels set in a forested wetland composed of mature western red cedar, Sitka Spruce, and western hemlock. The history of landuse in the valley from predevelopment to the 1960's is summarized in the following paragraph from the Conditions Report (King County1995):

> *"A 1909 USGS map of the area shows considerable stream meandering. USGS Maps of the 1920s indicate that some channel straightening had occurred. The earliest aerial photographs from 1936 show stream channelization to be almost as it is today, indicating that the channel was most likely straightened and dredged between 1910 and 1936. In the 1940's, due to extensive flooding and increased sediment loads, the County dredged the creek and deposited dredge material on surrounding properties. By the 1960's sediment had again accumulated in much of May Creek."*

The Conditions Report also states that the 1992/1993 condition of the wetland "has actually *improved* substantially since 1936 as a result of the abandonment of agricultural lands and natural restoration of relatively high-quality, predominantly deciduous, forested, shrub-scrub, and emergent wetland habitats in some locations."

Existing Valley Conditions

GeoEngineers conducted stream reconnaissance surveys during three separate site visits in August 22, 2006, February 12, 2007 and July 19, 2007. The August reconnaissance survey was conducted during a period of low flow (approximately 2 cfs). The February reconnaissance survey was completed at a moderate flow (approximately 12 cfs), soon after and immediately prior to periods of high wintertime flows and flooding (approximately 90 cfs). Evidence of extensive flooding during periods of high flow was observed. Flooding was still occurring in some areas, with flows at or just above bankfull discharge levels. The July site visit was completed at a time of moderately-low flow (approximately 5 cfs). No areas were found to be actively flooding during the July visit. Some sections of May Creek were observed to be close to bankfull discharge levels, however, water surface elevations in some sections of May Creek were affected by in-channel obstructions (e.g. beaver dam, reed canarygrass).

The purpose of the site visits were to observe and document existing physical conditions and flow patterns within the subbasin as well as sections of the creek immediately upstream and downstream of the valley. Information obtained from the site reconnaissance was later used to divide the valley into six geomorphic reaches to evaluate and describe existing conditions and to propose possible remedial projects for the reaches. Conversations with landowners, together with observations made during site visits were also used to guide the prioritization of supplemental survey work by the project team. During the July 2007 site visit, the area surrounding the 148th Avenue SE bridge crossing was identified as a high priority for supplemental survey work.

Supplemental cross-section surveys, hydrologic and hydraulic modeling were completed in 2006 and 2007. The results of the study are summarized in the memorandum to Mid-Sound Fisheries dated November 8, 2006 and in communications used to produce this report. Attempts were made to reproduce the May Creek Future Mitigated HSPF conditions documented in the Conditions Report (King County 1995). However, modeled discharge and velocity results were generally lower than those documented in the Conditions Report (King County 1995). Several potential reasons for the discrepancies between the models include the following:

- Documentation of exact parameters used in the 1995 Conditions Report were generally not available,
- Exact dates over which the modeling was completed for the Conditions report were not known,
- Evaporation data has been modified since the modeling was completed,
- Precipitation data may have been modified since the modeling was completed,
- Coefficients and other parameters used in the modeling for the 1995 Conditions Report could not be verified.

Eleven discrete areas in the main channel of May Creek were identified as having ineffective flow during the supplemental survey work completed between the 148th Avenue SE and 164th Avenue SE bridges. The supplemental survey work was used to refine model calibration and to better reflect current conditions. Based on model results, the project team identified four areas of ineffective flow:

- Two areas near 148th bridge (approximately RM 4.5),
- Two bridges upstream from the 148th Avenue bridge
  - Cottom Stables (Jones) Bridge (approximately RM 4.6)
  - Private bridge upstream of Cottom Stables (near the Red Barn, approximately RM 4.9).

Model results identifying these four locations as discrete areas of ineffective flow confirmed the findings of prior reports and observations made in the field. These areas, therefore, were deemed high priorities for flood mitigation and habitat restoration.

Additional hydrologic and hydraulic modeling was completed in 2008 to reevaluate areas of ineffective flow. Throughout the May Creek corridor there are numerous stretches where water is not effectively flowing downstream. These areas create many problems for the stream and adjacent land owners. Slow moving water allows for deposition of sediment within the channel. This deposition tends to fill in the channel, promote shallow flooding, and tends to raise flood elevations. Stagnant water can also allow for more active vegetation growth within the channel, which can choke and block flow. These areas of ineffective flow also increase water temperature and promote nesting areas for mosquitoes and other unwanted insects.

The HEC-RAS model for the May Creek Valley was utilized in determining specific segments of ineffective flow. This analysis was conducted for a high frequency return event, and the 2-year flow was utilized to determine these areas. The Creek was analyzed and ranked for ineffective flow areas by combining three different ineffective flow indicators, from the HEC-RAS including: 1) model average channel velocity, 2) in-channel conveyance, and 3) the overall top width of the water. Each parameter was ranked from zero to five, where a zero is the best rank, and five is the worst. These three rankings were then averaged to determine an overall effective flow ranking. A low ranking meant that the section of the Creek was effectively conveying water downstream while a high ranking meant the section of Creek was not effectively conveying water downstream. Table 1 shows the overall ranking system and defines what each rank means in terms of ineffective flow areas.

Table 1. Overall Ranking and Rank Definitions

Rank	Rank Definition
0.0-1.0	No Ineffective Flow
1.1-2.0	Minor Ineffective Flow
2.1-3.0	Average Ineffective Flow
3.1-4.0	Moderate Ineffective Flow
4.1-5.0	Extreme Ineffective Flow

The first ineffective flow indicator used in the analysis is the average channel velocity. This was used to determine areas where slow moving water was present; this condition could lead to channel deposition and excessive vegetation growth. In-channel conveyance is the second parameter used. The in-channel conveyance shows how much of the water is flowing within the defined channel; during a 2-year event the majority of the water should be conveyed within the channel's banks. The third parameter is the overall top width of the water; this parameter indicates areas where broad shallow flooding exists due to overtopping of the banks and ineffective flow conditions exit. Table 2 below shows the three parameters and their ranking levels.

Table 2. Ineffective Flow Parameter Rankings

Rank	Velocity (ft/sec)	Channel Conveyance (%)	Top Width (ft)
5	0-1	0-20	>250
4	1-2	20-40	150-250
3	2-2.5	40-60	100-150
2	2.5-3.5	60-75	50-100
1	3.5-5	75-90	25-50
0	>5	>90	0-25

From this ranking system four segments were identified as having moderate to extremely ineffective flow areas under existing conditions.

The next step involved modeling the proposed conditions to verify the reduction of ineffective flow following mitigation. As mitigation efforts were modeled it became apparent that some ineffective flow areas were propagating upstream. Ultimately, some of the ineffective flow areas were lengthened to create a final condition where there were no adverse impacts upstream of these mitigation areas. The final four proposed mitigation segments are the following:

- Segment 1 from RM 4.281 to 4.892,
- Segment 2 from RM 5.050 to 5.300,
- Segment 3 from RM 5.477 to 6.533, and
- Segment 4 from RM 6.945 to 7.296.

MAY VALLEY SUBAREA REACH CHARACTERISTICS

The function of the stream channel, floodplain, and aquatic habitat in the May Valley Subarea is governed by the large-scale features described in the regional setting and May Valley Subarea sections. Any efforts to address flooding, fish habitat or other problems in the May Valley Subarea must take these fundamental influences into account. This section of the report builds upon the large-scale framework described above by describing reach and site-specific characteristics of the May Valley Subarea. These reach and site-specific features present small-scale challenges and opportunities which any proposed restoration efforts must address to be effective. The reach descriptions described below were developed from information documented in various reports and conditions observed in the study area during site visits. Reach boundaries and reach-specific features and conditions are illustrated in Figures 6-11 (Appendix A).

Previous reports divided the May Valley Subarea into four units. However, for the purposes of this project, the May Valley Subarea was delineated the into 6 geomorphic reaches to better illuminate site-specific opportunities and challenges regarding flood reduction and habitat improvement for each of the 6 reaches. The extent of each or the six reaches is below from downstream to upstream:

- Reach 1 - from the western May Valley Subarea boundary at River Mile (RM 3.9) upstream to the 148th Avenue SE bridge (RM 4.5),
- Reach 2 - from the 148th Avenue SE bridge (RM 4.5) upstream to the Colasurdo/Fisher property fence line (RM 5.35),
- Reach 3 - from the Colasurdo/Fisher fence line (RM 5.35) upstream to the 164th Avenue SE bridge (RM 5.93),
- Reach 4 - from the 164th Avenue SE bridge (RM 5.93) to the Hendrix Creek Confluence Area (RM 6.35),
- Reach 5 - from the Hendrix Creek Confluence Area (RM 6.35) upstream to the Highway 900/ Renton-Issaquah Highway (RM 7.02),
- Reach 6 - from the Highway 900 (RM 7.02) upstream to the east end of the May Valley Subarea boundary along the North and South Forks of May Creek.

Each of the reaches in the May Valley Subarea were delineated based on their unique geomorphic characteristics and reach-specific problems, as defined in the Action Plan (King County 2001), including: wetland, stream, and fish habitat condition and use, flooding, water quality, erosion, and sediment deposition.

Reach 1. Subarea boundary (RM 3.9) to 148th Avenue SE bridge (RM 4.5)

Mainstem Reach Description and Conditions

Reach 1 is approximately 0.6 miles long, beginning at the May Valley Subarea boundary located at RM 3.9 and ending at the 148th Avenue SE at RM 4.5 (Figure 6, Appendix A). This reach is transitional between the high-gradient canyon section of May Creek, downstream from Coal Creek Parkway, and the low-gradient main portion of May Valley upstream of 148th Avenue SE. The reach is a migratory corridor for anadromous salmonid species and provides some spawning and rearing habitat. Aquatic and riparian habitat in this reach has been impaired by erosion, channel incision, habitat simplification, and loss of large woody debris.

May Creek in Reach 1 includes an incised channel such as this adjacent the Duffus property near RM 4.0.

This section of May Creek has a mean annual flow of approximately 13.6 cfs (Conditions Report, King County 1995). In general, most flood events in Reach 1, including the 100-year flow event, are contained within the stream channel (Conditions Report, King County 1995).

Channel conditions include the following:

- From RM 3.9 upstream to a point just above the 143rd Avenue SE bridge, the May Creek channel is confined. The channel has a moderate gradient with instream and riparian habitat that has been degraded by erosion and headcutting.
- From 143rd Avenue SE bridge (RM 4.1) and 146th Avenue SE bridge (RM 4.3) the streambed gradient decreases and the stream has greater access to the floodplain. There are no known significant flooding or erosion problems in this part of the reach, but aquatic habitat has been assessed as degraded in the Conditions Report (King County 1995) and Action Plan (King County 2001).
- From the 146th Avenue SE bridge upstream to the 148th Avenue SE bridge crossing, May Creek transitions into a low-gradient stream with an undersized channel and wide floodplain. The undersized channel frequently floods into a wetland described in the Action Plan (King County 2001) as degraded.
- An ineffective flow segment exists from RM 4.3 to RM 4.9.

The Conditions Report (King County 1995) indicated that HEC-2 model results showed the bridges across May Creek at the Coal Creek Parkway, the 143rd Avenue SE, and the 146th Avenue SE roads as having sufficient elevation (capacity) to accommodate 100-year floodwaters of both current (King County 1995) and future conditions. HEC-RAS modeling conducted by OTAK in 2006 and 2007 confirms those findings.

Tributaries and Conditions

Two tributaries flow into May Creek within Reach 1. An unnamed tributary (# 0287D) flows into May Creek from the north (right) bank at RM 4.4, approximately 700 feet downstream from the 148th Avenue SE bridge crossing. This tributary is approximately 0.4 miles long and contains fish passage barriers located at RM 0.08 (culvert) and 0.11 (pond spillway) respectively. The tributary tends to incise and scour vertically through sandy gravel alluvium overlying compact till or bedrock. The May Creek channel was observed to be unobstructed by silt or vegetation at the point of confluence with tributary # 287D, and appears capable of accommodating tributary inflow. There was some erosion in tributary # 287D, as the confluence area was largely devoid of vegetation due to clearing and use as animal pasture.

An unnamed tributary (# 287D) flows into May Creek from the right (north) bank near RM 4.4.

The second tributary, Greene's Creek (tributary # 288), enters May Creek from the south (left bank) near RM 4.5, just downstream from the 148th Avenue SE bridge crossing May Creek. This tributary has a mean annual flow of approximately 1.5 cfs and is expected to receive ever increasing flows due to development (Conditions Report 1995). It is currently eroding through compact silty glacial outwash near the confluence. The channel functions primarily as a stormwater drainage ditch, conveying water from recently built residential developments to the mainstem Creek. High stormwater flows are detained in a stormwater pond of approximately 1 acre in area, located near the confluence with May Creek. Reed canarygrass (Phalaris arundinacea), willow (Salix spp.), and other riparian vegetation grow densely near the confluence of Greene's Creek and May Creek, obscuring the confluence area. If planted and allowed to mature, riparian vegetation coupled with the placement of large woody debris may stabilize the channel, but increased flows are anticipated to continue to carry sediment (sand/silt) to May Creek.

Fish Distribution and Habitat Use

This reach has the highest anadromous salmonid species use of all the May Creek reaches in the Valley. The upstream limit of distribution for such species as sockeye (Oncorhynchus nerka), steelhead (O. mykiss) and Chinook salmon (O. tshawytscha) is either within or below this reach (RM 4.5). The reach is primarily a migratory corridor for coho salmon and cutthroat trout. These species are able to move upstream to spawn and rear in reaches of May Creek and tributaries, as described later in this document.

The aquatic, riparian and wetland habitat in Reach 1 has been degraded as a result of landuse management include historic logging and mining activities, and more recent animal pasture activities.

Reach 2. 148th Avenue SE (RM 4.5) to Colasurdo/Fisher boundary line (RM 5.35)

Reach Description and Conditions

Reach 2 is approximately 0.85 miles in length, extending from the 148th Avenue SE bridge crossing to a point near the Colasurdo (Celigoy-Norton) and Fischer property boundary line (Figure 7, Appendix A).

Reach 2 of May Creek, at a flow of 12 cfs, looking downstream during the February 2007 site visit. Note flooding of pasture on right and left banks.

Reach 2 has mean annual flow of approximately 8.6 cfs (Conditions Report, King County 1995), with a gradient of less than 1 percent throughout its length. This reach is characterized by a single, undersized channel that has been artificially straightened and dredged. The adjacent floodplain is a degraded wetland used presently and historically as pasture and for other agricultural purposes (Conditions Report, King County 1995).

The Conditions Report (King County 1995) and the Action Plan (King County 2001) characterize Reach 2 as being subject to numerous problems, including frequent flooding, sedimentation, degraded water quality, degraded wetland habitat, and degrading riparian and aquatic habitat. In many areas the channel has been further constricted by sedimentation and the invasion of reed canarygrass. Overtopping of the banks occurs at relatively low flows (e.g. 12 cfs during February site visit), and floodwaters can remain on the floodplain for months at a time. Most sediment entering this reach is either deposited on the floodplain immediately adjacent the channel or in the channel due to ineffective (low) flow conditions. An ineffective flow segment exists from RM 5.05 to RM 5.3.

Tributaries and Conditions

A number of small tributaries flow into May Creek in Reach 2. Two tributaries are described in the Conditions Report (King County 1995). Long Marsh Creek (Tributary #289) and Indian Meadow Creek (Tributary #291) both flow into May Creek from the north (right) bank and convey storm water runoff from the Highlands Subarea. As compared to other tributaries in the adjacent subareas, these tributaries drain a disproportionately high volume of water to May Valley. Higher rainfall and steeper terrain contribute to the high flows and sediment loads, in spite of the relatively dense forest canopy cover. These tributaries produce high levels of sediment, exacerbate flooding, and degrade channel functions and habitat in Reach 2 (King County 1995).

The confluence of May Creek and Indian Meadow Creek (Tributary #291) is clogged with silt and reed canarygrass.

The Conditions Report (King County 1995) described Long Marsh Creek as having a mean annual flow of approximately 1.8 cfs, entering May Creek near RM 4.6. The gradient of Long Marsh Creek is moderate (less than 5 percent) within the lowermost 0.2 mile. The streambed gradient increases to approximately 10 percent up to RM 0.25, and then decreases upstream of RM 0.25. The lower 0.2 miles of Long Marsh Creek flows across an alluvial fan that rests on glacial till. This section of channel has incised through the alluvium, has

been dredged and straightened, and has little riparian vegetation. These changes in gradient and geology have intensified erosion in Long Marsh Creek and sediment deposition near the confluence with May Creek. Culverts, a waterfall, a dam and other barriers are located in the Creek at or below RM 0.3.

The Conditions Report (King County 1995) describes Indian Meadow Creek as having a mean annual flow less than 5 cfs. The point of confluence is located on May Creek at approximately RM 4.85. The gradient of Indian Meadow Creek is low (less than 1 percent) within the lowermost 50 feet where it has been diverted to a subsurface culvert. The lowermost 50 feet of Indian Meadow Creek and the confluence area with the mainstem have been degraded by sedimentation and a proliferation of reed canarygrass. No discernable channel connecting Indian Meadow Creek to May Creek was observed during a recent site visit. The downstream end of the Indian Meadow Creek culvert is almost completely clogged by sediment and reed canarygrass, causing water to emerge from the culvert as sheet flow into May Creek.

Fish Distribution and Habitat Use

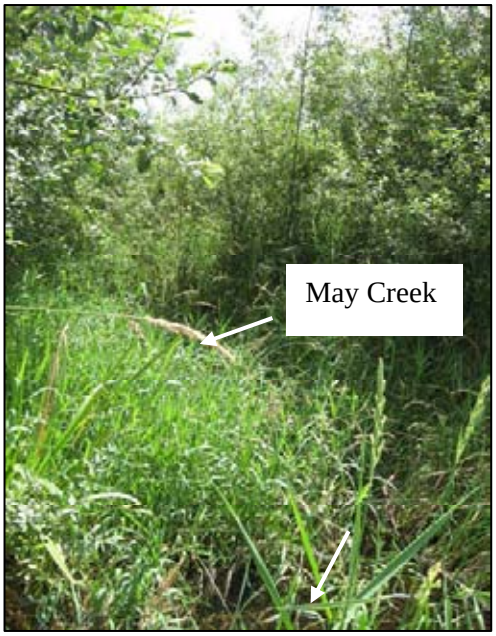
Reach 2 has limited aquatic habitat and fish use. Aquatic habitat has been degraded by dredging and by the use of the riparian corridor for grazing and other human uses. Coho salmon and cutthroat trout have historically used Reach 2 for rearing purposes and were captured by sportfishers. More recently, this reach serves as a migratory corridor to upstream Locally Significant Resource Areas in the 291-A and Country-Cabbage Creek drainages. The Conditions Report (King County 1995) identified Coho salmon stocking as occurring between 148th Avenue SE bridges and 164th Avenue SE bridges, but did not specify a location.

Reach 3 Colasurdo-Fisher Fence Line (RM 5.35) to 164th Avenue SE (RM 5.93)

Reach Description and Conditions

Reach 3 extends approximately 0.58 miles upstream from the Colasurdo (Celigoy-Norton)-Fischer fence line, to the 164th Avenue SE bridge (Figure 8, Appendix A). This reach is characterized by a very low gradient, a wide floodplain, and an abundance of hydrophilic vegetation (e.g. reed canarygrass,). The creek flows through a degraded wetland with several fish passage impediments caused by channel constrictions and sedimentation. Reach 3 has an ill-defined or non-existent channel throughout most of its length. Where a defined channel does exist, the adjacent streambank is typically saturated, posing a risk of further erosion and sedimentation of the main channel.

The history of dredging in May Creek is evidenced throughout this reach by the unnaturally straight channel alignment. The creek is undersized throughout this reach. Excessive sediment and riparian vegetation exacerbates the degraded channel condition and frequency of flooding. This area of the May Valley is rural in character, with a mix of residences, open space and pasture land for stock. An ineffective flow segment exists from RM 5.48 to RM 6.53.



Reach 3 of May Creek contains sections completely clogged with reed canarygrass and silt.

The Conditions Report (King County 1995) and Action Plan (King County 2001) assesses frequent flooding, habitat degradation, and water quality problems as prevalent within Reach 3.

Tributary 291A was found to be intermittent during the July 2007 site visit.

Tributaries and Conditions

One notable tributary is present in Reach 3, tributary #291A, which flows into May Creek from the left (south) bank. The Action Plan (King County 2001) identifies this tributary as a "Locally Significant Resource Area" (LSRA), given its use by cutthroat trout (O. clarki) and coho salmon (O. kisutch). This Tributary has a mean annual flow of approximately 1.6 cfs. In the vicinity of the tributary/mainstem confluence, both channels are currently subject to extensive deposition and dense growth of hydrophilic vegetation. At the time of our site visit, the lowermost 300 feet tributary channel was very poorly defined, and the main stem channel appeared to be significantly aggraded.

The Conditions Report (King County 1995) describes the confluence area as being located at RM 5.5 on May Creek. During the July 2007 site visit the channel was found to be dry within the lower reaches.

The headwaters of Tributary 291A include two wetlands (Wetland 2 and 3, King County 1995). The two wetlands have been described as degraded by residential development. Wetland functions are expected to further degrade as development in this area expands. Historically, these wetlands moderated flooding, improved water quality, and provided aquatic, wetland, and riparian habitat in Tributary 291A and May Creek. The Conditions Report (King County 1995) describes this tributary as highly unstable, with further degradation likely to occur as landscape modifications continue in the uplands areas. Tributary 291A is expected to continue to erode, providing a continuous source of sediment to May Creek. This ongoing process is further destabilizing the channel, increasing the risk of flooding, and degrading habitat in the confluence area. The Conditions Report (King County 1995) states that "[w]ithout mitigation for the past increases in flows and sediment transport and without any significant stream bank vegetation and LWD, the channel will continue to incise and erode, delivering increased sand downstream. Increased flow and sediment transport will increase sand delivery into May Creek."

Fish Distribution and Habitat Use

Anadromous salmonids use Reach 3 primarily as a migratory corridor to access Tributary 291A and the Country-Cabbage Creek drainage (tributaries in Reach 5). Based on field observations, anadromous fish migration has been severely impaired by the loss of a defined channel within Reach 3. Coho salmon have previously been stocked between the 148th Avenue SE (lower Reach 2) and 164th Avenue SE (upper Reach 3) bridges. According to the Conditions Report (King County 1995) returns have been very limited.

Tributary 291A is identified in the Action Plan (2001) as a Locally Significant Resource Area (LSRA). This tributary has been used by both cutthroat trout (O. clarki) and Coho salmon (O. kisutch), with observation of cutthroat and coho spawning in the tributary up to RM 0.3. The Conditions Report (King County 1995) states that in 1994 cutthroat trout were found rearing in Tributary 291A up to RM 0.5 (location of perched culvert).

Aquatic habitat use has been impaired by aggradation of channel near the confluence area and by erosion in Tributary 291A between RM 0.1 and 0.3 (Conditions Report, King County 1995). Upstream portions of Tributary 291A have been ditched and placed in culverts, further reducing aquatic habitat value, and intensifying erosive forces and runoff rates below the culverts.

Reach 4. 164th Avenue SE (RM 5.93) to Hendrix Creek Confluence Area (RM 6.35)

Reach Description and Conditions

Reach 4 extends approximately 0.42 river miles from the 164th Avenue SE Bridge (RM 5.93) upstream to approximately RM 6.35 near the confluence of May Creek and Hendrix Creek (Figure 9, Appendix A). Like Reaches 2 and 3, this reach includes a low-gradient channel, wide floodplain, and an abundance of hydrophilic vegetation (e.g. reed canarygrass, P. arundinaceae) throughout the flat valley topography. The history of dredging in May Creek is apparent, as evidenced by the straight channel alignment. Most of this reach has a single, well defined, and undersized channel extending through a degraded wetland and broad valley floodplain. Excessive sediment and riparian vegetation extending into the channel exacerbates the degraded channel condition. This area of the May Valley is primarily rural, mixed with limited commercial and residential development, open space and pasture land for live stock.

Reach 4 of May Creek contains sections of ineffective flow such as this section above the 164th Avenue SE Bridge.

This reach is subject to flooding, sedimentation and water quality problems, as well as degraded wetland, riparian and aquatic habitat.

Approximately 5.6 square miles of the May Creek basin, or 40 percent of the total basin, drains into Reach 4 (King County 1995). The Conditions Report (King County 1995) identifies the 164th Avenue SE Bridge crossing as having insufficient capacity to pass flood flows and indicates that the 25-year flow would overtop the bridge and cause roadway flooding. As development continues in the headwaters of the May Creek basin, flooding, erosion, sedimentation, and habitat degradation is expected to worsen in Reach 4. An ineffective flow segment exists from RM 5.48 to RM 6.53.

Tributaries and Conditions

There are two tributaries to May Creek in this reach, identified on maps and the GIS database as unnamed tributary (0291-B) and Hendrix Creek (Tributary 0291-C). Tributary 0291-B is a small stream with a mean annual flow of less than 5 cfs (King County 1995). It enters the valley from the south (left bank), with its confluence is located immediately upstream from the 164th Avenue SE bridge crossing (RM 5.93). No well defined confluence of tributary # 291-B and May Creek and no well defined channel within the lowermost 100 feet was observed during recent site visits. Tributary # 291-B serves primarily as a stormwater drainage ditch, conveying water from the East Renton plateau south of the May Valley. In the upper portion of the creek, the tributary has been channelized to form drainage ditches and placed in culverts along much of its length, including that portion near the semi-commercial intersection of 164th Avenue SE and SR 900.

Tributary 291B upstream from the May Creek confluence has been converted to a storm drain for 164th Avenue SE.

Hendrix Creek (Tributary # 291-C) enters May Creek from the south (left bank). Again, there is no well defined confluence area between Tributary 291B and May Creek, and no well defined Tributary channel within the lowermost 100 feet of the May Valley floodplain. Tributary 291B serves as a stormwater drain, moving water from the East Renton plateau south of the May Valley. The tributary has a mean annual flow less than 5 cfs (Conditions Report, King County 1995). The Conditions Report (King County 1995) and Action Plan (King County 2001) describes the upstream portions of the creek as channelized and placed in culverts, including that portion intersecting SR 900.

Fish Distribution and Habitat Use

Anadromous salmonids use Reach 4 primarily as a migratory corridor to access upper May Creek and certain tributaries like the Country-Cabbage Creek drainage upstream in Reach 5. Salmonid migration has been severely impaired by channelization, loss of wetland function, and loss of riparian and aquatic habitat. Tributaries 291B and Hendrix Creek are small, disconnected streams with no known anadromous fish use.

Reach 5. Hendrix Creek Confluence Area (RM 6.35) to SR-900 Bridge (RM 7.02)

Reach Description and Conditions

Reach 5 includes approximately 0.67 river miles of May Creek extending from the Hendrix Creek confluence area (RM 6.35) upstream to the SR-900 bridge crossing (RM 7.02), see Figure 10 (Appendix A). Reach 5 includes the upper-most portion of the broad, low-relief, portion of the May Valley floodplain. This reach of May Creek, like Reaches 2, 3, and 4, flows in an artificially straightened channel through a degraded wetland.

Reach 5 of May Creek contains some of the last remaining viable salmonid spawning habitat along the mainstem in May Valley.

This section of the May Valley is used as pasture, hobby-farming, and residential purposes. Unlike other reaches within May Valley, Reach 5 contains relatively diverse stream habitat, along with varied substrate composition and some healthy riparian areas. The reach is characterized by a wide, low gradient (less than 1 percent) channel with a slightly more sinuous channel morphology than the other four downstream reaches. It has a relatively high level of floodplain connectivity. Based on channel form, bend configuration, distribution of sediment deposits, and the character of erosion, the channel appears to be subject to active channel migration.

The upper-most portion of this reach is free-flowing, and bisects a forested wetland that is in an early succession stage. This forested wetland is thought to exhibit the type of wetland, riparian and aquatic habitat present in the May Valley prior to anthropogenic disturbance. This wetland, however, has not fully matured to include coniferous species like western red cedar, Sitka Spruce, and western hemlock likely present prior to logging in the valley, as described in the Conditions Report (King County 1995). An ineffective flow segment exists from RM 6.95 to RM 7.3.

The channel through this reach is expected to continue to migrate and braid. Future migration rates will depend on rates of incoming sediment influx, as well as changes in peak flows, the extent of local bank

hardening, and influence of backwater conditions associated with the bridge. It is also possible that channel position and/or alignment could change abruptly in the course of a single large flow event or a series of smaller events. Any such change may have a profound effect on the alignment and character of one or more downstream reaches.

Tributaries and Conditions

One tributary is present within Reach 5. This tributary, however, conveys flow from two individual creeks, Country Creek (Tributary 292) and Cabbage Creek (Tributary 293). The Country Creek and Cabbage Creek drainages flow in a southerly direction, draining the Highland area north of the May Valley. Like other tributaries draining the Highland Subarea, the creeks produce relatively high flows per unit area. Both creeks have been placed in culverts under the SE May Valley Road on the north side of the valley. Upon reaching the valley floor, the creeks have been re-directed to flow in a westerly direction, joining together to form lower Country Creek. Erosion and flooding are common problems where the channels have been re-aligned, and placed in improperly designed, poorly installed or poorly maintained culverts.

The Country-Cabbage Creek drainage is a Locally Significant Resource Area (LSRA) due to the valuable salmonid habitat.

Country Creek has a mean annual flow of approximately 1.3 cfs. Lower Country Creek flows approximately 0.2 miles across the May Valley floodplain to a point of confluence with May Creek at RM 6.5. Country Creek is identified in the Conditions Report (1995) as stable, with little risk of significant change in flooding or sedimentation.

Cabbage Creek has a mean annual flow of approximately 1.9 cfs. The Cabbage Creek drainage, however, as identified in the Conditions Report (1995) as unstable and subject to increased flooding, erosion, and sediment delivery to lower Country Creek and May Creek as development continues in the Highlands area. Cabbage Creek contributes the highest runoff of all the tributaries to the May Creek Basin.

Fish Distribution and Habitat Use

Lower Country Creek between RM 0 and RM 0.11 was identified in the Conditions Report (King County 1995) and the Action Plan (King County 2001) as a Locally Significant Resource Area (LSRA) because this section of tributary stream is used by Coho salmon (O. kisutch) and cutthroat trout (O. clarki) for spawning and rearing purposes. This tributary has degraded habitat due to channel straightening, loss of instream habitat complexity, loss of large woody debris, and loss of riparian cover and functions. The Conditions Report (King County 1995) describes upstream passage into Country and Cabbage Creeks as blocked above RM 0.11 by a concrete block. The remaining habitat, however, provides some of the last remaining, productive habitat in the May Valley.

Reach 6. SR-900 Bridge Crossing (RM 7.02) to Upper May Valley Subarea Boundary

Reach Description and Conditions

Reach 6 is the upstream-most reach within the May Valley Subarea, and provides a transition between the low-gradient May Valley and moderate-gradient headwater tributary streams. The North, East, and South Forks of May Creek (headwater tributaries) compose the majority of Reach 6 including approximately 0.75 miles of the North Fork (Tributary 294A), 0.6 miles of the East Fork (Tributary 297), and 0.56 miles of the South Fork (Tributary 282) of May Creek. These three tributaries join together in this transition reach to form the mainstem May Creek, less than 0.1 mile from the SR-900 bridge crossing (Figure 11, Appendix A).

Reach 6 of May Creek extends upstream from this culvert under SR-900, including portions of the North, East, and South Forks of May Creek.

The mainstem May Creek in Reach 6 has primarily been affected by construction of SR-900. This portion of May Creek has been directed through an arched culvert (see photograph), under the highway. Fill was placed on either side of May Creek to form the road prism. Embankments and arch culvert wingwalls further confine the channel, conveying water from Reach 6 into upper Reach 5. The mainstem May Creek, however, comprises less than 0.1 mile of Reach 6. An ineffective flow segment exists from RM 6.95 to RM 7.3.

Tributaries and Conditions

The North Fork May Creek between RM 0 and 0.7 has been moved and straightened from its original position (Condition Report, King County 1995). Historically, this channel was thought to be a moderate to low-gradient channel meandering through a cedar, cottonwood, and alder forest.

The East Fork May Creek flows into the South Fork May Creek within a forested wetland. The tributary has a low gradient up to RM 0.45, with a steeper gradient between RM 0.45 and 0.6 where it crosses an alluvial fan. On the alluvial fan, the channel flows through a culvert under the SE May Valley Rd, which forms the eastern boundary of this portion of the Subarea.

The South Fork May Creek flows approximately 0.56 miles in a northwesterly direction. The channel has a low-gradient through the lower portion of this reach up to RM 0.3 (May Creek RM 7.3), flowing adjacent to a sand and gravel mining operation. Upstream from RM 0.3 the gradient increases to approximately 10 to 15 percent with a substrate of sand and gravel. Between RM 0.3 and 0.6 the South Fork of May Creek travels through an area that has recently experienced residential development.

As development increases in the headwaters of May Creek, flooding and erosion are expected to worsen in the North, East, and South Fork of May Creek. Severe future erosion problems have been predicted for the North, East, and South Forks of May Creek (Conditions Report, King County 1995). Increased flood flows and sedimentation conveyed from the headwaters are anticipated to further degrade the mainstem May Creek in the May Valley, causing further flooding, sedimentation, and habitat degradation.

Fish Distribution and Habitat Use

The North, East and South Forks of May Creek have been severely impacted by SR-900, culverts, berms and quarries. However, Coho salmon (O. kisutch) and possibly cutthroat trout have been observed in the North and East forks of May Creek. WDFW has planted coho in the upper North Fork between RM 1.0 and 1.45. No fish use has been reported in the South Fork.

RESTORATION CONCEPTS

The project design team offers the following summary of approaches that have been used to address flooding, ineffective flow, sedimentation and habitat degradation in other rivers, creeks and streams. In this section, restoration concepts are described generally. Subsequent sections of this report look at feasibility of restoration concepts given the existing and desired future condition in the May Creek drainage basin, and suggest a prioritized approach to conceptual project implementation.

Restoration actions represent modifications to the stream channel, banks, floodplain, and/or drainage basin intended to restore self-sustaining channel form and function to an otherwise degraded channel. Potential restoration actions include direct, indirect, and off-channel modifications. Restoration actions described in this CRP focus on actions to reduce flooding, protect and restore aquatic habitat for anadromous species, while also addressing issues identified in Recommendation #5 in the Action Plan (King County 2001). Actions are generally categorized as either direct channel modifications, indirect channel modifications, or off-channel modifications.

DIRECT CHANNEL MODIFICATION

Direct channel modification involves reconstruction of the channel by altering the channel cross-sectional area, planform, and/or profile. Directly modifying channel shape and geometry can alter the channel's water conveyance to serve restoration needs.

- **Cross-Section Modification:** The cross-sectional area of a channel is defined by its overall depth and width. Typically, reducing the cross-sectional area of a channel will decrease channel capacity while increasing water velocity. The opposite is true for increasing the cross-sectional area of a channel. Cross-section modification can be used to increase or decrease sediment transport capacity, alter flood stage elevation, bank erosion, and habitat.
- **Planform Modification**: Channel planform is defined as the shape and sinuosity of a channel as seen from above. Modifying channel planform will serve to lengthen or shorten the channel, thereby altering channel gradient, water velocity, and sediment transport capacity. Channel planform can also be modified by altering the connectivity of the primary channel with the floodplain and associated abandoned channels (i.e.: levee modification and/or removal). Reconnection with the floodplain can reduce water velocity, flooding downstream, and alter sedimentation.
- **Profile Modification:** Channel profile is defined as the variation in elevation of a channel over its length (i.e.: gradient). The profile of a stream channel may be altered as a means of controlling energy dissipation patterns within the channel. Altering energy dissipation along a channel serves to vary water velocity and therefore stream power and sediment transport capacity, promoting channel complexity. Measures taken to change a channel's profile may include lengthening of the channel by increasing sinuosity, installing drop structures, or increasing bed roughness with large woody debris or boulders.

INDIRECT CHANNEL MODIFICATION

Indirect channel modification incorporates incremental changes in channel-forming processes, wherein the introduction of a feature or structure induces channel change over time. Features or structures may include: In-stream structures, Bank Structures, In-stream nutrients and substrate management. Promoting certain channel-forming processes in strategic locations can be used to modify water conveyance through the channel to serve restoration needs.

In-stream Structures

The placement of in-stream structures is primarily used to redirect flow, control channel grade, and/or increase channel complexity and fish habitat. Following are several examples of in-stream structures and their uses:

- **Boulder clusters:** The placement of large, immobile boulders in a homogeneous stream section is used to increase channel complexity by increasing the hydraulic diversity and structural composition of the channel. Immobile boulders create water velocity gradients (fast-moving water adjacent to slow-moving water) desirable to many fish species. Boulder clusters represent channel roughness elements and may promote localized scour and may induce a backwater effect upstream.
- **Drop Structures:** Drop structures are low-elevation structures spanning the width of the channel creating an abrupt drop in channel bed and water surface elevation redistributing and dissipating energy. Grade controls, sills, and weirs are examples of drop structures primarily used to regulate channel grade and to increase channel complexity. Drop structures are used to stabilize the channel bed, limit incision, promote the collection, sorting, and deposition of sediment, and improve fish habitat.
    - **Beaver Management:** Beaver dams are excellent sediment traps that can greatly reduce downstream sediment loads. In certain systems, beaver dam drop structures can be utilized in a restoration plan. Beaver dams typically impound water, reduce water velocity and bank erosion, improve fish habitat, and elevate the water table upstream of the dam.
    - **Fish Passage:** In-stream structures including culverts, woody debris, weirs, and other drop structures may be barriers to fish passage if not properly configured to the associated channel and flow regime. The "fish passage" action includes that action that removes or modifies structures to allow fish passage to upstream reaches. Removing or modifying in-stream structures may also impact stream character, potentially increasing channel conveyance, sediment transport capacity, and water velocity. The timing, frequency and duration required for unimpeded access varies by fish species, therefore target fish species should be identified before fish passage barriers are modified.
- **Large Woody Debris (LWD) and Log Jams:** Large wood can provide both structure and habitat to a stream. Woody debris and log jams can alter the channel pattern and planform and promote scour. Woody debris is also a roughness element in streams increasing friction, reducing water velocities, retaining and sorting sediment, and recruiting organic debris and nutrients. For these reasons, woody debris is often used to stabilize banks and provide fish habitat.
- **Porous Weirs (U-shaped, V-shaped, and J-hook):** A porous weir is primarily used to redirect flow and increase channel complexity. Most porous weirs are constructed of boulders and may incorporate pieces of LWD. Water is redirected as it passes partially through and over a porous weir, unlike traditional weirs where water flows entirely over the top. The shape of the porous weir dictates its use in a stream, because water flows over and through a porous weir perpendicular to the weir's face. As such, U-shaped and V-shaped weirs generally point upstream and span the width of a stream directing flow to a pocket in the middle of the structure where scour typically occurs. J-hooked weirs are similar in shape and function to U-shaped and V-shaped weirs, but generally do not span the width of the channel. J-hooked weirs are angled upstream with a "hook" focusing flow through a pocket. Scour occurs in the pocket of the hook and in some cases along the downstream length of the structure. J-hooked weirs are most commonly used to direct flow away from the bank and toward the center of the channel while U-shaped and V-shaped weirs are most commonly used to create channel complexity.

Bank Structures

Bank structures used for restoration purposes generally encourage natural processes. LWD and rock are the most common materials used for bank structures in conjunction with riparian vegetation. Often the purpose of a bank structure is to stabilize bank soils in order to facilitate the establishment of riparian vegetation. Both LWD and rock can affectively dissipate stream power without dislodging from the bank, providing protection for bank soils and deflecting flow back toward the middle of the channel.

In-Stream Nutrient and Substrate Management

- **Nutrient Management:** Distributing fish carcasses, analogs (processed fish cakes) and fish fertilizer augments in-stream nutrient levels and improves fish habitat. Nutrients help fish health by increasing biologic activity, productivity in riparian zones and associated uplands, and food for juvenile fish and macro invertebrates.
- **Substrate Management:** Adding and/or removing substrate materials to a stream encourages the natural redistribution and sorting of sediment enhancing fish and aquatic insect habitat. Spawning habitat is dictated, in part, by the size, permeability, and compaction of the substrate. Removing fines and/or adding gravel to a stream may therefore improve spawning habitat. Substrate management treats a symptom of a larger problem, and should therefore be used in conjunction with other restoration techniques in an effort to solve the larger problem.

OFF-CHANNEL MODIFICATIONS

Off-channel modifications include improvements to the floodplain and drainage basin that can benefit the restoration effort of the stream. Following is a list of several off-channel modification measures beneficial to stream restoration:

- **Riparian Area Protection and Restoration:** The riparian area includes the active floodplain and adjacent plant communities. A well-established riparian area can provide shade, woody debris, organic material, and nutrients to the stream. Riparian soils and vegetation will retain water during storms. The vegetation will stabilize stream banks and provide near-bank fish cover and habitat as well as adding a roughness component to the floodplain and banks. Restoration of the riparian area may require years to decades to be realized and requires short and long term land use compliance.
- **Off-Channel Habitat Restoration:** Off-channel riparian habitat depends on the connection with water and nutrients from the main channel distributed via surface flow or hyporheic (subsurface) flow. Allowing flood flows onto the floodplain and allowing hyporheic interaction in the riparian zone will benefit the off-channel and riparian habitat.
- **Modify the Amount of Erosion in the Drainage Basin:** Often the root cause of a degraded stream is the lack or abundance of sediment available to the stream. Reducing large-scale inputs of sediment, meanwhile maintaining small-scale gravel recruitment areas, will promote a healthy substrate for spawning and reduce channel aggradation. Land use and land cover may need to be altered in order to achieve the desired volume of sediment available to the stream.
- **Land Acquisition:** Land use is most often dictated by the owner of the land in question. Modifying land use to reflect the goals of the restoration effort is paramount to successful stream restoration. If favorable land use and/or restoration efforts cannot be realized with the current land owner, a land acquisition may be an option, provided that the necessary funds are available.

- **Reduce Sediment Load:** Aside from reducing erosion, sediment loads can be further managed by capturing sediment before and/or after it enters the stream. Dense vegetation can effectively capture sediment from surface sheet flow. Sediment detention basins are used to capture excessive sediment from stream flow. A sediment detention basin is an area where sediment-laden water is directed to a low-energy environment for a time period sufficient to allow fine sediment to deposit. Mechanical removal of sediment from the basin is often required.
- **Reduce Surface Runoff:** Reducing surface runoff in a drainage basin will directly reduce flooding in the valley and may reduce in-stream erosion. Surface runoff can be reduced by reducing the area of hard (impermeable) surfaces in the basin, increasing vegetative cover, and increasing residence time on the slope.
- **Water Storage and Stormwater Retention:** Increasing the amount of time required for surface runoff to reach the stream will reduce the peak flood discharge of the stream and may reduce erosion. Water storage and stormwater retention via ponds and/or infiltration act to meter flow into the stream, thereby reducing peak storm discharge by lengthening its duration.

FEASIBILITY OF RESTORATION ACTIONS

The feasibility or applicability of the various restoration actions described above was evaluated based on the regional, basin, reach, and site-specific characteristics of the May Creek basin. The feasibility of using potential restoration actions to address issues identified in the Action Plan, Recommendation 5 were also evaluated based on the scope of that Recommendation. Furthermore, the feasibility of using restoration actions to address May Valley issues were evaluated in terms of landowner interest, permitting, regulatory compliance and funding opportunities identified while scoping this report. The following summarizes the feasibility of the various potential restoration actions.

DIRECT CHANNEL MODIFICATION

- **Cross-Section Modification** was determined to be an unlikely or infeasible action in low-gradient sections in the May Valley (Reaches 2, 3, 4). The channel in the May Valley is already undersized in many areas. Invasion of non-native plant species like reed canarygrass has resulted where reduced channel capacity and reduced velocity exist. This may be a feasible approach in higher gradient reaches (Reaches 1, 5, 6) and/or tributaries (Long Marsh Creek, 291A, Country-Cabbage or other tributaries).
- **Planform Modification** was determined to be an unlikely or infeasible action in the low-gradient sections of May Valley. Increased sinuosity may result in reduced stream power. Reduced stream power would likely result in increased sediment deposition and further clogging of undersized channels in these low-gradient reaches. Planform modifications may be feasible treatments in higher gradient areas like Reaches 1, 5, 6 or tributaries like Long Marsh Creek, 291A, Country-Cabbage or other tributaries.
- **Profile Modification** was determined to be an unlikely or infeasible action given the very low-gradient of most of the Reaches in May Valley. Grade control structures or roughened channel profile modifications may be feasible treatments in higher gradient areas like Reach 1 or in tributaries like Long Marsh Creek, 291A, Country-Cabbage or other tributaries.

INDIRECT CHANNEL MODIFICATION

In-stream Structures

Generally instream structures were not deemed feasible restoration actions in the May Valley Subarea. Instream structures would tend to reduce velocities and capture and trap sediments in the low-gradient areas of the May Valley. These structures would tend to increase siltation, flooding, and may accelerate erosion and channel migration.

- **Boulder clusters** may be feasible actions in higher gradient areas like Reaches 1, 5, 6 or tributaries like Long Marsh Creek, 291A, Country-Cabbage or other tributaries. Concerns about head cutting, erosion, and loss of natural grade control structures in Reach 1 may feasibly be treated with boulder clusters.
- **Drop Structures** generally are construed as infeasible restoration actions in the May Valley Subarea. However, a specialized beaver management drop structure may represent an effective restoration treatment in the valley.
    - **Beaver Management** may result in improved fish habitat while addressing flooding issues in the May Valley. It may be feasible to apply new methods like "Beaver Deceivers" that make use of naturally constructed drop structures (beaver dams) to increase habitat complexity while managing floodwaters and water elevations. Beaver Deceivers provide floodplain and fish habitat managers the ability to manipulate floodwaters and elevations while maintaining the natural habitat features of beaver dams.
- **Fish Passage** structures were generally deemed to be feasible restoration actions in the May Valley Subarea. Correction of impassible or partial passage barriers like constricted channels and improperly functioning bridges and culverts were deemed reasonable actions that could address both fish habitat and flood-related issues (such as backwatering effects) in the May Valley .
- **Large Woody Debris (LWD) and Log Jams** generally were not deemed feasible restoration actions in the May Valley Subarea. These instream structures typically reduce flow velocities and capture and trap sediments in the low-gradient areas of the May Valley. These structures would tend to cause increased siltation, and thus, flooding, and may accelerate erosion and channel migration. LWD and log jams may be feasible in higher gradient areas like Reaches 1, 5, 6 or tributaries like Long Marsh Creek, 291A, Country-Cabbage or other tributaries.
- **Porous Weirs (U-shaped, V-shaped, and J-hook)** generally were not deemed feasible restoration actions in the May Valley subarea. These instream structures would also tend to reduce flow velocities and capture sediments in the low-gradient areas of the May Valley. Such structures would likely cause increased sedimentation, flooding due to aggradation, and may accelerate erosion and channel migration. LWD and log jams may be feasible in higher gradient areas like Reaches 1, 5, 6 or tributaries like Long Marsh Creek, 291A, Country-Cabbage or other tributaries.

Bank Structures

In general, bank structures were determined to be generally infeasible for the low-gradient sections of May Creek in the valley, for the same reasons that instream LWD, drop structures, and porous weirs were deemed infeasible. Bank structures would, however, be feasible and may prove very valuable in addressing erosion, head-cutting and similar issues identified in higher gradient sections of May Creek (e.g. Reach 1) and in tributaries like Long Marsh Creek and the Country-Cabbage Creek drainage.

In-Stream Nutrient and Substrate Management

In-stream nutrient and substrate management were deemed infeasible or inappropriate as potential restoration actions for the May Valley, given that they fail to address issues identified in Recommendation 5 of the Action Plan.

- **Nutrient Management** was determined to be outside the scope of this project. Further, the May Valley tends to have an abundance of nutrients indicating that nutrient management would be unnecessary and potentially harmful to aquatic resources.
- **Substrate Management** was determined to be an unlikely or infeasible restoration action. This restoration method would, at best, do little to address flooding. At worst, substrate management could worsen flooding problems in the low-gradient section of the May Valley. Substrate management, like boulder clusters and roughened channels may be appropriate for higher gradient areas like Reach 1 or tributaries like Longmarsh Creek or the Country-Cabbage Creek drainage.

OFF-CHANNEL MODIFICATIONS

- **Riparian Area Protection and Restoration** was determined to be a feasible and potentially a high priority treatment in the May Valley Subarea.
- **Off-Channel Habitat Restoration** was determined to be a feasible restoration action in both low gradient and higher gradient sections of May Creek. Both riparian and associated wetland habitat protection and restoration actions were considered to be viable treatments.
- **Modify the Amount of Erosion in the Drainage Basin** was generally deemed a feasible restoration action in the May Valley. Erosion and associated elevated sediment levels are significant problems in the basin. However, not all erosion reduction methods were determined to be feasible in such a low-gradient system.
- **Land Acquisition** was determined to be infeasible because it is outside the scope of this project. The recommendations section of this report includes a brief discussion about how land acquisition may be a reasonable, feasible, and potentially a priority restoration action in the May Valley.
- **Reduce Sediment Load** was determined to be a feasible restoration action in both low gradient and higher gradient sections of May Creek. Restoration and enhancement of riparian and wetland habitat were determined to be potential treatments to reduce sediment. Stormwater and sediment basins were also considered to be potentially feasible treatments.
- **Reduce Surface Runoff** was determined to be generally infeasible. The ongoing conversion of forested uplands to residential areas and other project with impervious surfaces in the May Valley drainage basin will continue to increase surface runoff. The recommendations section of this report includes a discussion of potential, feasible actions outside the project area that may reduce or mitigate the effects of increased surface runoff.
- **Water Storage and Stormwater Retention** was determined to be generally infeasible. Some feasible treatments such as stormwater ponds and wetlands may have minor storage components, but generally the volume of flood flows in May Valley far exceed the ability to reduce surface runoff within the project area (May Valley Subarea). The recommendations section of this report includes a discussion of potential action outside the project area that may be feasible treatments to reduce or mitigate the effects of increased surface runoff.

Summary of Feasibility of Restoration Alternatives

Restoration Alternative Treatment Name	Feasibility in Low-Gradient Reaches (e.g. Reaches 2, 3, 4)	Feasibility in Higher Gradient Reaches and Tributaries (e.g. Reaches 1, 5, 6, Longmarsh and Country-Cabbage Creeks)
Direct Channel Modification		
Channel Cross-Section	Yes - ephemeral	YES
Planform	Yes - ephemeral	YES
Profile	Yes - ephemeral	YES
Indirect Channel Modification		
In-stream Structures	No – unlikely	YES
Boulder Clusters	No – unlikely	YES
Drop Structures	No – unlikely	YES
Beaver Management	YES	YES
Fish Passage	YES	YES
Large Woody Debris (LWD)	No – unlikely	YES
Porous Weirs	No – unlikely	YES
Bank Structures	No – unlikely	YES
In-Stream Nutrient and Substrate	No – unlikely	YES
Nutrient Management	No – unlikely	YES
Substrate Management	No – unlikely	YES
Off-Channel Modification		
Land Acquisition	No – unlikely	YES
Modify the Amount of Erosion	YES	YES
Off-Channel Habitat Restoration	YES	YES
Reduce Sediment Load	YES	YES
Reduce Surface Runoff	No – unlikely	YES
Riparian Area Protection/Restoration	YES	YES
Water Storage and Stormwater Retention	No – unlikely	No – unlikely

RESTORATION ACTIONS AND PRIORITIZATION

DEVELOPMENT OF RESTORATION ACTIONS

The design team of MPSFEG, GeoEngineers, and OTAK staff used information contained in the Conditions Report (King County 1995), Action Plan (King County 2001), GIS and LiDAR databases, HSPF and HEC-2 and HEC-RAS models, air photographs and other available information to develop conceptual restoration projects. Conceptual project designs were developed to address reach-specific issues summarized in the reach descriptions provided earlier in this document. Conceptual project designs were also guided by the project feasibility principles summarized above.

A total of 33 conceptual project designs were developed for the May Valley Subarea (Appendix C). Conceptual project designs were further developed and refined during site visits in 2006 and 2007. The efficacy of conceptual designs addressing biologic, hydrologic and hydraulic objectives described in Recommendation 5 in the Action Plan (King County 2001) were evaluated by a variety of means, including hydrologic and hydraulic models.

A project prioritization matrix was developed to assist the MPSFEG, King County, landowners, other others to select priority projects from among the 33 described. The following summarizes the prioritization criteria, process, and results. Please note that conceptual projects are preliminary and may be modified by the MPSFEG, King County, landowners or others to better meet project objectives. Please also note that the prioritization criteria, process, and results listed below are offered as a means to select and proceed with a preferred alternative project. The MPSFEG, King County, and May Valley landowners are encouraged to suggest changes to the prioritization criteria and process to better address project objectives, as described in Recommendation 5 of the Action Plan (King County 2001).

PRIORITIZATION CRITERIA AND PROCESS

GeoEngineers used a prioritization process consistent with the process used in developing recommendations in the Action Plan (King County 2001). This approach enables project proponents and sponsors to compare the relative priority of projects in this Conceptual Restoration Plan with the priority of other projects identified in the Action Plan.

The prioritization process applies five (5) general criteria to potential projects. More than two-thirds of the possible points in this prioritization methodology are contained in two major criteria: the importance of the problem addressed, and the overall effectiveness of the proposed project in addressing that problem.

- **Importance** – (1 to 10 scale): How important is the problem addressed by the project? Determining the significance of the problem is generally guided by the Solutions Analysis and information presented in the Conditions Report.
- **Effectiveness** – (1 to 6 scale): How effective is the project as a solution to the problem? The determination of effectiveness can be affected by the size and complexity of the problem; a well conceived project can receive a low Effectiveness score if it addresses only one aspect of a, complex problem.

A little less than one-third of the possible points in this methodology are contained in three minor criteria that cover less critical, but still important aspects of the project.

- **Feasibility –** (1 to 3 scale): How hard will it be to undertake and complete the project effectively? This criterion accounts for the ease or difficulty of meeting permitting requirements.
- **Offsite/Multiple Benefits -** (-3 to +3 scale): What effect(s) – positive and/or negative – will this project have on surrounding areas and the system as a whole?
- **Public/Local Support** – (-1 to +1): If the community is aware of this project, has the response been positive or negative?

The maximum point total a project can receive using this methodology is 23 points. The following table provides a list of the projects shown in the order of their priority for implementation, as determined on a basinwide basis using the above described prioritization process.

Prioritized List of Conceptual Restoration Projects

Proposed Project Sequence[1]	Project Number	Conceptual Project Name	Reach	Estimated Construction Cost[2]
A	7	148th Avenue SE Culvert and High-flow Channel	1 and 2	$ 243,500
A	17	Beaver Management Demonstration Project	3	$ 15,200
B	18	164th Avenue SE Conveyance Project	3 and 4	$ 160,200
B	IFP-3	Ineffective Flow Project 3	3 and 4	$ 356,900
C	4	Hydraulic Control and High-flow Channel	1	$ 43,500
D	15	May Creek Side-Channel Project	3	$ 85,100
E	11	Colasurdo Wetland Enhancement – Reed Canarygrass Abatement	2	$ 89,200
E	IFP-1	Ineffective Flow Project 1	1 and 2	$ 179,700
F	5	Stonegate Wetland Enhancement – Reed Canarygrass Abatement	1	$ 69,000
F	6	Greene's Creek Confluence Area Project	1	$ 59,800
F	IFP-2	Ineffective Flow Project 2	2	$ 58,200
G	10	Tsegay Wetland Enhancement – Reed Canarygrass Abatement	2	$ 104,500
G	28	Wetland Habitat Enhancement (WSDOT South)	5	$ 68,400
H	1	Streambank Protect and Instream Habitat Enhancement	1	$ 190,100
H	2	143rd Avenue SE Bridge Crossing	1	$ 148,500
H	16	291-A Confluence Area Project	3	$ 63,200
H	25	Cabbage Creek Culvert Replacement	5	$ 160,200
H	26	Country Creek Culvert Replacement	5	$ 160,200
H	27	Country-Cabbage Confluence Culvert Replacement	5	$ 160,200
I	24	Lower Country Creek Habitat Enhancement	5	$ 74,600
J	14	Colasurdo Stormwater Detention Pond	2	$ 169,700
K	9	Long Marsh Creek Enhancement	2	$ 69,900
K	12	Indian Meadow Confluence Area Project	2	$ 33,900
K	21	Hendrix Creek Confluence Area Project	4	$ 362,000
K	22	North Hendrix Wetland Complex	4	$ 172,800
L	3	Streambank and Off-Channel Habitat Enhancement	1	$ 145,700
L	19	291-B Confluence Area Project	4	$ 61,600
L	20	Stormwater/Sediment Retention Area	4	$ 119,400
L	29	North Fork High Flow Detention Basins	6	$ 345,900
L	IFP-4	Ineffective Flow Project 4	6	$ 186,900
M	23	Coho Rearing Pond	5	$ 27,300
N	8	Dunvegan Trust Wetland Enhancement – Reed Canarygrass Abatement	2	$ 148,300
N	13	Colasurdo Off-Channel Pond/Wetland Enhancement	2	$ 15,400

Notes:

[1] "Proposed Project Sequence" – The alphabetical sorting of projects provides a proposed sequencing of conceptual restoration action based on an application of the prioritization criteria and process described on page 30 of this report.

[2] "Estimated Construction Cost" – This column provides planning-level cost estimates based on a uniformly applied construction cost estimation procedure. Nominal estimates of engineering design and permitting costs were included in the estimate as a small percentage of estimated construction costs. Actual costs may be significantly greater for projects requiring detailed engineering designs or complicated permitting or regulatory compliance actions. The actual percent cost of engineering or permitting/regulatory compliance may vary from project to project.

RECOMMENDATIONS

This section of the CRP provides an initial sort list of prioritized projects that address issues identified in Recommendation 5 of the Action Plan (King County 2001). Projects were developed in an effort to identify sustainable approaches to floodwater conveyance and habitat restoration that, once implemented, would be self-maintaining through natural channel-forming processes. The projects were developed on a reach-by-reach basis, progressing through the May Valley Subarea from a downstream to upstream orientation. These recommendations focus on the core issues associated with Action Plan Recommendation 5, and are limited to the May Valley Subarea. They do not address other recommendations or subareas described in the Action Plan. These recommendations identify actions and opportunities outside the scope of Recommendation 5, or that lie outside the May Valley Subarea, that would be expected to help address issues associated with Recommendation 5.

The following overarching recommendations are offered as guidance to the use of information and conceptual project designs summarized in this report and detailed in Appendix C:

1. Implement a finite number of priority conceptual projects to serve as demonstration projects,
2. Monitor demonstration projects for effectiveness,
3. Refine designs and implement additional projects based on demonstration project findings, and
4. Explore opportunities to use methods or implement actions in areas beyond the scope of Recommendation 5.

PRIORITIZED CONCEPTUAL PROJECTS

Figure 12 provides a comprehensive view of the May Valley Subarea, including the locations of the 33 conceptual restoration projects. The 33 conceptual projects are relatively evenly distributed throughout the May Valley Subarea with some concentration of projects in areas subject to severe flooding, priority habitat areas, or other priority issues. The following summarizes prioritization results and provides reach-specific recommendations.

Reach 1

Six conceptual restoration projects and the lower-most portion of another project were identified in Reach 1 (Figure 13). Conceptual project designs included a wide variety of project types including: streambank protection and instream habitat enhancement, grade control, high-flow side channels, riparian habitat enhancement and wetland habitat enhancement project types, and direct in-channel alteration. All projects identified in Reach 1 were determined to provide some degree of mitigation to the issues identified (see Appendix B for details). The prioritization process identified Project 4 – Hydraulic Control and High-flow Channel (see Appendix B) - as the highest priority project in Reach 1 and the fourth highest priority of the 33 Projects. Project 4 should be considered a candidate project for early implementation as a demonstration project as part of the May Valley Habitat Enhancement project.

Reach 2

Nine conceptual restoration projects and the upstream-most portion of another project were identified in Reach 2 (Figure 14). Conceptual project designs include culvert (conveyance), high-flow side channels, riparian habitat enhancement and wetland habitat enhancement project types, and direct in-channel alteration. All projects identified in Reach 2 were determined to provide some degree of mitigation to identified issues (see Appendix B for details). The prioritization process identified Project 7 – 148th Avenue SE Culvert and High-flow Channel (see Appendix B for details) as the highest priority project in Reach 2; this project is the highest priority project in the May Valley sub-area. Project 1 should be considered a top

priority candidate project for early implementation as a demonstration project as part of the May Valley Habitat Enhancement project.

Reach 3

Three conceptual restoration projects and the lower-most portion of another project were identified in Reach 3 (Figure 15). Conceptual project designs include tributary passage, side-channel passage, conveyance improvement, beaver management, riparian habitat enhancement and wetland habitat enhancement project types, and direct in-channel alteration. All projects identified in Reach 3 were determined to provide some degree of mitigation to identified issues (see Appendix B for details). The prioritization process identified Project 17 – Beaver Management Demonstration Project (see Appendix B for details) - as the highest priority project in Reach 3; this project is the second highest priority project in the May Valley sub-area. Project 17 should be considered a top priority candidate project for early implementation as a demonstration project as part of the May Valley Habitat Enhancement project. Implementation of Project 17 should be coordinated with plans to implement Project 18.

Reach 4

Five conceptual restoration projects and the central portion of another project were identified in Reach 4 (Figure 16). Conceptual project designs include floodwater conveyance, tributary stormwater, riparian habitat enhancement and wetland habitat enhancement project types, and direct in-channel alteration. All projects identified in Reach 4 were determined to provide some degree of mitigation to issues identified (see Appendix B for details). The prioritization process identified Project 18 – 164th Avenue SE Conveyance Project (see Appendix B for details) - as the highest priority project in Reach 4, it is the third highest priority project in the May Valley sub-area. Expected benefits of Project 18 were projected based on coordination of implementation with Project 17 in Reach 3. Project 18 should be considered a top priority candidate project for early implementation as a demonstration project as part of the May Valley Habitat Enhancement project.

Reach 5

Six conceptual restoration projects and the up-stream and downstream portions of two other projects were identified in Reach 5 (Figure 17). Conceptual project designs include floodwater conveyance (culverts), tributary riparian and aquatic habitat enhancement, coho salmon off-channel rearing habitat enhancement, wetland habitat enhancement project types, and direct in-channel alteration. All projects identified in Reach 5 were determined to provide some degree of mitigation to issues identified (see Appendix B for details). The prioritization process identified Project 28 – Wetland Habitat Enhancement (WSDOT South, see Appendix B for details) - as the highest priority project in Reach 5. This project is ranked 9th of 33 projects in the sub-area. Project 28 may be a candidate project for early implementation as a demonstration project as part of the May Valley Habitat Enhancement project.

Reach 6

One conceptual restoration project and the up-stream portion of another project was identified in Reach 6 (Figure 18). Conceptual project designs were limited to a potential high flow and sediment detention basin project. The detention basin project identified in Reach 6 was determined to provide some, minor, mitigation to issues identified (see Appendix B for details). The prioritization process identified Project 29 – North Fork High Flow Detention Basins (see Appendix B for details) as relatively low priority (number 23 of 33), in the May Valley sub-area. Project 29 should not be considered a priority project for early implementation as a demonstration project as part of the May Valley Habitat Enhancement project.

OTHER ALTERNATIVE ACTIONS RECOMMENDED FOR CONSIDERATION

In the process of developing conceptual project designs to address issues identified in Recommendation 5 of the Action Plan (King County 2001), a number of potential solutions were identified but determined to be outside the scope of this project. GeoEngineers elected to exclude these projects from the conceptual project designs list (Appendix B), but to include them in this Recommendations section because of the benefit they would bring to the May Valley sub-area. Brief descriptions of these projects are summarized below.

- **Highlands and Renton Plateau Stormwater Treatments**: One of the most significant issues exacerbating flooding in the May Valley, as identified in the Conditions Report (King County 1995) and this Conceptual Restoration, is the increase in impervious surfaces (and thus stormwater runoff) in the Highlands and Renton Plateau Subareas. The Conditions Report (King County 1995) indicated that increases in the frequency of flooding in the May Valley are a result of development in these headwater areas. Hydrologic analyses completed as part of this CRP provide evidence that the predicted changes have been occurring. Development of stormwater detention, retention, infiltration, dispersion facilities, and reduction of impervious surfaces in the headwater areas should be encouraged to minimize further changes in flood frequency.

- **Land Acquisition:** The May Valley, like many areas in King County, is subject to development pressure. During site visits, staff observed a number of properties for sale. In an area like May Valley where there are limited restoration and flood reduction actions that can be implemented, an alternative may be to use public funds to acquire lands as part of restoration projects. Site specific land acquisition through conservation easements or through fee-simple acquisition may be regulated by public or private land management agencies to protect riparian, wetland and aquatic resources and flood storage. Land acquisition alone, however, will not resolve flooding or habitat problems. Each acquisition must be coupled with the implementation of the proposed restoration project to achieve the desired restoration objective for that area.

- **Horizontal Directional Drilling below 148th Avenue SE:** One significant geologic feature in the May Valley Subarea that significantly limits options that resource mangers may use to address flooding is the flat topography. The terminal glacial moraine, located downstream from the 148th Avenue SE Bridge, has produced a very low gradient portion of May Creek running through the May Valley. Not surprisingly, this portion of May Creek in the lower May Valley is subject to frequent flooding. GeoEngineers has successfully used horizontal direction drilling (HDD) to address a variety of issues for clients. Perhaps HDD might be used to produce a managed drainage system in the lower portion of the May Valley, downstream from the 148th Avenue SE Bridge, to alleviate flooding in this portion of the valley.

LIMITATIONS

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to the appendix titled Report Limitations and Guidelines for Use for additional information pertaining to use of this report.

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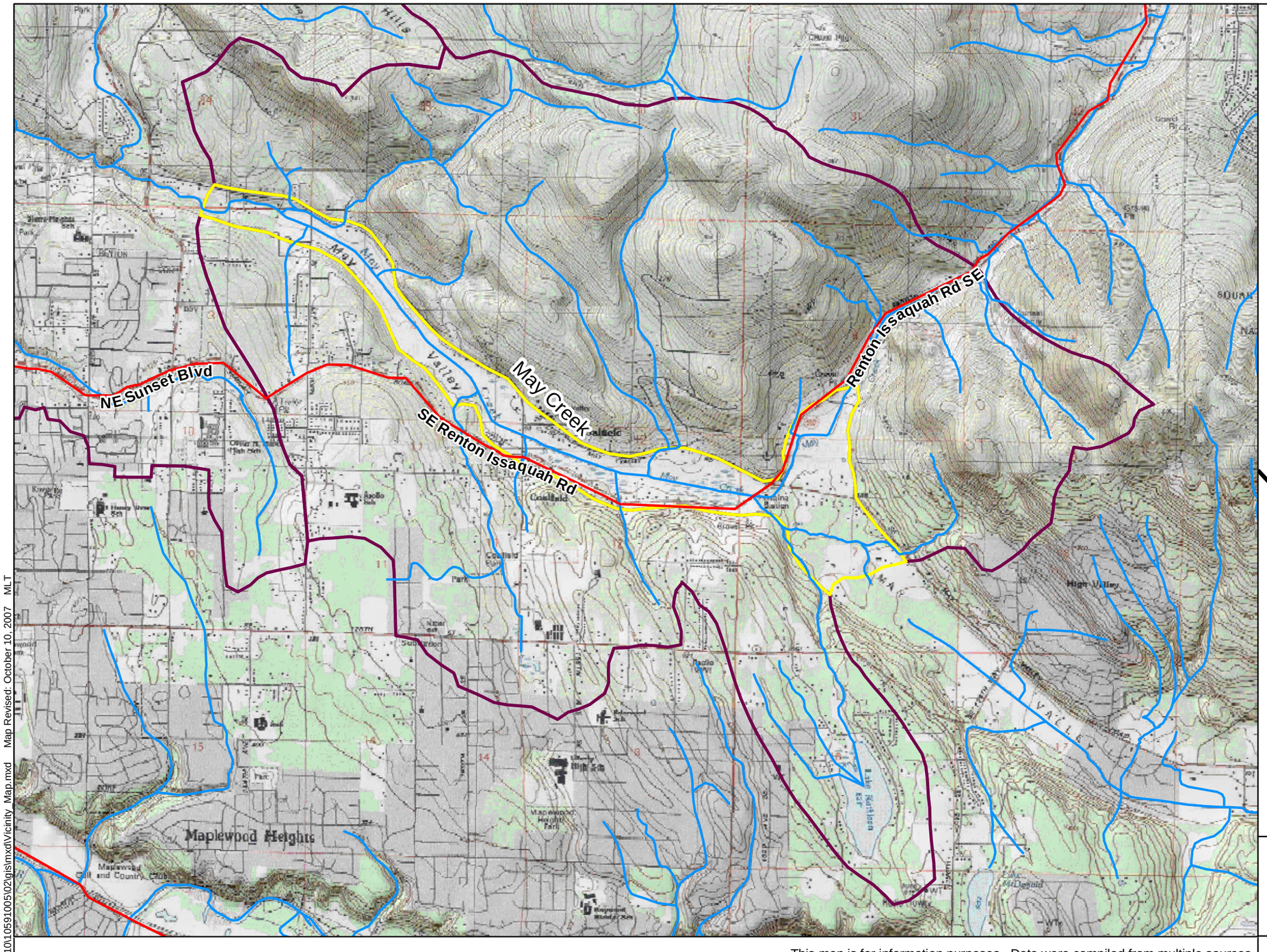
APPENDIX A
GIS-BASED FIGURES



May Valley Sub Area

Sub Areas

King County Water Courses

State Routes

Data Sources: Rivers, waterbodies, state highways, and political boundaries are provided by the Washington Department of Transportation. Water Courses are from the King County Department of Natural Resources. Topographic Hillshade from USGS. Area boundaries were created by GeoEngineers.

This map is for information purposes. Data were compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication. The locations of all features shown are approximate.

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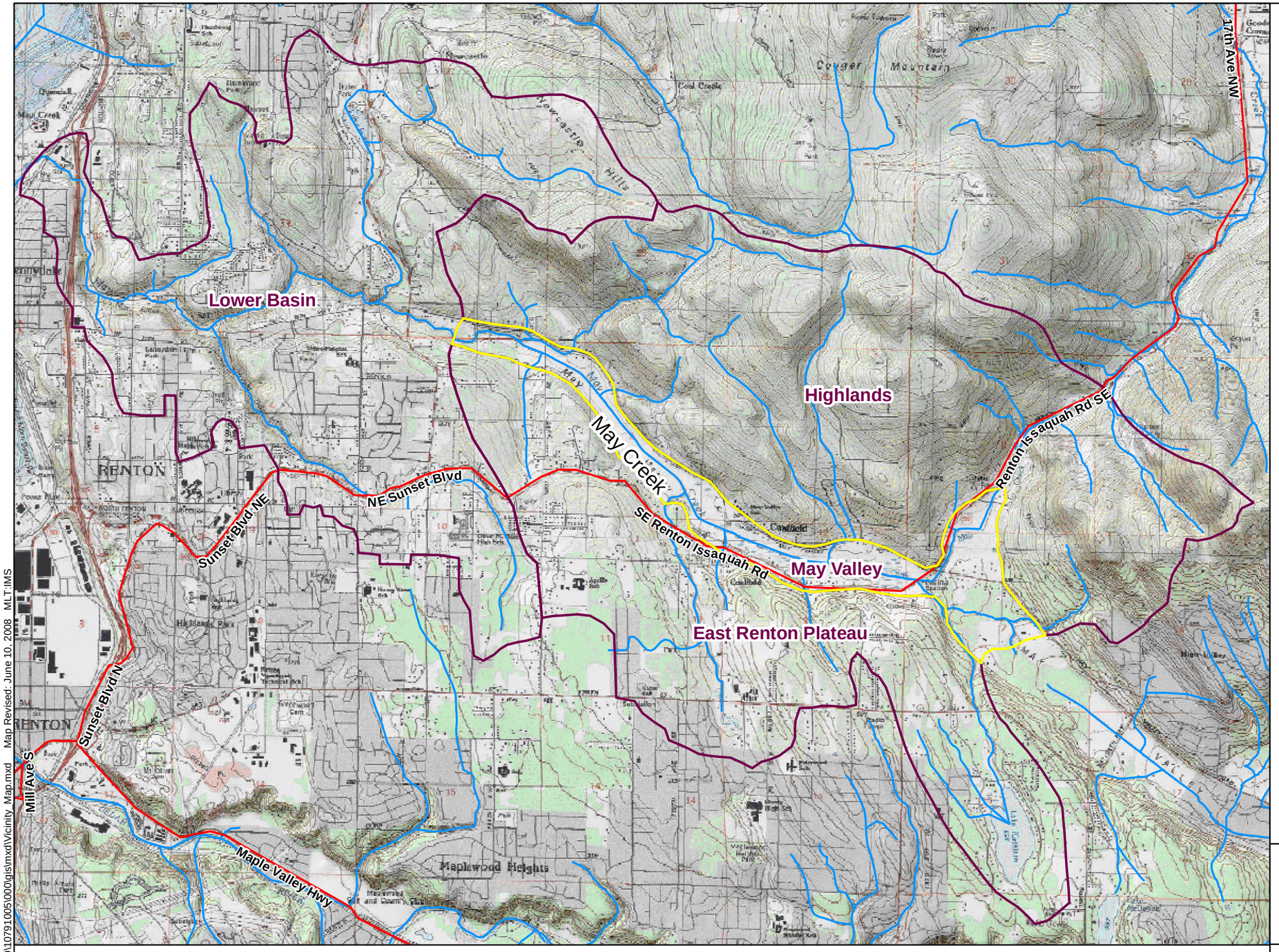
Vicinity Map

FIGURE 1

Office: BHAM P:\01\05910051\02\gis\mxd\Vicinity_Map.mxd Map Revised: October 10, 2007 MLT



May Valley Sub Area

Sub Areas

King County Water Courses

State Routes

3,000 1,500 0 3,000 Feet

GeoEngineers

May Valley Sub Areas

FIGURE 4

Data Sources: Rivers, waterbodies, state highways, and political boundaries are provided by the Washington Department of Transportation. Water Courses are from the King County Department of Natural Resources. Topographic Hillshade from USGS. Area boundaries were created by GeoEngineers.

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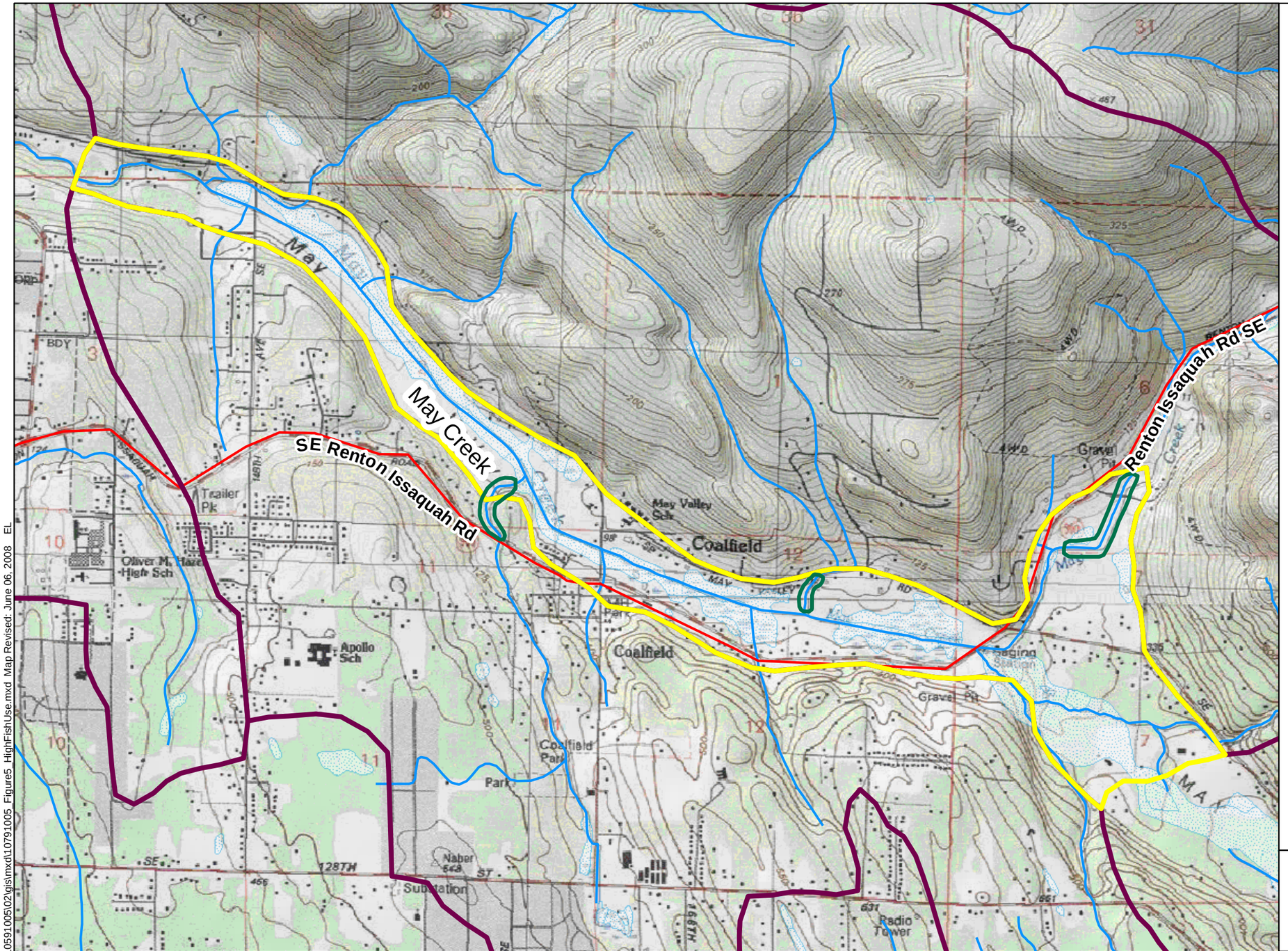

- High Fish Use
- May Valley Sub Area
- Sub Areas
- National Wetland Inventory
- King County Water Courses
- State Routes

1,000 500 0 1,000 Feet

Data Sources: Rivers, waterbodies, state highways, and political boundaries are provided by the Washington Department of Transportation. Water Courses are from the King County Department of Natural Resources. Topographic Hillshade from USGS. Area boundaries were created by GeoEngineers.

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May Valley Habitat Features

FIGURE 5

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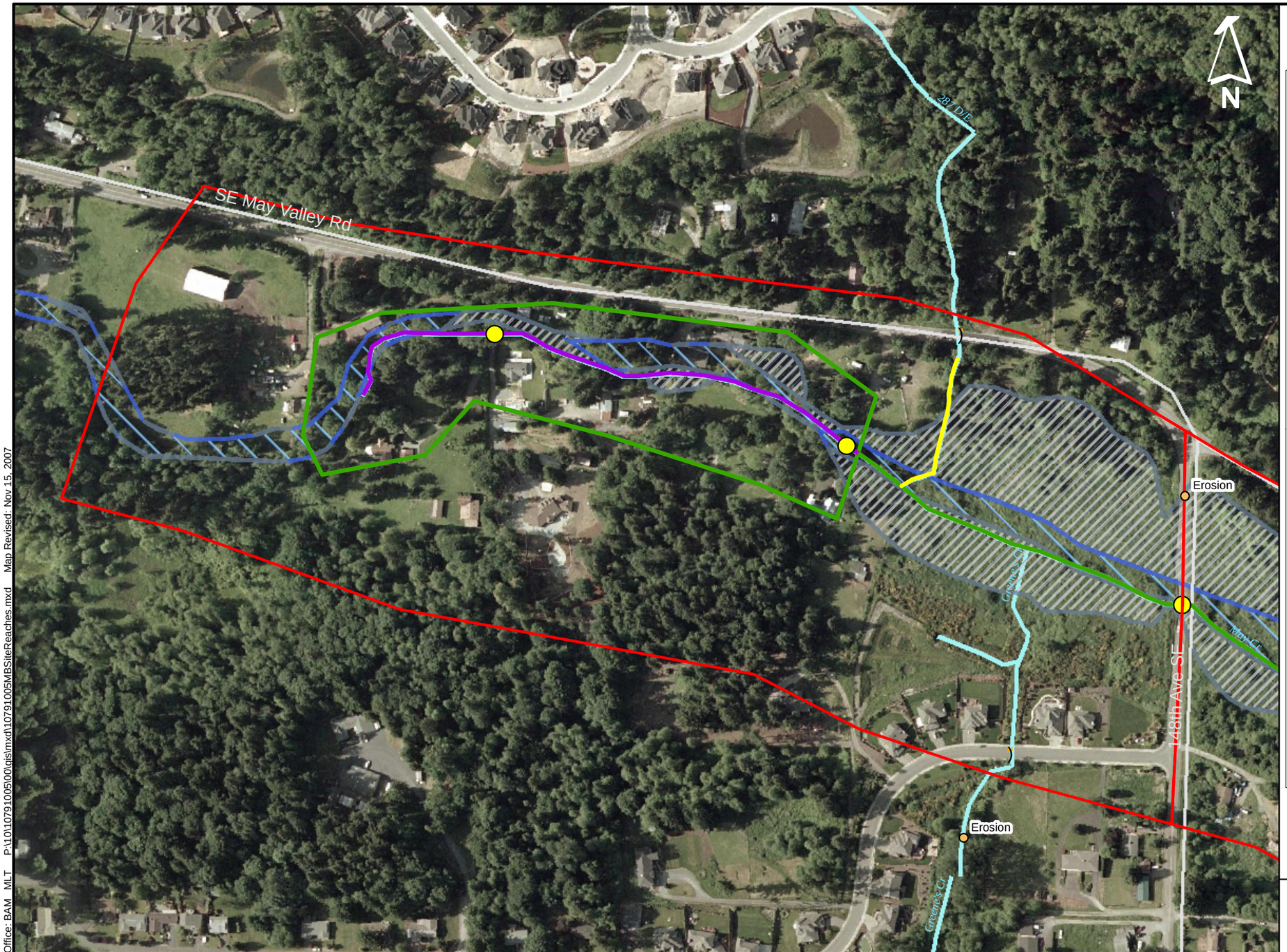

Office: BAM MLT P:\10\10791005\00\gis\mxd\10791005MBSiteReaches.mxd Map Revised: Nov 15, 2007

May Valley Reaches
Street Centerlines
Approximate Culvert Locations 2006 (GEI)
Known Bridges 2006 (GEI)
Watercourses 2006 (GEI)
100-Year Floodplain (FEMA)
Floodway (FEMA)

Channel Problems (Current)
Clogged: Vegetation
Clogged: Silt
Culverts: Fish-impass
Erosion

Channel Problems (1995 Conditions Report)
Erosion
Erosion; Stream habitat
Fish habitat; Flooding
Flooding
Stream habitat
Clogged
Deposition
Erosion
Gravel
Hard bed
Old Beaver Dam
Dense Vegetation
Submerged Obstruction

250 125 0 250 Feet

GeoEngineers

Data Sources: Water Courses, Roads, FEMA Floodway and 100 yr Floodplain from King County Department of Natural Resources; Imagery from USGS; 1995 Channel Problems, Deposition and Erosion, and Constrictions were generated by GeoEngineers from hard copy images within the May Creek Conditions Report; All other data created by GeoEngineers.

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MAY CREEK HABITAT RESTORATION
Reach 1

FIGURE 6

May Valley Reaches
Street Centerlines
Approximate Culvert Locations 2006 (GEI)
Known Bridges 2006 (GEI)
Watercourses 2006 (GEI)
100-Year Floodplain (FEMA)
Floodway (FEMA)

Channel Problems (Current)

Clogged: Vegetation
Clogged: Silt
Culverts: Fish-impass
Erosion

Channel Problems (1995 Conditions Report)

Erosion
Erosion; Stream habitat
Fish habitat; Flooding
Flooding
Stream habitat
Clogged
Deposition
Erosion
Gravel
Hard bed
Old Beaver Dam
Dense Vegetation
Submerged Obstruction

450 225 0 450 Feet

GeoEngineers

Office: BAM MLT P:\101\079\005\00\gis\mxd\101791005MBSiteReaches.mxd Map Revised: Nov 15, 2007

Data Sources: Water Courses, Roads, FEMA Floodway and 100 yr Floodplain from King County Department of Natural Resources; Imagery from USGS; 1995 Channel Problems, Deposition and Erosion, and Constrictions were generated by GeoEngineers from hard copy images within the May Creek Conditions Report; All other data created by GeoEngineers.

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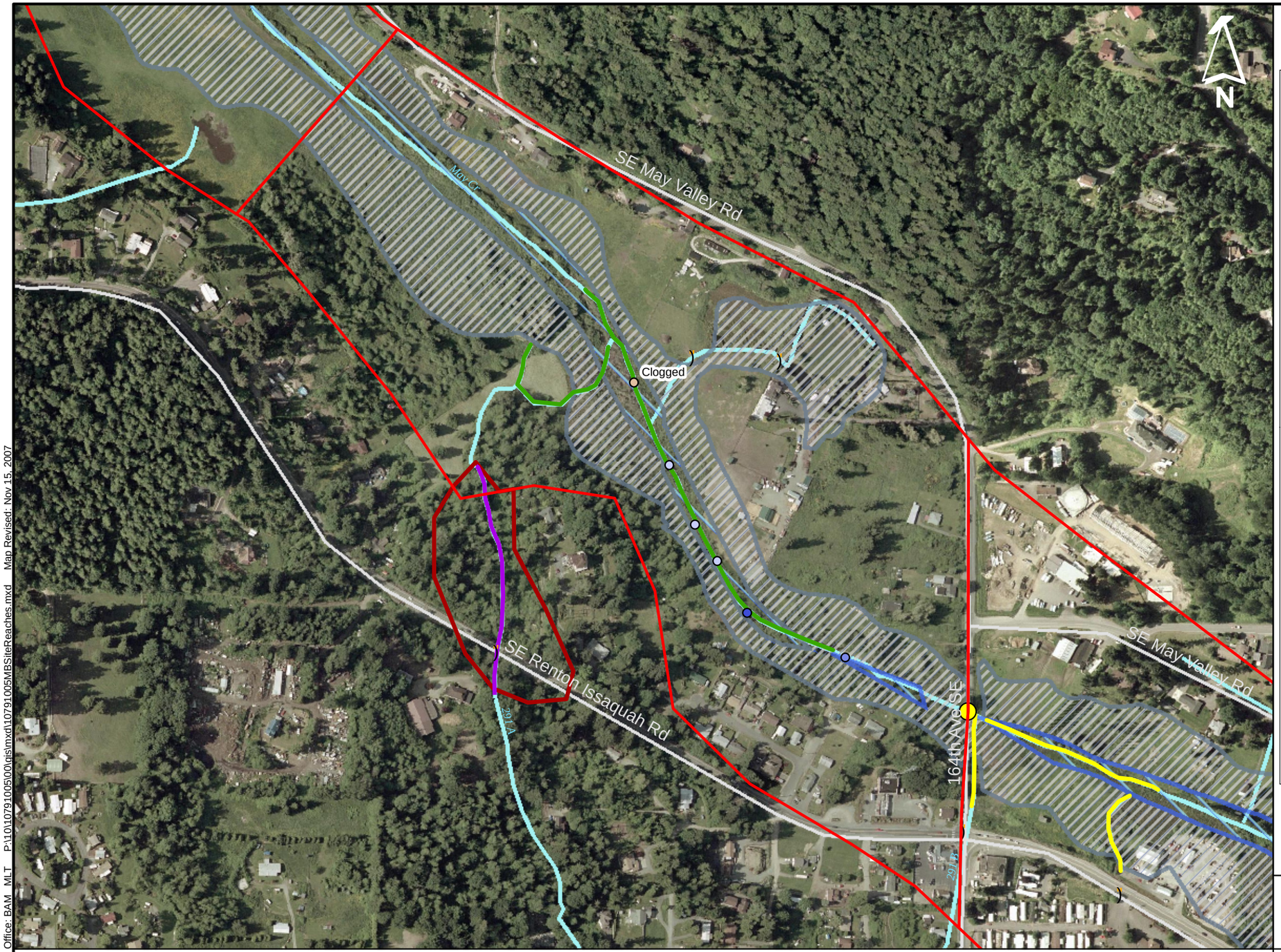
MAY CREEK HABITAT RESTORATION
Reach 2

FIGURE 7



Office: BAM MLT P:\10\10791005\00\gis\mxd\10791005MBSiteReaches.mxd Map Revised: Nov 15, 2007

May Valley Reaches

Street Centerlines

Approximate Culvert Locations 2006 (GEI)

Known Bridges 2006 (GEI)

Watercourses 2006 (GEI)

100-Year Floodplain (FEMA)

Floodway (FEMA)

Channel Problems (Current)

Clogged: Vegetation

Clogged: Silt

Culverts: Fish-impass

Erosion

Channel Problems (1995 Conditions Report)

Erosion

Erosion; Stream habitat

Fish habitat; Flooding

Flooding

Stream habitat

Clogged

Deposition

Erosion

Gravel

Hard bed

Old Beaver Dam

Dense Vegetation

Submerged Obstruction

350 175 0 350 Feet

GeoEngineers

Data Sources: Water Courses, Roads, FEMA Floodway and 100 yr Floodplain from King County Department of Natural Resources; Imagery from USGS; 1995 Channel Problems, Deposition and Erosion, and Constrictions were generated by GeoEngineers from hard copy images within the May Creek Conditions Report; All other data created by GeoEngineers.

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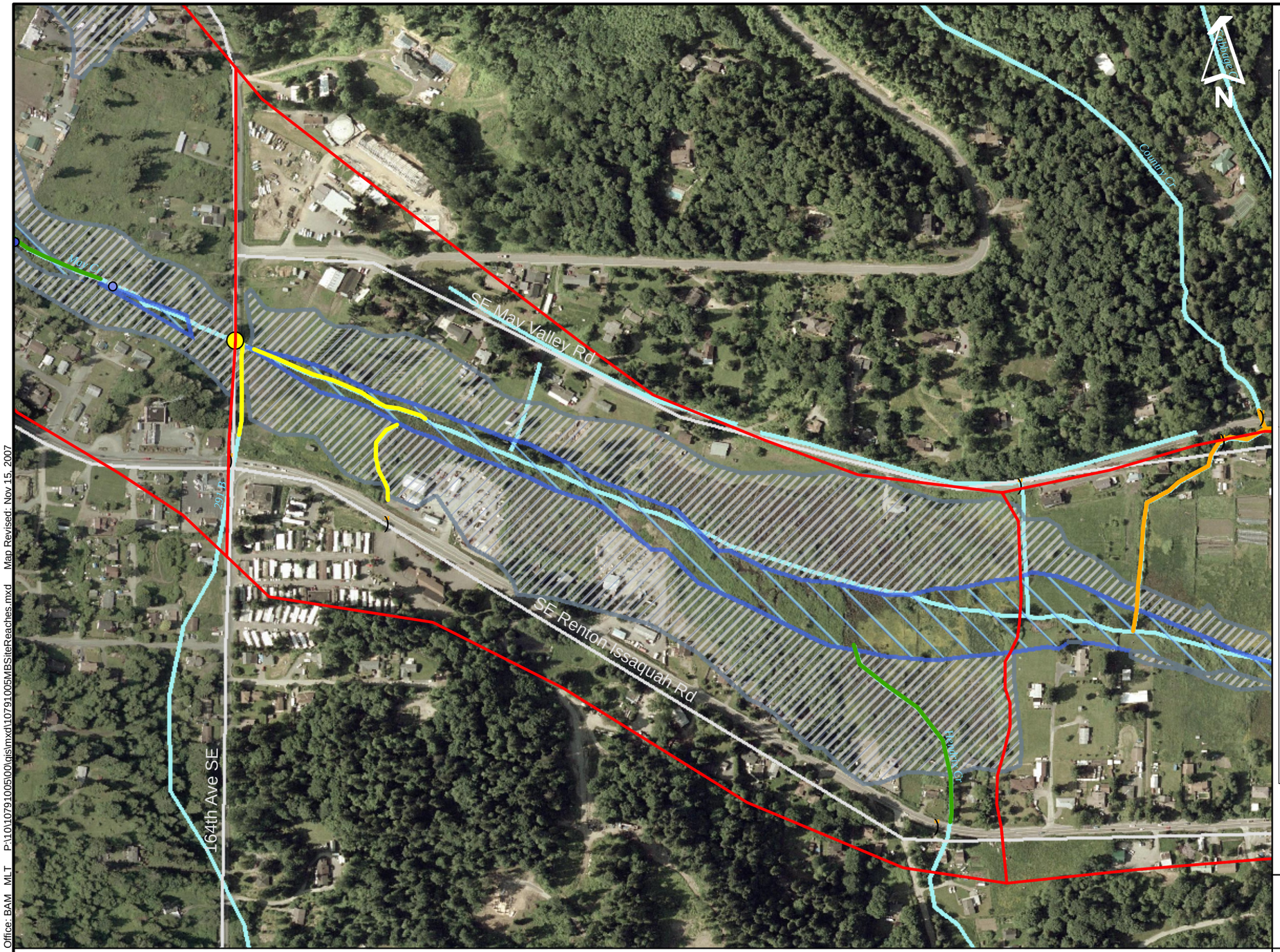
MAY CREEK HABITAT RESTORATION
Reach 3

FIGURE 8



- May Valley Reaches
- Street Centerlines
- Approximate Culvert Locations 2006 (GEI)
- Known Bridges 2006 (GEI)
- Watercourses 2006 (GEI)
- 100-Year Floodplain (FEMA)
- Floodway (FEMA)

Channel Problems (Current)

- Clogged: Vegetation
- Clogged: Silt
- Culverts: Fish-impass
- Erosion

Channel Problems (1995 Conditions Report)

- Erosion
- Erosion; Stream habitat
- Fish habitat; Flooding
- Flooding
- Stream habitat
- Clogged
- Deposition
- Erosion
- Gravel
- Hard bed
- Old Beaver Dam
- Dense Vegetation
- Submerged Obstruction

Feet
350 175 0 350

Office: BAM MLT P:\101079100510\gis\mxd\10791005MBSiteReaches.mxd Map Revised: Nov 15, 2007

Data Sources: Water Courses, Roads, FEMA Floodway and 100 yr Floodplain from King County Department of Natural Resources; Imagery from USGS; 1995 Channel Problems, Deposition and Erosion, and Constrictions were generated by GeoEngineers from hard copy images within the May Creek Conditions Report; All other data created by GeoEngineers.

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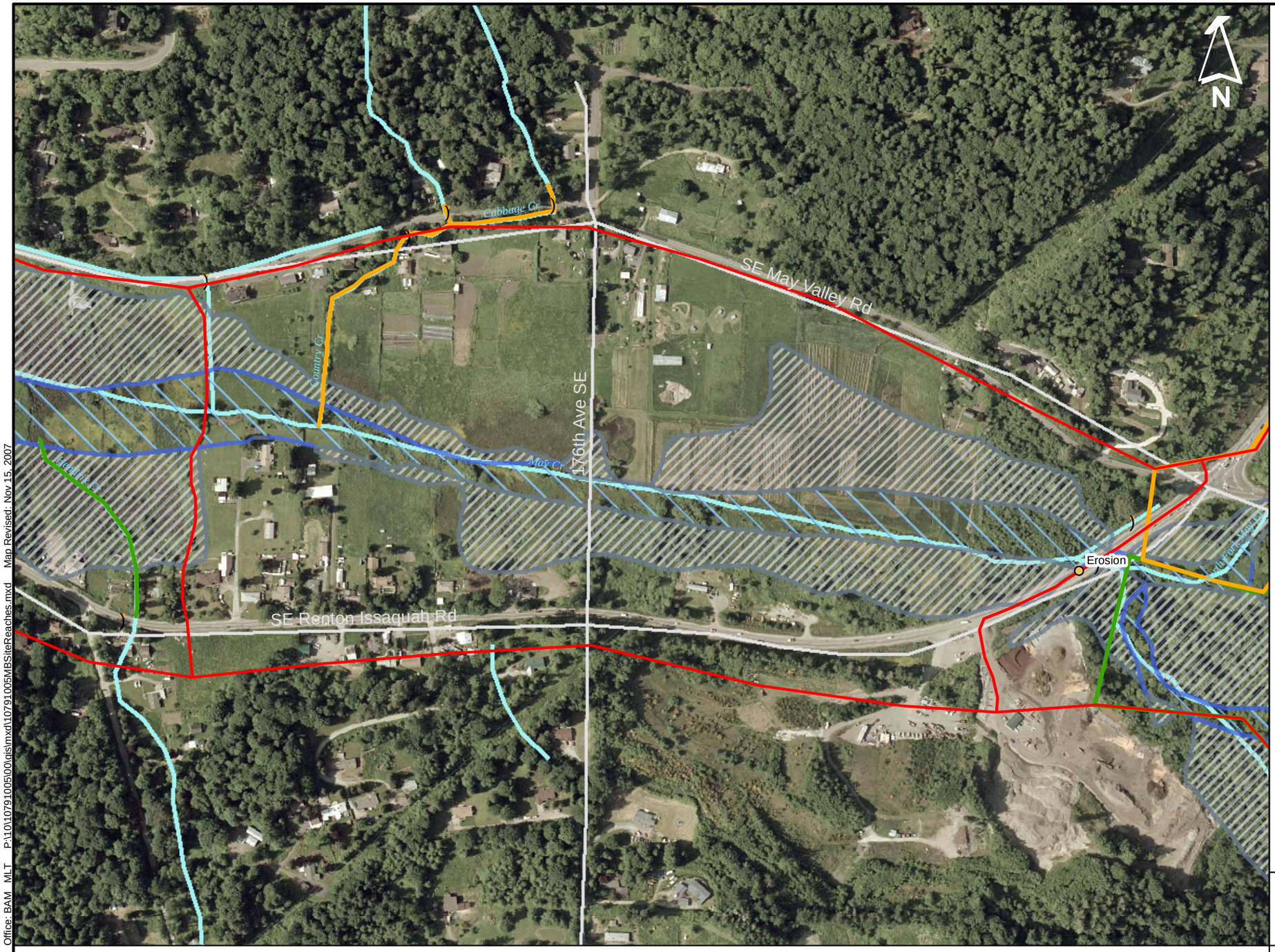
MAY CREEK HABITAT RESTORATION
Reach 4

FIGURE 9



May Valley Reaches
Street Centerlines
Approximate Culvert Locations 2006 (GEI)
Known Bridges 2006 (GEI)
Watercourses 2006 (GEI)
100-Year Floodplain (FEMA)
Floodway (FEMA)

Channel Problems (Current)
Clogged: Vegetation
Clogged: Silt
Culverts: Fish-impass
Erosion

Channel Problems (1995 Conditions Report)
Erosion
Erosion; Stream habitat
Fish habitat; Flooding
Flooding
Stream habitat
Clogged
Deposition
Erosion
Gravel
Hard bed
Old Beaver Dam
Dense Vegetation
Submerged Obstruction

Feet
350 175 0 350

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MAY CREEK HABITAT RESTORATION
Reach 5

FIGURE 10

Data Sources: Water Courses, Roads, FEMA Floodway and 100 yr Floodplain from King County Department of Natural Resources; Imagery from USGS; 1995 Channel Problems, Deposition and Erosion, and Constrictions were generated by GeoEngineers from hard copy images within the May Creek Conditions Report; All other data created by GeoEngineers.

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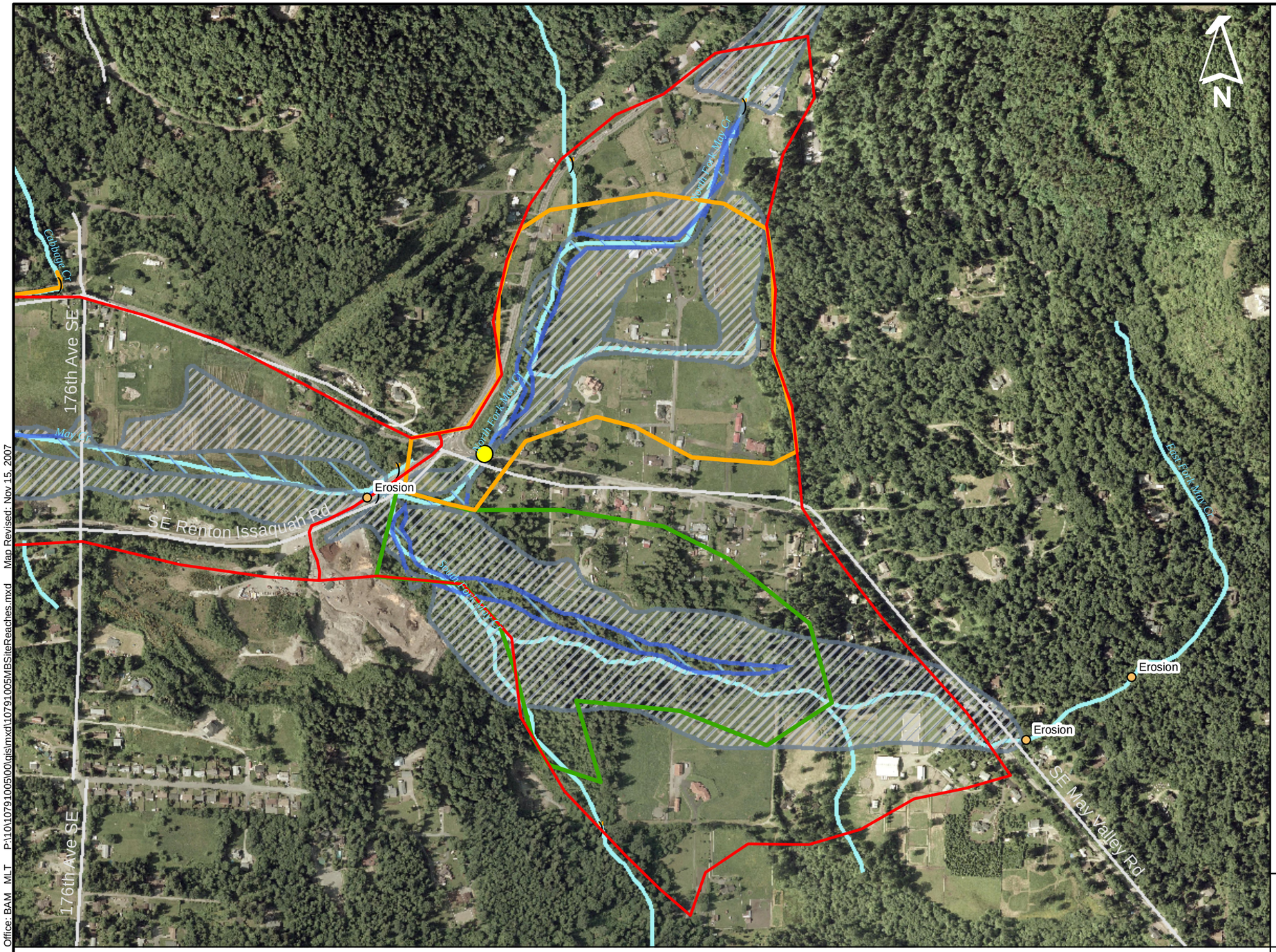

May Valley Reaches
Street Centerlines
Approximate Culvert Locations 2006 (GEI)
Known Bridges 2006 (GEI)
Watercourses 2006 (GEI)
100-Year Floodplain (FEMA)
Floodway (FEMA)

Channel Problems (Current)

Clogged: Vegetation
Clogged: Silt
Culverts: Fish-impass
Erosion

Channel Problems (1995 Conditions Report)

Erosion
Erosion; Stream habitat
Fish habitat; Flooding
Flooding
Stream habitat
Clogged
Deposition
Erosion
Gravel
Hard bed
Old Beaver Dam
Dense Vegetation
Submerged Obstruction

600 300 0 600 Feet

GeoEngineers

MAY CREEK HABITAT RESTORATION
Reach 6

FIGURE 11

Data Sources: Water Courses, Roads, FEMA Floodway and 100 yr Floodplain from King County Department of Natural Resources; Imagery from USGS; 1995 Channel Problems, Deposition and Erosion, and Constrictions were generated by GeoEngineers from hard copy images within the May Creek Conditions Report; All other data created by GeoEngineers.

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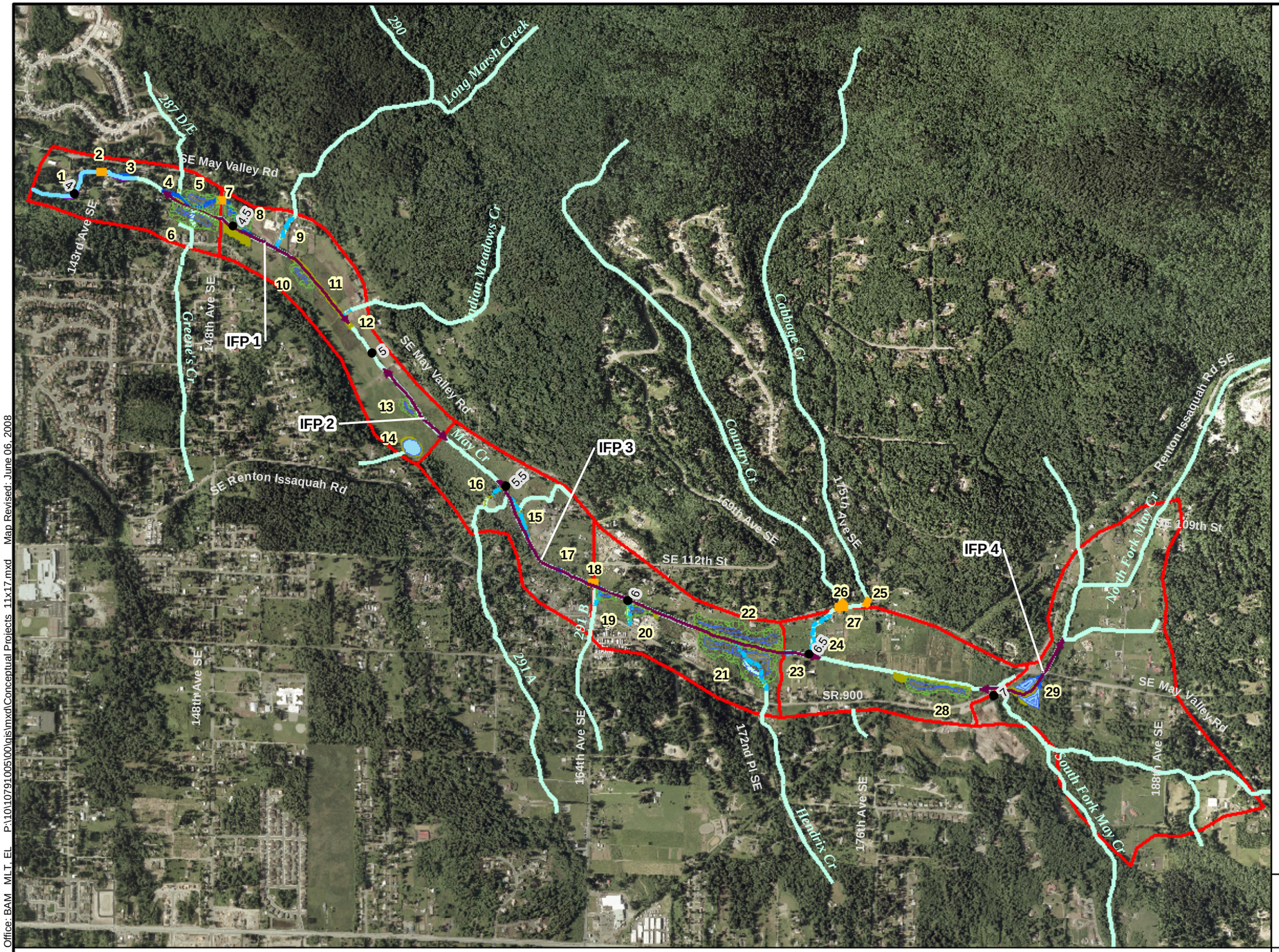

Office: BAM MLT, EL P:\110\10791005\00\gis\mxd\Conceptual Projects 11x17.mxd Map Revised: June 06, 2008

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

This map is for information purposes. Data were compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication. The locations of all features shown are approximate.

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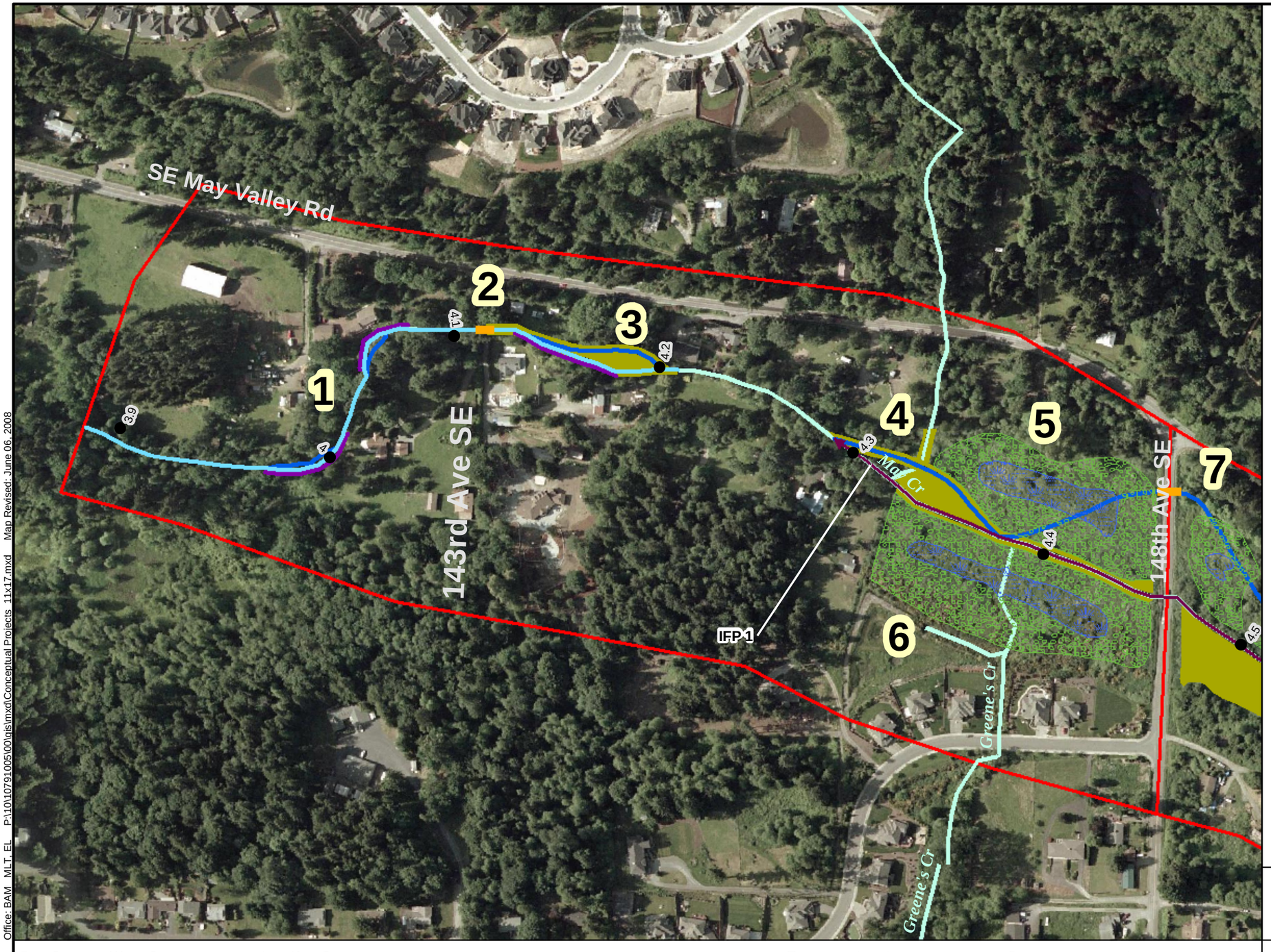
MAY CREEK HABITAT RESTORATION
Conceptual Projects All

FIGURE 12



1 Project Number

4.5 River Mile 0.1 mi

Innefective Flow Projects (IFP)

New Pool Habitat

Detention Basin

Beaver Management

Culvert

Streambank Protection Erosion Control

Restored Instream Habitat

New High-Flow Channel

New Channel Alignment

New Side Channel

Riparian Features

Created Wetland

Enhanced Wetland Buffer

Watercourses 2006 (GEI)

May Valley Reaches

N

250 125 0 250 Feet

GeoEngineers

MAY CREEK HABITAT RESTORATION
Conceptual Projects Reach 1

FIGURE 13

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

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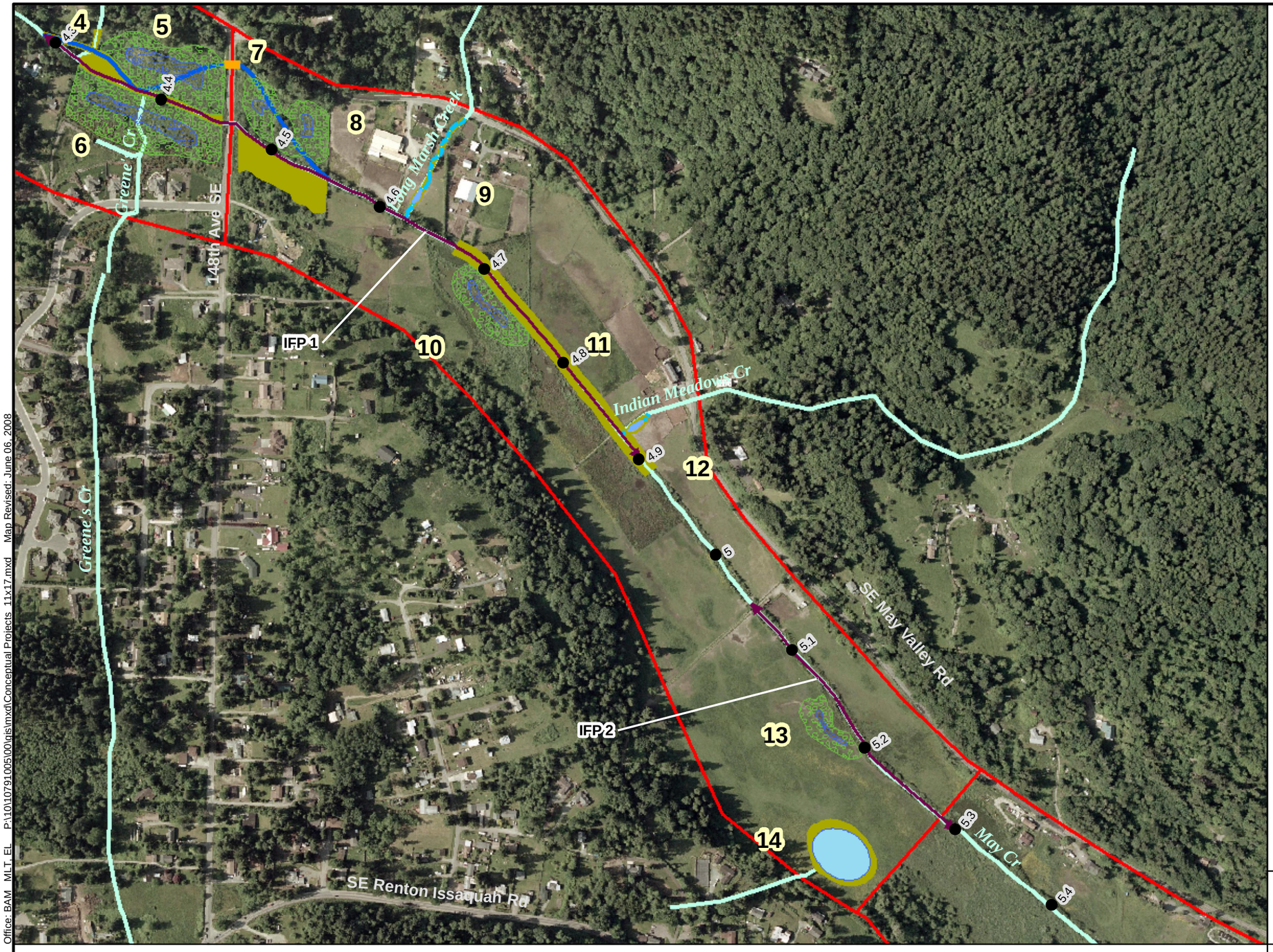

1 Project Number

4.5 River Mile 0.1 mi

Innefective Flow Projects (IFP)

New Pool Habitat

Detention Basin

Beaver Management

Culvert

Streambank Protection Erosion Control

Restored Instream Habitat

New High-Flow Channel

New Channel Alignment

New Side Channel

Riparian Features

Created Wetland

Enhanced Wetland Buffer

Watercourses 2006 (GEI)

May Valley Reaches

N

Feet

500 250 0 500

GeoEngineers

MAY CREEK HABITAT RESTORATION
Conceptual Projects Reach 2

FIGURE 14

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

This map is for information purposes. Data were compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication. The locations of all features shown are approximate.

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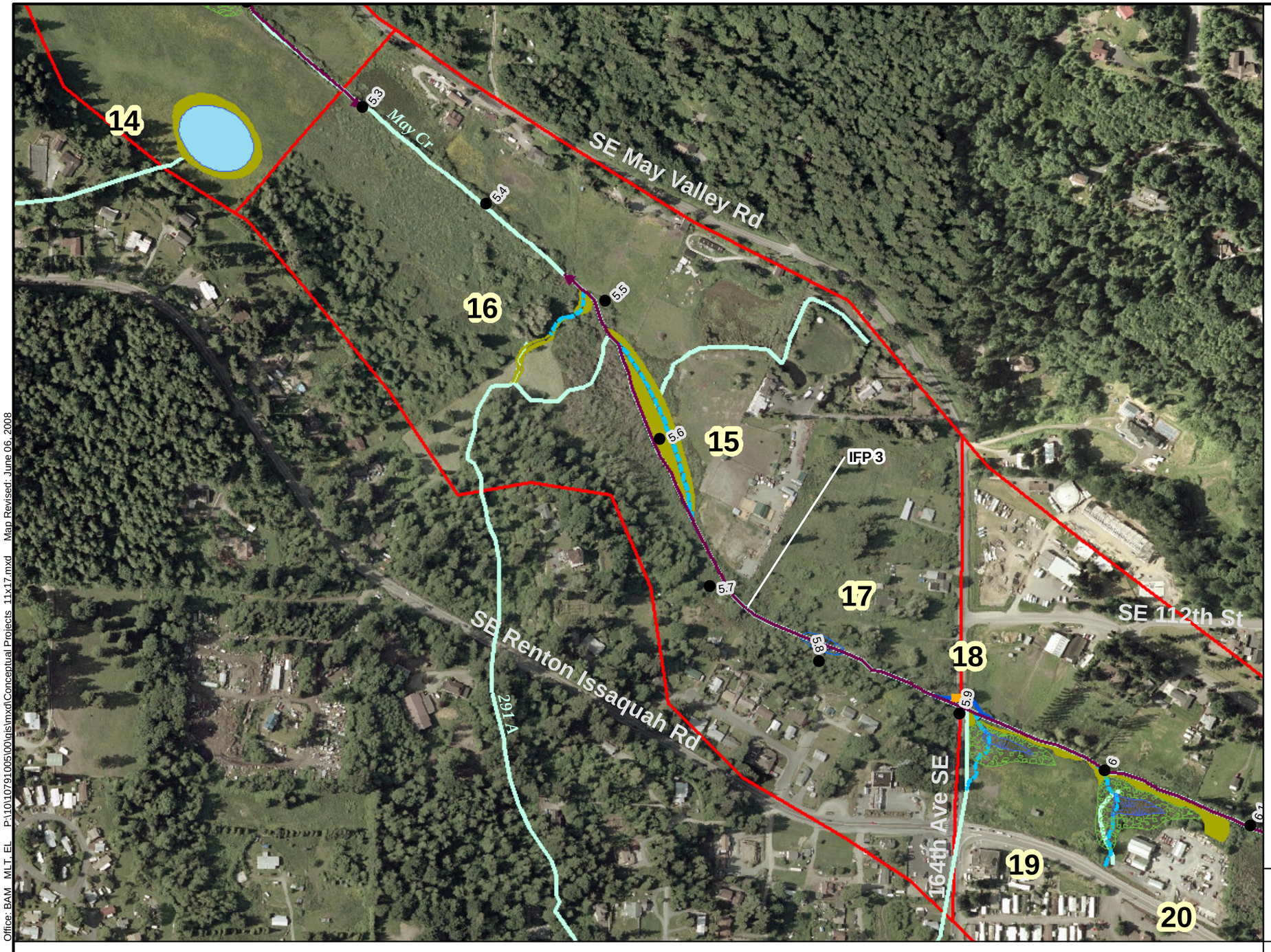

1 Project Number
4.5 River Mile 0.1 mi
Innefective Flow Projects (IFP)
New Pool Habitat
Detention Basin
Beaver Management
Culvert
Streambank Protection Erosion Control
Restored Instream Habitat
New High-Flow Channel
New Channel Alignment
New Side Channel
Riparian Features
Created Wetland
Enhanced Wetland Buffer
Watercourses 2006 (GEI)
May Valley Reaches

N

Feet
250 125 0 250

GeoEngineers

MAY CREEK HABITAT RESTORATION
Conceptual Projects Reach 3

FIGURE 15

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

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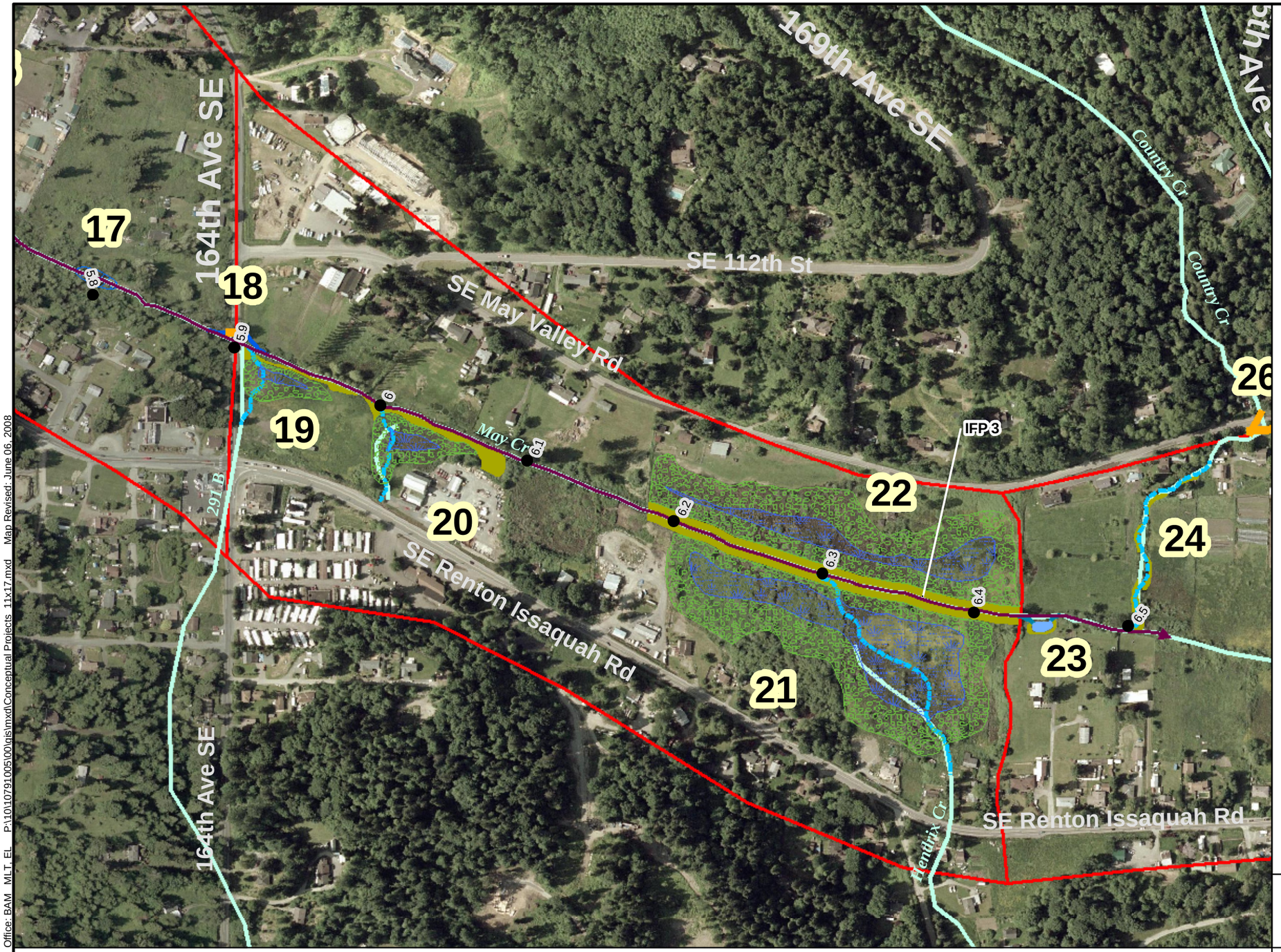
Office: BAM MLT EL P:\10\10791005\00\gis\mxd\Conceptual Projects 11x17.mxd Map Revised: June 06, 2008



1 Project Number

4.5 River Mile 0.1 mi

Innefective Flow Projects (IFP)

New Pool Habitat

Detention Basin

Beaver Management

Culvert

Streambank Protection Erosion Control

Restored Instream Habitat

New High-Flow Channel

New Channel Alignment

New Side Channel

Riparian Features

Created Wetland

Enhanced Wetland Buffer

Watercourses 2006 (GEI)

May Valley Reaches

N

Feet

250 125 0 250

GeoEngineers

MAY CREEK HABITAT RESTORATION
Conceptual Projects Reach 4

FIGURE 16

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

This map is for information purposes. Data were compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication. The locations of all features shown are approximate.

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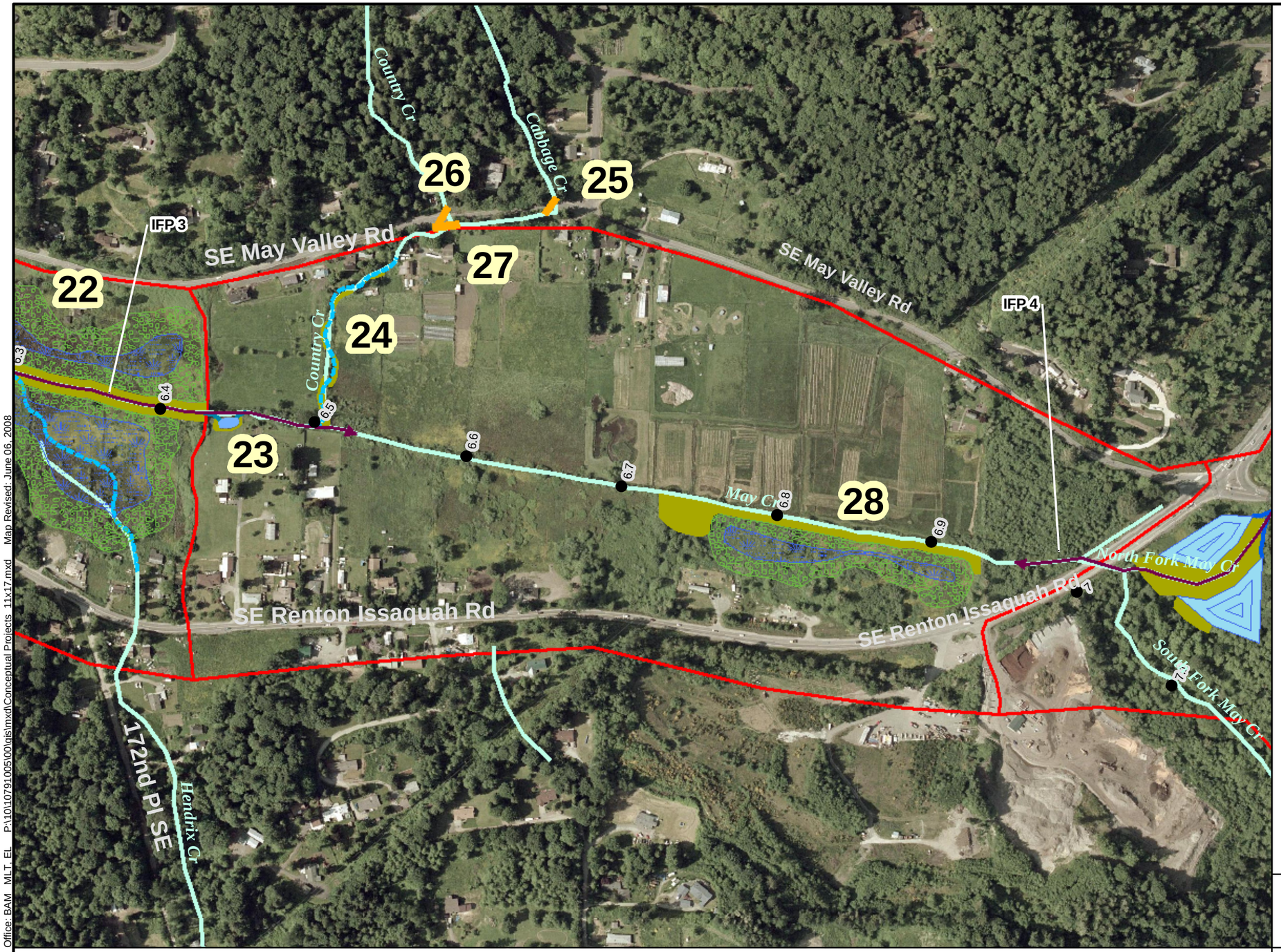

1 Project Number

River Mile 0.1 mi

Innefective Flow Projects (IFP)

New Pool Habitat

Detention Basin

Beaver Management

Culvert

Streambank Protection Erosion Control

Restored Instream Habitat

New High-Flow Channel

New Channel Alignment

New Side Channel

Riparian Features

Created Wetland

Enhanced Wetland Buffer

Watercourses 2006 (GEI)

May Valley Reaches

N

Feet

250 125 0 250

GeoEngineers

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

This map is for information purposes. Data were compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication. The locations of all features shown are approximate.

MAY CREEK HABITAT RESTORATION
Conceptual Projects Reach 5

FIGURE 17

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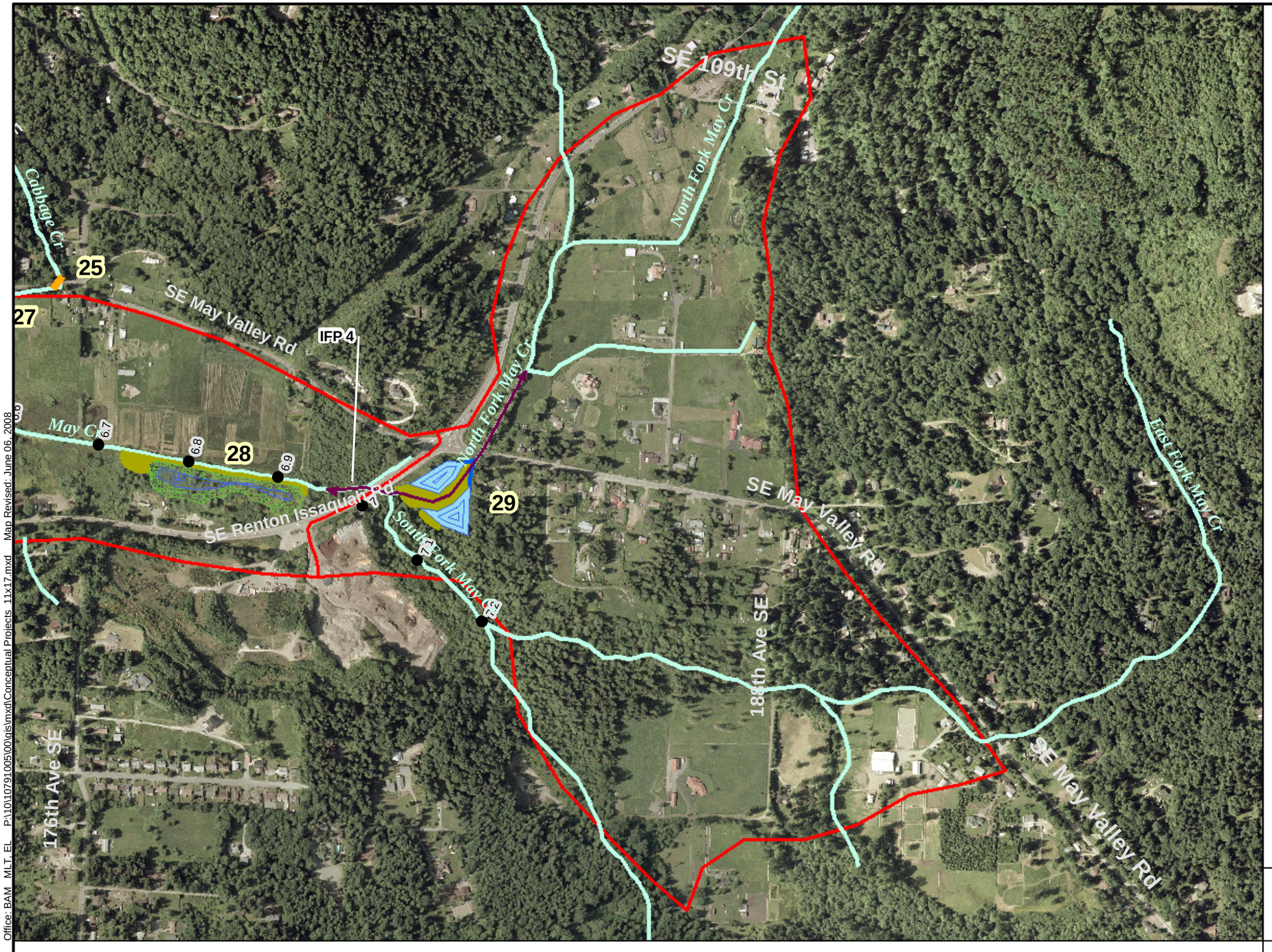

1 Project Number
River Mile 0.1 mi
Innefective Flow Projects (IFP)
New Pool Habitat
Detention Basin
Beaver Management
Culvert
Streambank Protection Erosion Control
Restored Instream Habitat
New High-Flow Channel
New Channel Alignment
New Side Channel
Riparian Features
Created Wetland
Enhanced Wetland Buffer
Watercourses 2006 (GEI)
May Valley Reaches

N

500 250 0 500 Feet

GeoEngineers

MAY CREEK HABITAT RESTORATION
Conceptual Projects Reach 6

FIGURE 18

Data Sources: Water Courses and roads from King County Department of Natural Resources. Imagery from USGS and ESRI. Reach boundaries and conceptual projects created by GeoEngineers.

This map is for information purposes. Data were compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication. The locations of all features shown are approximate.

Office: BAM MLT EL P:\10\10791005\00\gis\mxd\Conceptual Projects 11x17.mxd Map Revised: June 06, 2008

GeoEngineers

APPENDIX B
CONCEPTUAL PROJECT DESCRIPTIONS

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PROJECT 1: STREAMBANK PROTECTION AND INSTREAM HABITAT ENHANCEMENT

This project provides for streambank protection and instream habitat restoration in a 1200 linear feet section of May Creek. This area, as well as all of Reach 1, is a transitional area between the May Creek Canyon and the extremely low gradient May Valley. Runoff in the May Creek drainage has increased as the result of three decades of intense upland development and other changes. Channel downcutting and streambank erosion, loss of instream habitat, flooding and siltation are issues in Reach 1 of the May Creek Habitat Enhancement project area (Figure B-1). This project was identified as a Category H project during the prioritization process.

Site Location

The proposed project site is located between River Mile (RM) 3.95 to RM 4.12 in the SW¼ SE¼ of Section 34, Township 24 North, Range 5 East of the Willamette Meridian (T. 24 N., R. 5 E., W.M.) and in the NW¼ NE¼ of Section 3, T. 23 N., R. 5 E., W.M., in King County, near Renton Washington. The project would be completed entirely on private properties located on both banks near River Mile 4.0 (Figure 13, Appendix A). The project site begins approximately 500 feet upstream from the lower-most boundary of the May Valley sub-area and continues approximately 700 feet upstream to the 143rd Avenue SE bridge (Figure 13, Appendix A).

Site Description

This 1,200-foot section of creek has degraded fish habitat associated with erosion, head-cutting, and channel simplification (Action Plan, King County 2001). The Action Plan characterizes this section of the creek as historically prone to erosion and channel degradation. Therefore, a streambank protection and instream habitat enhancement project is proposed in this area.

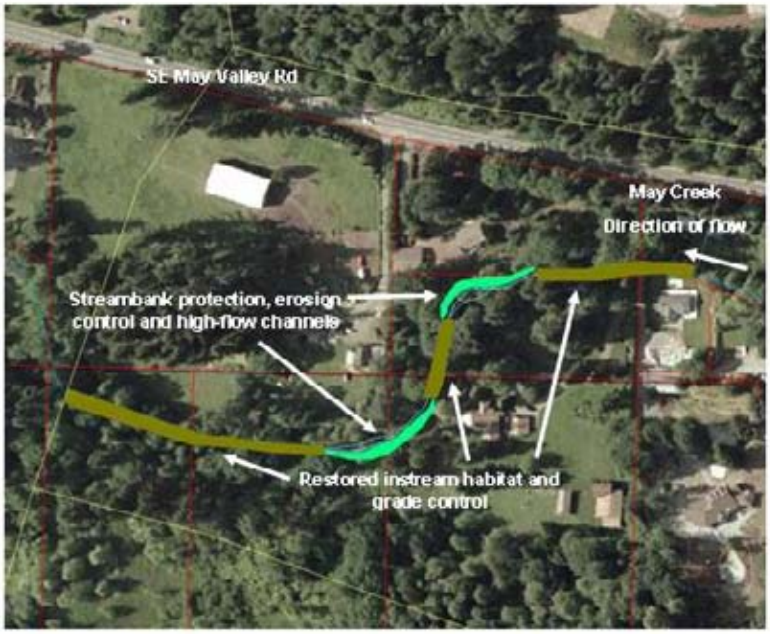
The GIS database developed by the project team supports these findings. The most prevalent features within this segment of May Creek were erosion and habitat degradation identified as part of the GIS analysis (Figure 6, Appendix A). Erosion problems and recent streambank treatments were observed during recent site visits (2007).

Project Description

Project 1 would include a combination of streambank treatments on the left bank, instream habitat and channel roughness features, and a high-flow channel braid on the right bank of May Creek. A combination of rock and wood bioengineered structures and riparian streambank treatments would be installed. It is likely that bank barbs, log-crib, and roughened channel elements would also be necessary. The project would help to stabilize the channel, reduce erosion and head-cutting, help stabilize sediment transport, and would enhance fish passage, instream habitat and riparian habitat and function. Any non-native plants found would be removed and replaced with native species.

Of any of the 6 reaches in the May Valley Subarea, this reach of May Creek is most readily accessed by anadromous salmonids. Enhancement of passage and habitat in this area is necessary to achieve upstream restoration objectives. Protection of this reach from ongoing erosion and head-cutting is recommended to avoid future impacts from upstream activities, including ongoing development and associated changes in the magnitude and volume of runoff.

Existing Channel Alignment



Conceptual Drawing of Restored Channel and Riparian Area

RED:\10\10791005\00\December 2007 Draft CRP\Figure E-1 Project 1 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 1

FIGURE B-1

Project Efficacy

Preliminary hydraulic modeling was completed to evaluate this project together with Project 2. To model the potential hydraulic changes associated with habitat restoration actions, channel roughness was increased within the project area, extending approximately 1,200 feet downstream of the 143rd bridge crossing. The existing channel roughness is estimated to be 0.04. The newly modeled roughness, which incorporates instream habitat, roughened channel features and boulder grade control is estimated to be 0.055. This hypothetical increase in roughness decreases the maximum reach-average velocity at the 2-year event (150 cfs) from 5.1 ft/s to 3.8 ft/s. This would assist in fish migration, and reduce erosional tendencies within the reach.

Models predict that local water surface elevations will increase due to these habitat features. At 150 cfs the water surface elevation is predicted to increase approximately 0.4 feet. As this portion of reach 1 does not flood during the 2-year event, changes in water surface elevation are not expected to effect flooding in the vicinity of the project. Further, models predict that there would be no upstream flood mitigating benefits from this project. However, several other benefits will be created, including:

- restoring approximately 1,200 linear feet of instream habitat,
- protecting approximately 400 feet of streambank from further erosion,
- minimizing channel headcutting through grade-control of approximately 600 feet of channel; and,
- increasing high-flow off-channel habitat area with the creation of almost 300 linear feet of channel.

Potential Challenges and Limitations

The project would need to be developed and completed on the reach scale and would not be effective if implemented only in part. Landowner access permissions would need to be secured across several private properties in order to complete the whole project. In addition, careful analysis of hydraulic and geomorphic condition at this site would be needed to determine if the reach had been significantly altered by the historic construction and operation of a mill pond in the lower portion of the reach. Even though the mill is no longer in operation, it is not evident that the reach has reached dynamic equilibrium.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley contains critical habitat areas. A critical areas assessment would need to be completed to determine the extent and function of habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $190,100 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and require placing fill in a critical area, As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations.
- Tribal and WDFW area biologist consultation

PROJECT 2: 143RD AVENUE SE BRIDGE CROSSING

Project 2 proposes to protect and enhance aquatic habitat and fish passage, while reducing headcutting and erosion risk at the proposed project site. As mentioned in Project 1, runoff in the May Creek drainage has increased as the result of three decades of intense upland development. Channel downcutting and streambank erosion is an issue in Reach 1, a transitional area between the May Creek Canyon segment and the extremely low gradient May Valley (Figure B-2). This project was identified as a Category H project during the prioritization process.

Site Location

Project 2 is located immediately downstream from a bridge crossing located at the intersection of 143rd Avenue SE and May Creek near RM 4.22 in the SE¼ of Section 34, T. 24 N., R. 5 E., W.M., of King County, near Renton Washington (Figure 13, Appendix A). The project would occur in the stream channel accessed through private property located on both banks of May Creek at the crossing.

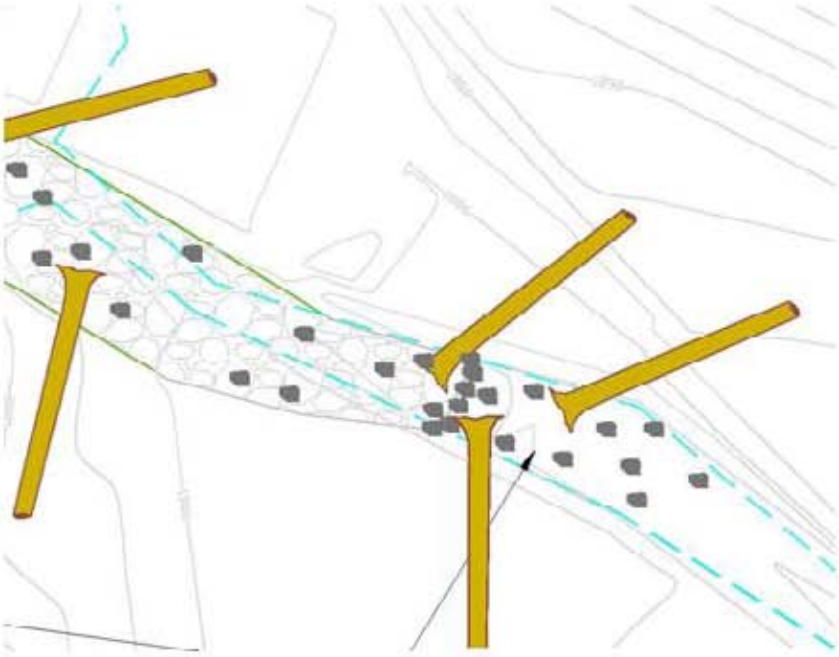
Site Description

As part of previous work at the project site to assess the potential for streambank erosion, GeoEngineers (2003) measured the opening of the open-bottom arch culvert bridge, measured as a 15-foot span with a 7-foot rise. A rectangular culvert 3 feet wide by 2 feet high was identified at a location through the embankment adjacent to the pipe arch and about 3 feet above the stream bottom. It was assumed that the rectangular culvert was installed to provide additional capacity for flood flows. GeoEngineers (2003) estimated the maximum opening of the combined culverts as approximately 83 square feet. However, it would require a water depth greater than about 3 to 4 feet above the streambank to utilize this full opening. GeoEngineers (2003) estimated only about 45 square feet of opening through the culverts for a water depth at the top of the streambank. Consequently, the culvert openings will be the limiting factor for flood flows through this channel reach.

A recently completed flood insurance study completed by Federal Emergency Management Agency (FEMA 1999) indicated that the 100-year flood elevation at the 143rd Avenue SE arch culvert had an elevation of 304.5 feet. The FEMA study also indicated a floodway width of 15 feet, a maximum section area of 78 square feet, and a mean velocity of 8.2 feet per second. FEMA data was used to compute a maximum flow depth for a 100-year event, resulting in a depth of about 3.0 to 3.5 feet at the arch culvert.

The bridge crossing over May Creek is used by several private landowners to access their residences. The bridge was constructed with concrete in the 1950's. Various activities, including bridge construction have altered hydraulic processes at the site. This has increased erosive forces, resulting in scour and erosion at the site and downstream as well as habitat simplification. This portion of May Creek was identified in Action Plan (2001) as having a stream habitat problem associated with erosion and habitat simplification. This area is also characterized in the Action Plan (King County 2001) and the Conditions Report (King County 1995) as being subject to flooding, erosion, degraded stream fish habitat and related problems. The Action Plan characterizes this section of the creek as historically prone to erosion and channel degradation. Erosion problems were observed downstream from the 143rd Avenue SE bridge during recent site visits (GeoEngineers 2007a). GeoEngineers has previously assisted landowners with erosion and flooding issues upstream from this site (GeoEngineers 2003). The GIS database developed by the project team supports these findings. The most prevalent features identified in this segment during the GIS development include erosion and habitat degradation (Figure 6, Appendix A).

Existing channel under 143rd Ave bridge



Conceptual drawing of channel and habitat bolder grade control elements

RED:\101\10791005\00\December 2007 Draft CR\Figure B-2 Project 2 JTM/WLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 2

FIGURE B-2

Project Description

This project would include installation of grade control, roughened channel, instream habitat, and bridge footer reinforcement treatments. The primary purpose of the project would be to reduce erosion and head-cutting occurring at the site to protect the bridge from failure. Secondary objectives would include improvements to fish passage and rearing habitat quality. Development of this project might serve to mitigate impacts from upslope activities, including increased runoff volume and intensity, as the result of the development of impervious surfaces in headwater areas.

Project Efficacy

The potential hydraulics effects of Projects 1 and 2 were modeled together. The projected increase in roughness was predicted to decrease the maximum reach average velocity at the 2-year event (150 cfs) from 5.1 ft/s to 3.8 ft/s. This would assist in fish migration, and reduce erosional tendencies within the reach. Local water surface elevations were predicted to increase due to these habitat features. At 150 cfs the water surface elevation is predicted to increase approximately 0.4 feet. Modeling predicted no upstream flooding benefits for this project. This result is not surprising as Projects 1 and 2 were developed to address local erosion issues and potentially serve to mitigate any effects from implementation of projects upstream.

Potential Challenges and Limitations

The existing 143rd Ave SE bridge was privately designed, constructed, and installed. The primary responsibility for the maintenance and improvement of this structure is therefore a private matter. The maintenance and improvement of the stream channel and habitat in the area of the bridge may, however, be an appropriate use of public funds. Landowners must grant permission for these projects to be implemented. Any work in or around the private bridge must, however, be coordinated with private landowners. The work should also be done in concert with other reach-based habitat enhancement and erosion control projects (see Projects 1 and 3).

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley contains critical habitat areas. A critical areas assessment would need to be completed to determine the extent and function of habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $148,500 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and require placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval, potential consultation with USFWS
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 3: STREAMBANK AND OFF-CHANNEL HABITAT ENHANCEMENT

Project 3 is another project proposed for implementation in Reach 1. This project would protect and enhance aquatic habitat and fish passage, while reducing erosion risk in a 500-linear-foot section of May Creek (Figure B-3). This project was identified as a Category L project during the prioritization process.

Site Location

The proposed project site is located at 9524 143rd Avenue SE between RM 4.12 to 4.23, in the SE¼ of Section 34, T. 24 N., R. 5 E., W.M. in King County, near Renton Washington (Figure 13, Appendix A).

Project 3 is proposed for approximately 500 linear feet of May Creek located immediately upstream from the 143rd Avenue bridge crossing May Creek. The project would occur entirely on private properties located on both banks of May Creek upstream from the 143th Avenue bridge crossing May Creek near River Mile 4.22.

Site Description

As part of previous work completed by GeoEngineers (2003) at this site, it was observed that the stream alignment causes the streamflow to impinge the left (south) streambank near the upstream (eastern) end of the retaining wall adjacent the Madfai property, at an angle of about 45 degrees. The stream then flows generally parallel with the left bank until it passes under the open-bottom arch culvert under 143rd Avenue SE. In 2003 GeoEngineers observed undercutting 1 to 2 feet back into the bank just beyond the downstream end of a masonry block wall. Loose to medium dense, fine to medium sand was observed down to approximately 2 feet below the ground surface behind and adjacent the block wall. In 2007 GeoEngineers (2007a) observed a 500-linear-foot section of May Creek with a combination of erosion (1 to 2 feet, left bank) and degraded instream and riparian habitat.

GeoEngineers (2003) completed cross-sectional measurements of the site as part of the erosion risk evaluation. Cross-sections indicate that there is considerable overflow capacity along the right side of the stream to provide additional flow capacity during high flow periods. The cross-sections indicated an available channel area of approximately 80 to 90 square feet below the elevation of the top of the masonry block wall. GeoEngineers measured the opening of the open-bottom arch culvert at the western side of the property as approximately a 15-foot span with a 7-foot rise. A rectangular culvert 3 feet wide by 2 feet high, is located through the embankment adjacent to the pipe arch and about 3 feet above the stream bottom. We assume that the rectangular culvert was installed to provide additional capacity for flood flows. We have estimated the maximum opening of the combined culverts as approximately 83 square feet. However, it would require a water depth greater than about 3 to 4 feet above the streambank to utilize this full opening. We estimate only about 45 square feet of opening through the culverts for a water depth at the top of the streambank. Consequently, the culvert opening was determined to be the limiting factor for flood flows through this channel reach.

GeoEngineers (2003) determined that there is a significant risk of loss of property and damage to the Madfai residence without the presence of substantial bank protection. The loose, sandy soils comprising the left streambank are very easily eroded. Furthermore, the impingement angle of the primary channel is such that at high flows the unprotected bank will erode rapidly. The residence is less than 25 feet from the streambank and the deck is only 13 feet from the bank. GeoEngineers (2003), therefore, determined that the risk to the residence and appurtenant structure is very significant if the masonry block wall were to be removed. This risk is evident in the erosion presently occurring at the downstream end of the masonry blocks.

This portion of May Creek was identified in the Action Plan (King County 2001) as having a stream habitat problem associated with erosion and habitat simplification. This area is also characterized in the Action Plan and the Conditions Report (King County 1995) as being subject to flooding, erosion, degraded stream fish habitat and related problems. The Action Plan characterizes this section of the creek as historically prone to erosion and channel degradation.

The GIS database developed by the project team supports these findings. The most prevalent features identified in this segment during the GIS development include erosion and habitat degradation (Figure 6, Appendix A). Erosion problems and recent streambank treatments were observed during recent (2007) site visits.

Project Description

This project would include the installation of a combination of rock and wood bioengineered structures, and create a high-flow side-channel habitat area along the right bank of May Creek, away from the private property. The project would help stabilize the channel and stabilize sediment transport, and would enhance fish passage, instream habitat and riparian habitat and function. Any non-native plants found would be removed and replaced with native species. This reach of May Creek is presently the most readily accessed by anadromous salmonids. Enhancement of passage and aquatic habitat will be necessary to achieve upstream restoration objectives. Protection of this reach from ongoing erosion and head-cutting is recommended to avoid any potential impacts from upstream activities, including ongoing development and associated changes in the magnitude and volume of runoff.

Project Efficacy

Based on recent modeling completed for Project 3, the project incorporates a high flow side channel on the right bank for approximately 500 feet upstream of the 143rd crossing. This was modeled by slightly increasing the channel roughness from 0.04 to 0.045 to account for habitat structures and also by altering the right overbank geometry to create a 3-foot deep side channel with a 10-foot bottom width and 3:1 side slopes. The assumed roughness for this channel is 0.045. The side channel was designed to capture flows once the water surface elevation of existing condition situation for 100 cfs is exceeded. The bottom elevation of the side flow channel was set at 305.4 feet at station 3571. Ineffective flow areas were removed in order to convey water through the high flow channel. The slope of the high flow channel was set at 0.0057 ft/ft which is the slope of the hydraulic grade line for 100 cfs through the reach.

The hydraulic results for this project indicate a marginal decrease in maximum velocity (5.75 ft/s to 5.57 ft/s) within the reach for the 2-year (150 cfs) flow rate. Further upstream near the beginning of the side channel the reach average velocity for the 150 cfs flow is reduced from 2.773.9 ft/s to 2.23.4 ft/s. The water surface elevations show mixed results for the side channel project. At the upstream end of the project there is an expected 0.3-2 foot rise over existing conditions for 150 cfs. This rise propagates upstream approximately 300 feet. Within the project reach, it is anticipated that there will be a 0.253-foot drawdown of the water surface profile at 150 cfs.

Based on the modeling, there would be no upstream flood mitigation benefits expected from this project. However, there are other benefits that would come from the project including:

- approximately 483 feet of restored instream habitat,
- 265 feet of protected stream bank from erosion,
- creation of a new high-flow channel, and
- approximately 14,912 feet of restored riparian area.

Existing Channel Conditions

Conceptual Drawing of Restored Channel and Riparian Area

GEOENGINEERS
Earth Science + Technology

Conceptual Drawing Project 3

FIGURE B 3

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Potential Challenges and Limitations

The project would need to be developed and completed on the reach scale and would not be effective if implemented only in part. Coordination of permissions to access the site via several private properties would be required to complete this project as a whole. Landowners must grant permission for these projects to be implemented. Reach and site-specific modeling, design, permitting, and funding of construction would also be required.

One residence along this reach of May Creek was constructed within 25 feet of the streambank, with a deck within 13 feet of the bank. Design and construction of instream habitat, streambank protection, and riparian areas would need to consider this spatial limitation. Work will need to be designed in a manner that does not undermine the 143rd Avenue SE bridge or other areas of May Creek upstream or downstream.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley contains critical habitat areas. A critical areas assessment would need to be completed to determine the extent and function of habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $145,700 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will result in fill to a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 4: HYDRAULIC CONTROL AND HIGH-FLOW CHANNEL

Project 4 is another project proposed for implementation in Reach 1. This project proposes to create a high-flow channel to improve conveyance through a very low gradient section of May Creek (Figure B-4). This project was identified as a Category C project during the prioritization process.

Site Location

The proposed Project 4 is located between May Creek RM 4.29 and 4.39 in the NE¼ NE¼ of Section 3, T.23 N., R. 5 E. and SE¼ SE¼ of Section 34, T. 24 N., R. 5 E., W.M. in King County, Washington. The site is at the confluence of May Creek and Tributary 287-D immediately downstream from the 148th Avenue SE bridge crossing May Creek (Figure 13, Appendix A). The site would include approximately 500 linear feet of May Creek and be completed entirely on private properties located on the right bank (north side) of May Creek near River Mile 4.3.

Site Description

This section of May Creek is an undersized channel with ongoing loss of channel capacity as the result of sediment deposition and encroachment or reed canarygrass and other riparian vegetation. Based on the Conditions Report (King County 1995), a bedrock hydraulic control is present at the downstream end of this site, serving as the gradient control for RM 4.4 through approximately RM 7.0. Both sides of the creek are degraded wetland habitat. As noted in the Conditions Report (King County 1995), this area was historically a coniferous-forested wetland, but it is used to manage stormwater through the Stonegate Drainfield. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland.

This portion of May Creek was identified in Action Plan (2001) as having a stream habitat problem. This area is also characterized in the Action Plan (2001) and the conditions report as being subject to flooding, erosion, stream fish habitat, sediment deposition, wetland habitat and related problems due to the low gradient and prevalence of fine sediment.

The GIS database developed by the project team supports these findings. The most prevalent features identified in this section during GIS development include channel constriction caused by the encroachment of vegetation and the accumulation of silt (Figure 6, Appendix A). Reed canarygrass (a non-native noxious weed) was observed during site visits to be the primary wetland an riparian habitat feature at the site (GeoEngineers 2007a). This highly invasive non-native species has been known to grow so aggressively that it eliminates competing, native species (Apfelbaum and Sams 1987). It is regarded as significant problem to the conveyance of water because it reduces velocities and can increase siltation (Marten and Heath 1973).

Project Description

This project would include the installation of a new high-flow channel and restored riparian area along the right bank of May Creek (Figure B-4). The existing channel will not be modified. This project would be designed to help convey water out of the drain-field following periods of prolonged inundation. This project would also be designed to avoid any change in the channel plan-form or gradient. The reported bedrock hydraulic control at RM 4.3 would not be changed. The new high-flow channel would be designed to work in parallel with this existing grade control feature, thereby protecting the channel profile upstream for headcutting, and the downstream channel from excessive runoff and sediment transport.

Existing Channel Conditions

Conceptual Drawing of Restored Channel and Riparian Area

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GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 4

FIGURE B-4

Project Efficacy

Recent preliminary hydraulic modeling completed by OTAK (2006) as part of this project revealed areas of ineffective flow in this reach of May Creek, suggesting that issues identified in the Action Plan can be expected to persist unless addressed.

More recent modeling to evaluate project efficacy assumed that the project would include construction of approximately 500 feet of high flow bypass channel on the right overbank of May Creek approximately 450 feet downstream from the 148th Street bridge crossing. This portion of May Creek has virtually no slope. The channel slope from the 148th Street bridge downstream to the bridge to a survey point just downstream of this project site was estimated as 0.00083 ft/ft. The total drop over the 870- foot reach was calculated to be 0.72 feet.

The constructed side channel was assumed to be two feet deep and set at an elevation of 305 feet with a 10-foot bottom width and 3:1 side slopes. The constructed channel Manning roughness was estimated to be 0.045, the same value as the existing channel roughness for moderate flow regimes (50 to 150 cfs) over the reed canarygrass.

Based on modeling results this project would be expected to help mitigate flooding of May Creek in the vicinity of the project. The anticipated drawdown for a discharge of 50 cfs in this reach would be 0.25 feet. This drawdown effect would decrease with increasing discharge at 150 cfs. The flood stage drawdown would be 0.16 feet. Another hydraulic effect of this project would be a decrease in-channel velocity as flood flows would be split between two channels. This would reduce transport capacity in the reach and exacerbate further sedimentation. Channel velocity in the immediate vicinity of the project, at 150 cfs design flow, was predicted to be 1.46 ft/s versus 1.61 ft/s for the existing conditions scenario. The velocity in the right overbank region would be increased. With the construction of the high flow bypass channel modeling predicts an increase in velocity from 0.43 ft/s to 1 ft/s. Such an increase may assist in mitigating some of the sedimentation issues at this site.

Other benefits from the project would include the construction of approximately 479 linear feet of new high-flow channel and 10,139 square feet of restored riparian area.

Potential Challenges and Limitations

GeoEngineers was provided guidance that the reported hydraulic control near RM 4.3 (Action Plan 2001) should not be disturbed. Work in this area will need to be done in coordination with land managers and landowners. Landowners must grant permission for these projects to be implemented. Contact has been made with two of the landowners, but not with a third private landowner. Permission from all owners will be required to access or construct a project at the lower end of this site.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $43,500 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM) and will require placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 5: WETLAND ENHANCEMENT/REED CANARYGRASS ABATEMENT

Project 5 would help improve water conveyance through a very low-gradient, reed canarygrass choked reach of May Creek located below the 148th Avenue SE bridge (Figure B-5). Project 5 would work together with Project 4 in Reach 1. This project was identified as a Category F project during the prioritization process.

Site Location

The proposed project site is located between May Creek RM 4.43 and 4.45 in SE¼ of Section 34, T. 24 N. R. 5 E., W.M., King County, Washington. The site is located near the confluence of May Creek and Greene's Creek, on the right bank, just downstream from 148th Avenue SE (Figure 13, Appendix A).

Site Description

The project proposes to enhance a degraded wetland located on the right bank of May Creek. It is reported in the Conditions Report (King County 1995) that historic landuse in the area eliminated a conifer and deciduous-based forested wetland previously existing at the site. The wetland remaining at the site is predominantly reed canarygrass and willow with limited other shrubs and forbes (GeoEngineers 2007a). The section of May Creek flowing past the wetland is an undersized channel with ongoing loss of conveyance capacity as the result of sediment deposition and encroachment of reed canarygrass in the channel. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland (Figure 6, Appendix A).

Project Description

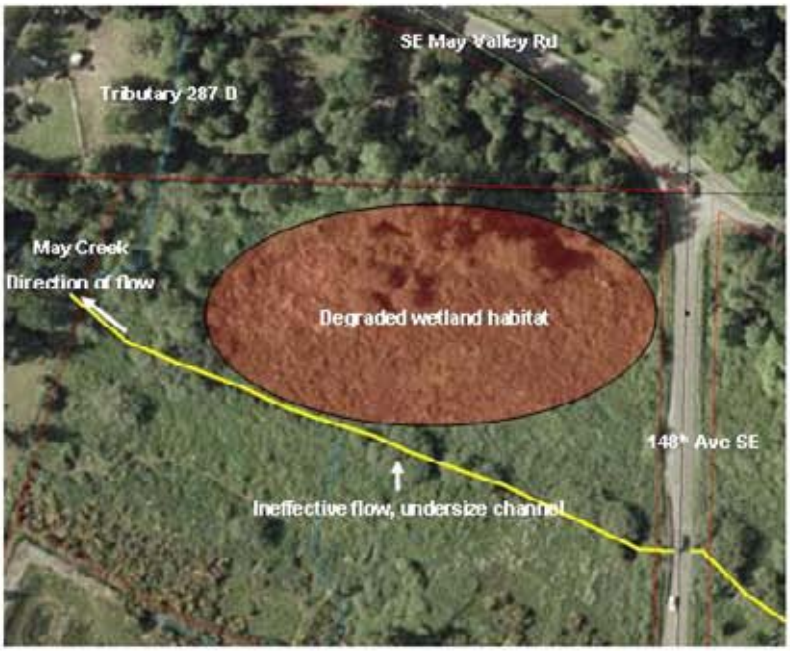
This project would include removing reed canarygrass from the stream channel and surrounding area and planting native wetland and riparian species to help restore a forested wetland along the right bank of May Creek (Figure B-5). The existing channel would not be modified at the site as part of this project. This project would be designed to help assimilate flood water, assimilate nutrients, and provide significantly improved riparian and wetland habitat. Fish passage will be improved by reducing the amount of reed canarygrass encroaching on the stream channel.

Project Efficacy

A hydraulic model was used to evaluate the efficacy of Project 5, assuming a 1-foot deep swale approximately 200 feet wide and 500 feet long along the longitudinal direction of the channel. Such a swale would result in an approximate 2.5 acre area. Flow through this area would be considered ineffective until the overbank stage was exceeded. At the overbank flow point, there would be skimming flow into the swale above the wetland stage.

The Santa Barbara Unit Hydrograph method was utilized to account for storm runoff changes due to the land use change. The runoff curve number was changed from 85 to 80 to account for the land use change. This curve number adjustment was made assuming a hydrologic type C soil and converting the land use from meadow/pasture to young second growth or brush forest land (King County 1992). It was anticipated that such a land use change would reduce flood runoff from this 2.52-acre site by approximately 54 percent for a 2-year, 24-hour precipitation event of 2 inches. The peak runoff rate would be decreased from 0.26 cfs to 0.12 cfs. This would help attenuate downstream flood flows.

According to the HEC-RAS analysis, this project would also help to lower local flooding levels by 0.23 feet for the 150 cfs flow. Reach average channel velocity would decrease from 1.67 ft/s to 1.51 ft/s for the 150 cfs flow rate within the reach due to the forest wetland detention of flood flows.



Existing Conditions

Conceptual Drawing of Restored Wetland and reed canarygrass abatement project

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Earth Science + Technology

Conceptual Drawing Project 5

FIGURE B-5

Model results indicated that the project would have no effect on upstream flood levels. The project, however, would have other benefits including the enhancement of 20,789 square feet of riparian habitat, as well as enhancement of 25,123 square feet of wetland and 85,080 square feet of wetland buffer habitat.

Potential Challenges and Limitations

GeoEngineers was provided guidance that the reported hydraulic control near RM 4.3 (Action Plan 2001) should not be disturbed. Work in this area will need to be done in coordination with land managers and owners. Landowners must grant permission for these projects to be implemented. Over 1 acre of area would be disturbed, requiring additional permitting and regulatory agency coordination steps.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $69,000 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will require placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would likely disturb over 1 acre of ground. This would, therefore, create additional permitting steps including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES), securing a Construction Stormwater General Permit.

PROJECT 6: GREENE'S CREEK CONFLUENCE PROJECT - POND/WETLAND ENHANCEMENT

Project 6 proposes to help address flooding in the project vicinity by improving wetland and riparian habitat in this reed canarygrass choked reach of the May Valley located downstream from the 148th Avenue SE bridge (Figure B-6). Project 6 would complement the projected effects of Project 5 in this area. Project 6 was identified as a Category F project during the prioritization process.

Site Location

The proposed project site is located between May Creek RM 4.33-4.45, in SE¼ of Section 34, T. 24 N., R. 5 E., W.M. in King County, WA. The site is located upstream from the confluence of May Creek and Greene's Creek, on the left bank, just downstream from 148th Avenue SE (Figure 13, Appendix A).

Site Description

The site is a degraded wetland on the left bank of May Creek. It is reported in the Conditions Report (King County 1995) that landuse in the area degraded the conifer and deciduous-based forested wetland that likely previously existed at the site. The present wetland is predominantly reed canarygrass and willow, with limited other shrubs and forbes. The section of May Creek adjacent this wetland is an undersized channel with ongoing loss of channel capacity as the result of sediment deposition and encroachment of reed canarygrass and other riparian vegetation (Figure 6, Appendix A). This area no longer functions as a forested wetland, but it does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. The abundance of vegetation and deposition of silt in this area has eliminated a clear confluence area of May Creek and Greene's Creek.

Project Description

This project would require the removal of reed canarygrass from the Greene's Creek stream channel and surrounding area and the planting of native wetland and riparian vegetation to help restore a forested wetland along the left bank of May Creek near the Greene's Creek confluence area (Figure B-6). The project would restore connectivity between May Creek and Green's Creek by creating a new channel through a constructed wetland and a new May Creek confluence area. It may also be possible to route Green's Creek through the existing storm water retention pond located southwest of the proposed site, to further enhance retention capabilities of this project. The existing May Creek channel would not be modified. This project would be designed with the intent to better assimilate flood water and nutrients in both May Creek and Greene's Creek. The project would also be designed to help maintain a free-flowing stream channel, and to significantly improved riparian and wetland habitat. Another purpose of the project would be to improve fish passage by reducing the amount of silt and vegetation clogging the channel.

Project Efficacy

The potential hydraulic effects of the project were modeled by simulating the excavation a 1-foot deep swale using the approximate dimensions of the basin to be 210 feet in width and 650 feet along the longitudinal direction of the stream, resulting in 3.27 acres of project site. Modeling results indicated that local flood levels would drop 0.64 feet for the 2-yr flood and velocities would decrease from an average channel velocity of 1.61 ft/s to 0.76 ft/s for the 150 cfs flow, as flood flows are dissipated over the forested wetland. The flow area would be considered ineffective flow until the overbank stage was exceeded. At this point there would be skimming flow above the wetland stage.

Existing Conditions

Conceptual Drawing of Restored Wetland and reed canarygrass abatement project

RED:\13\10791005\00\December 2007 Draft CRP\Figure B-6 Project 6 JTM/MLT 12th 7:07

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Earth Science + Technology

Conceptual Drawing Project 6

FIGURE B 6

The Santa Barbara Unit Hydrograph method was utilized to account for storm runoff changes due to the land use change. The runoff curve number was changed from 85 to 80 to account for the land use change. This curve number adjustment was made assuming a hydrologic type C soil and converting the land use from meadow/pasture to young second growth or brush forest land (King County 1992). It is anticipated that this land use change would reduce flood runoff from this 3.27-acre site by approximately 54 percent for a 2-year, 24-hour precipitation event of 2 inches. The peak runoff rate would be decreased from 0.34 cfs to 0.18 cfs. This would help attenuate downstream flood flows.

The project would also provide over 140,000 square feet of combined created wetland and enhanced wetland buffer.

Potential Challenges and Limitations

The reported existing hydraulic control should not be disturbed. Work in this area will need to be coordinated with the land owners and managers. Landowners must grant permission for these projects to be implemented. The project would need to be designed to work in concert with an existing stormwater pond, located to the west of Green's Creek. Over 1 acre of area would be disturbed, requiring additional permitting and regulatory agency coordination steps.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $59,800 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will require placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project is expected to disturb over 1 acre of ground. As a result, additional permitting steps will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES), securing a Construction Stormwater General Permit.

PROJECT 7: 148TH AVENUE SE HIGH-FLOW CONVEYANCE PROJECT

Project 7 was developed in an effort to alleviate flooding over 148th Avenue SE and reduce backwater effects that may be worsening flooding upstream. This project proposes to improve conveyance under 148th Avenue SE utilizing a high-flow channel and culvert on the right (north) bank of May Creek (Figure B-7). This project was identified as a Category A project during the prioritization process.

Site Location

The proposed project site is located between May Creek, RM 4.39 to 4.55 in the SE¼ of Section 34 and the SW¼ of Section 35, T. 24 N., R. 5 E., W.M., in King County, Washington. The site is at 148th Avenue SE, and extends approximately 500 feet upstream and downstream of 148th Avenue SE (Figure 14, Appendix A).

Site Description

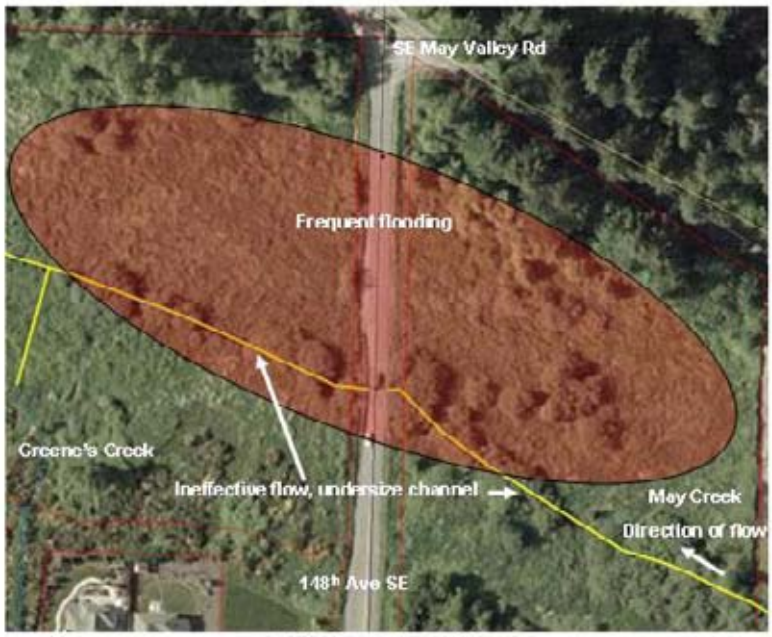
The proposed project located at 148th Avenue SE and traverses degraded wetlands located on the right (north) bank of May Creek, both upstream and downstream of 148th Avenue SE. The Conditions Report (King County (1995) indicates that landuse changes in the area resulted in degradation of a coniferous and deciduous-based forested wetland likely previously present at the site. The present-day wetland is predominantly composed of reed canarygrass and willow. This section of May Creek is an undersized channel with ongoing loss of channel capacity as the result of sediment deposition and encroachment of reed canarygrass (Figure 6, Appendix A). This area no longer functions as a forested wetland, but it does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. The area frequently floods (Figure B-7).

Project Description

This project would primarily address flooding by creating a high-flow channel and culvert through 148th Avenue SE north of the existing May Creek bridge crossing (Figure B-7). The project would also provide habitat benefits creation of off-channel habitat for fish, and creation of riparian habitat adjacent to the created high-flow channel. The new high-flow channel project would not alter the existing bridge crossing or the existing May Creek channel alignment. This project would help reduce flooding, sediment deposition, and loss of channel capacity upstream from 148th Avenue SE.

Project Efficacy

HEC-RAS multiple opening analysis was utilized to evaluate the effectiveness of the bypass channel proposed by this project. A 10-foot-wide by 4-foot-tall box culvert was added on the right (north) bank and was assumed to have a Manning "n" of 0.04 for the stream simulation culvert. The culvert invert elevation was set 306.5 feet at the upstream side of the crossing and incorporates a 0.2-foot drop across the crossing. The modeling results suggest that the bypass channel would increase upstream channel velocities from 1.73 ft/s to 2.4 ft/s for the 2-year, 150 cfs event. This should help to alleviate some of the sedimentation problems in this area. At the downstream end of the 148th crossing this project would reduce in-channel velocities because of the flow split. For the 2-year event, the velocity is reduced from 5.49 ft/s to 3.84 ft/s. The upstream water surface elevations would be reduced locally. The magnitude and upstream extent of the flood stage reduction would increase with increasing discharge. For example, at 50 cfs, models predicted a water surface drop of 0.1 foot, extending approximately 300 feet upstream. At 150 cfs, the water surface was predicted to drop 0.5 feet and extend 600 feet upstream. At 300 cfs, approximately a 5-year event on this reach of May Creek, the hydraulic effects are stronger and flood stage is reduced approximately 0.5 feet and the flood reduction was projected to extend approximately 1,000 feet upstream.



Existing Conditions

Conceptual Drawing of high-flow channel and culvert

RED:\\C\10791005000\December 2007 Draft CRP\Figure B-7 Project 7 JTM/MLT 12/17/07

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Earth Science + Technology

Conceptual Drawing Project 7

FIGURE B-7

Potential Challenges and Limitations

Work in this area would need to be well coordinated with traffic management to minimize traffic congestion on or close to 148th Avenue SE. This road is heavily used and long-term closure would not be well received by residents or others that frequent the area. King County may already be considering bridge or road improvements in the area. Therefore, any work completed as part of this project should be coordinated with any 148th Avenue SE bridge and road maintenance to be completed by King County. Coordination with county roads staff will be required to avoid duplication of effort, and to minimize any potential traffic-flow impacts.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Conceptual Designs and Planning-Level Cost Estimates

Estimated Construction Costs: $243,500 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will require placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project also would be expected to disturb over 1 acre of ground. As a result, additional permitting steps will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES) for securing a Construction Stormwater General Permit.

PROJECT 8: WETLAND ENHANCEMENT/REED CANARYGRASS ABATEMENT PROJECT

Project 8 proposes to help address flooding in the project vicinity by improving wetland and riparian habitat in this reed canarygrass choked reach of the May Valley above the 148th Avenue SE bridge (Figure B-8). Project 8 may complement the projected effects of Projects 4 and 7 if also implemented. This project was identified as a Category N project during the prioritization process.

Site Location

The proposed site is located between RM 4.45 to 4.57 of May Creek, being within the SW¼ of Section 35, T. 24 N., R. 5 E., W.M., in King County, Washington. The site is upstream of 148th Avenue SE on the right and left banks of May Creek (Figure 14, Appendix A).

Site Description

The site is currently a degraded wetland on both banks of May Creek. Based on the Current Conditions Report, landuse in the area eliminated the coniferous and deciduous-based forested wetland likely historically present at the site. The wetland presently is predominantly reed canarygrass and willow, with few other shrubs and forbes. This section of May Creek is an undersized channel with ongoing loss of channel capacity as the result of sediment deposition and encroachment of reed canarygrass and other riparian shrubs (Figure 7, Appendix A). This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. The area frequently floods.

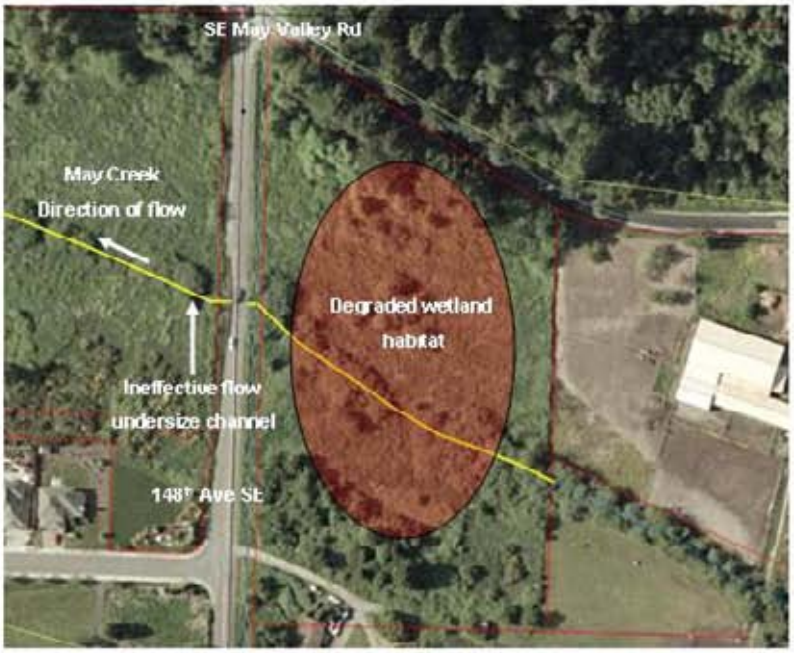
Project Description

This project would primarily focus on removing reed canarygrass and planting native wetland species in an attempt to restore the forested wetland and buffer adjacent to May Creek (Figure B-8). Removal of the reed canarygrass would reduce flooding and sediment deposition by allowing for better conveyance of water; improve water quality; and improve riparian and wetland habitat at the site. By minimizing vegetative encroachment on the stream channel, this project would also improve fish passage to other high fish use areas upstream in May Creek.

The existing May Creek channel would not be modified. This project would be designed to better assimilate flood water and sediment approaching the 148th Avenue SE and to work in conjunction with Project 7 and IPR 1.

Project Efficacy

The effectiveness of Project 8 was evaluated using approximate dimensions of the wetland depression as 370 feet in width and 260 feet along the longitudinal direction of the stream. This complex spans both sides of the stream and the resulting average flow path was estimated as approximately 200 feet. The total area of the wetland complex was estimated to be 1.6 acres. The flow area was considered to be ineffective flow until the overbank stage was exceeded. At this point there would be skimming flow above the wetland bottom. The Santa Barbara Unit Hydrograph method was utilized to account for storm runoff changes due to the land use change. The runoff curve number was changed from 85 to 80 to account for the land use change. This curve number adjustment was made assuming a hydrologic type C soil and converting the land use from meadow/pasture to young second growth or brush forest land (King County 1992). Results of hydraulic modeling analyses suggest that the anticipated land use change would reduce flood runoff from this 1.61-acre site by approximately 54 percent for a 2-year, 24-hour precipitation event of 2 inches. The peak runoff rate would be decreased from 0.167 cfs to 0.091 cfs. This would help attenuate downstream flood flows.



Existing Conditions

Conceptual Drawing of Restored Wetland and reed canarygrass abatement project

RED:\\10791005\00\December 2007 Draft CRP\Figure B-8 Project 8 .TM/MLT 12/17/07

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Conceptual Drawing Project 8

FIGURE B-8

This project was modeled by excavating a swale with a bottom depth that is one foot lower than the adjacent overbank elevation for nearby May Valley survey transects. The swale was assumed to have 20:1 side slopes, a width of 50 feet on the left bank side and 185 feet on the right bank side. Modeling results indicated that this project would slightly increase flood stage elevations for the 2-year event locally on the order of 0.1 feet. Modeled velocities decreased upstream of the detention feature (2.1 ft/s (existing) vs. 2.0 ft/s (proposed)) and increased in the vicinity of the detention feature (1.5 ft/s for existing conditions vs. 1.99 ft/s for the proposed project conditions. The reach average velocity increases minimally from 1.9 ft/s to 1.96 ft/s.

Based on modeling results, the proposed project would provide better velocity continuity within the reach. The project would also provide about 56,000 square feet of enhanced wetland, 6,300 square feet of created wetland and 64,000 square feet of enhanced wetland buffer.

Potential Challenges and Limitations

The landowner has not been contacted for permission to further develop this project. Landuse at the site is presently open-space wetland. The project proposes to restore forested wetland and buffer over the majority of the parcel, possibly precluding other uses. Alternative designs should be developed to accommodate landuse plans of the landowner/manager. Landowners must grant permission for these projects to be implemented. It is likely that over 1 acre of area would be disturbed, requiring additional permitting and regulatory agency coordination steps.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Conceptual Designs and Planning-Level Cost Estimates

Estimated Construction Costs: $148,300 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will require placing fill or working in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project is expected to disturb over 1 acre of ground. As a result, additional permitting steps may be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES) to secure a Construction Stormwater General Permit.

PROJECT 9: LONGMARSH CREEK ENHANCEMENT PROJECT

Project 9 proposes to help address flooding in the project vicinity by reducing sediment transport for Longmarsh Creek into May Creek. This would be accomplished by improving instream and riparian habitat conditions in lower Longmarsh Creek (Figure B-9). This project was identified as a Category K project during the prioritization process.

Site Location

The proposed Project 9 is located at the May Creek – Long Marsh Creek confluence area near RM 4.6 in the SW¼ of Section 35, T. 24 N., R. 5 E., W.M. in King County, Washington (Figure 14, Appendix A). The site includes the lowermost 500 feet of Long Marsh Creek up to the SE May Valley Road culvert (Long Marsh Creek RM 0 to 0.1).

Site Description

The site includes one of the few open, free-flowing, gravel-bottomed segments of May Creek in the May Valley subarea. The gravel source is Long Marsh Creek, flowing into May Creek from the north (right) bank at approximately RM 4.6. Riparian and instream habitat in May Creek and Long Marsh Creek have been degraded. There is very little riparian vegetation between RM 0 and 0.1 on Long Marsh Creek, below the culvert under the SE May Valley Road. Long Marsh Creek is eroding, often contributing large amounts of sediment to May Creek (Figure 7, Appendix A). Mature trees growing along May Creek provide shade and help maintain the free-flowing channel in this reach.

Project Description

This project would install a variety of bioengineered structures, meanders and a pool in Longmarsh Creek to move toward a more stable geomorphic regime in this tributary stream, between RM 0 to RM 0.1. These added features would enhance instream and riparian habitat throughout Long Marsh Creek. Water quality should also improve as the habitat is restored, through the reduction of total suspended solids, including a reduction in animal waste. In addition to improving habitat in this tributary stream, the project would also help to maintain a free-flowing stream channel in May Creek. The free-flowing channel would result in a reduced sediment load to May Creek at the confluence and, as a result, reduce upstream flooding.

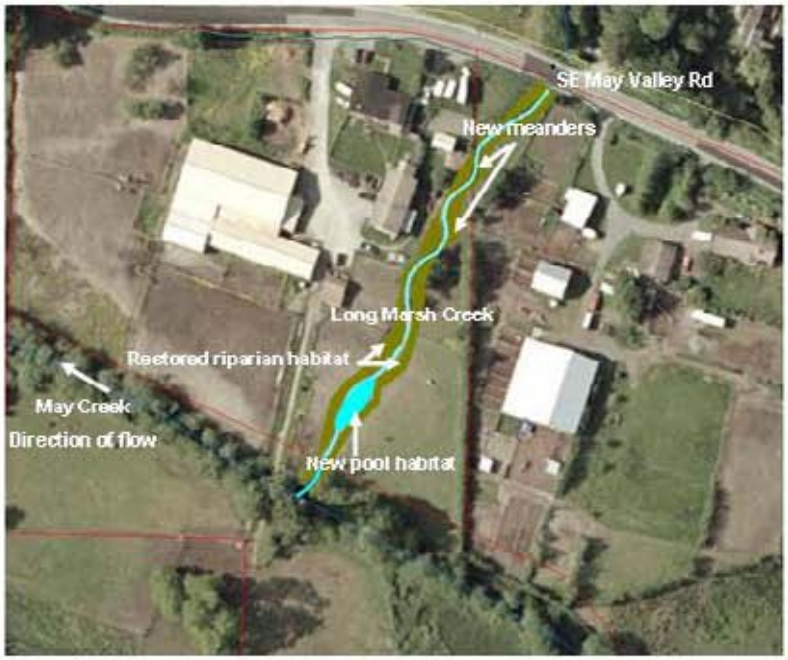
Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. Qualitatively speaking, reducing sediment loading from this unstable tributary would be expected to help reduce local flooding issues and improve downstream habitat. Further investigation into this project would be worthwhile. The project would also create about 541 linear feet of new channel, 1,400 square feet of new pool habitat and 9,200 square feet of restored riparian habitat.

Potential Challenges and Limitations

This project would occur on lands owned by two private parties. The land is being actively used for residential and livestock purposes. Landowners must grant permission for these projects to be implemented. Some of the area used by livestock would need to be converted to streambed and riparian area or at least fence to restrict livestock use for this project to succeed. It is unknown if enhancement of this tributary would be of interest to landowners. A number of private properties have been up for sale in this area. There are uncertainties about landowner contact information at the time this report was written.

Existing Channel Conditions



Conceptual Drawing of Restored Channel and Riparian Area

RED:\101079100500\December 2007 Draft CR\Figure B-9 Project S JTM/WLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 9

FIGURE B-9

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $69,900 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will require placing fill to a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 10: TSEGAY WETLAND ENHANCEMENT/REED CANARYGRASS ABATEMENT

Project 10 proposes to help address flooding in the project vicinity by improving wetland and riparian habitat in this reed canarygrass-choked reach of the May Valley (Figure B-10). Project 10 may complement the projected effects of Project 11 and IFP 1, if also implemented. This project was identified as a Category G project during the prioritization process.

Site Location

Proposed Project 10 is located on the left (south) bank of May Creek near RM 4.7, approximately 500 feet upstream from the confluence of May Creek and Long Marsh Creek. The project site is located in the west ½ of Section 2, T 23 N., R 5 E.,W.M. in King County, Washington (Figure 14, Appendix A). The property is currently owned by the Tsegay's.

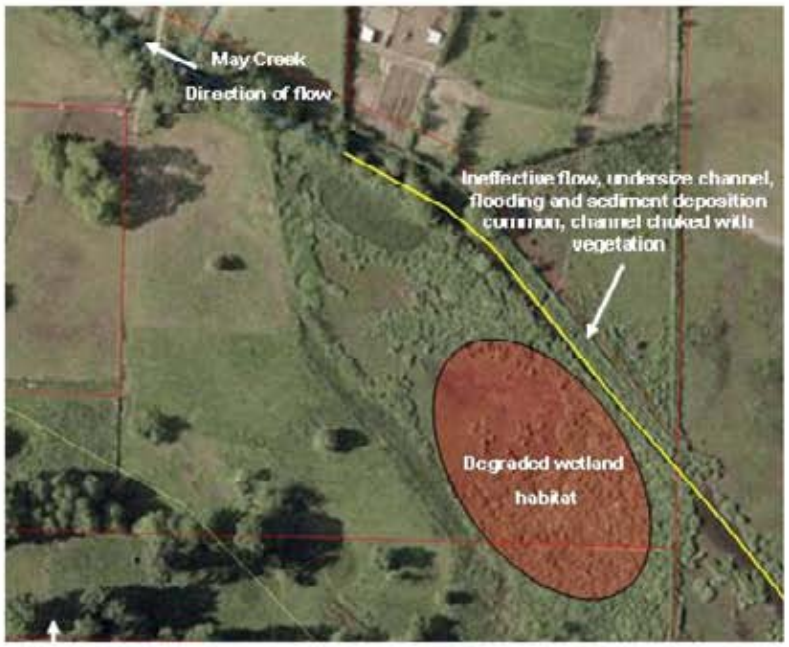
Site Description

The site is a degraded wetland and is currently used as horse pasture. Based on the Conditions Report, landuse in the area eliminated the conifer and deciduous-based forested wetland likely historically present at the site. The remnant wetland (Figure 5, Appendix A) is predominantly reed canarygrass and willow, with several other shrubs and forbes. The section of May Creek adjacent this site is an undersized channel with ongoing loss of channel capacity as the result of sediment deposition and encroachment of reed canarygrass and other riparian vegetation. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. The area frequently floods (Figure 7, Appendix A).

Project Description

This project would primarily focus on removing reed canarygrass and restoring native wetland and riparian species in an attempt to restore forested wetland and wetland buffer within an area of approximately 1 to 1.5 acres adjacent to the left (south) bank of May Creek. Removal of the reed canarygrass and other design features are intended to help the area better assimilate flood water and nutrients in both May Creek and from upland sources. The project also intends to help reduce flooding and sediment deposition, improve water quality; and improve riparian and wetland habitat at the site. The removal of canarygrass that has encroached on May Creek also would improve fish passage to other high fish use areas upstream in May Creek. A wetland detention area is proposed for the left overbank region with the following approximate dimensions: 150 feet in width and 320 feet long along the longitudinal direction of the stream

The existing May Creek channel would not be modified.



Existing Conditions

Conceptual Drawing of Restored Wetland and reed canarygrass abatement project

RED:\13\10791005\00\December 2007 Draft CRP\Figure B-10 Project 10 JTM/ML T 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 10

FIGURE B-10

Project Efficacy

The effectiveness of Project 10 was modeled assuming that a 1.2-acre wetland complex would be created. Similar assumptions were utilized as for other wetland modeling scenarios described for earlier projects. This project was predicted to reduce the storm runoff from this area from 0.13 cfs to 0.056 cfs, a 56 percent reduction for the 2-year event. Results of the modeling indicate that this project, in combination with Project 11, would lower water surface elevation within the reach for the 2-year event of 150 cfs. The water surface would be lowered by approximately 0.1 foot. This project would also help to increase channel velocities along the reach. In-channel velocities were predicted to marginally increase as a result of the project. For example, in-channel velocities at one modeling point were predicted to increase from 1.48 ft/s to 1.61 ft/s, a nine percent relative increase. These increases in channel velocity may mitigate some of the sedimentation problems in the area.

Based on modeling results, Project 10 in combination with Project 11 is projected to reduce flooding, increase channel velocities, and decrease sedimentation in this reach of May Creek. Project 10 would also create about 8,000 square feet of wetland and enhance approximately 45,500 square feet of wetland buffer.

Potential Challenges and Limitations

This project would occur on lands owned by two private parties. The land is being actively used for residential and livestock purposes. Landowners must grant permission for these projects to be implemented. Some of the area used by livestock would need to be converted to enhanced wetland and riparian area or at least fenced to restrict livestock use for this project to succeed. It is unknown if these actions would be of interest to landowners. It is likely that over 1 acre of area would be disturbed, requiring additional permitting and regulatory agency coordination steps.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $104,500 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the ordinary high water mark (OHWM), and will require placement of fill in a critical area, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project is expected to disturb over 1 acre of ground. As a result, additional permitting steps will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES) to secure a Construction Stormwater General Permit.

PROJECT 11: COLASURDO WETLAND ENHANCEMENT/REED CANARYGRASS ABATEMENT

Project 11 is primarily a reed canarygrass abatement and native plant restoration project, similar to several other projects being proposed in this CRP (Figure B-11). Dense stands of reed canarygrass monocultures have developed throughout the valley, and are contributing to flood, silt, fish passage, fish habitat, riparian and wetland function and related problems. This project was identified as a Category E project during the prioritization process.

This project was selected as a pilot project to be completed in 2007 in an attempt to begin mitigating flooding and address some of the negative effects of the highly invasive weed, reed canarygrass. This project was presented in a Pre-Design Report (GeoEngineers, 2007). It is one of four projects identified as potential early-implementation projects proposed for implementation in 2007 and 2008. As a result, a more detailed overview is provided for this project, as compared to the majority of the other projects in this Appendix. The detail is provided for this project, based on the additional work that the project team completed during the predesign process in early 2007. Please note that the project was in permitting, with available funding in the spring of 2007, and ready for implementation but construction has not begun because of site access challenges.

Site Location

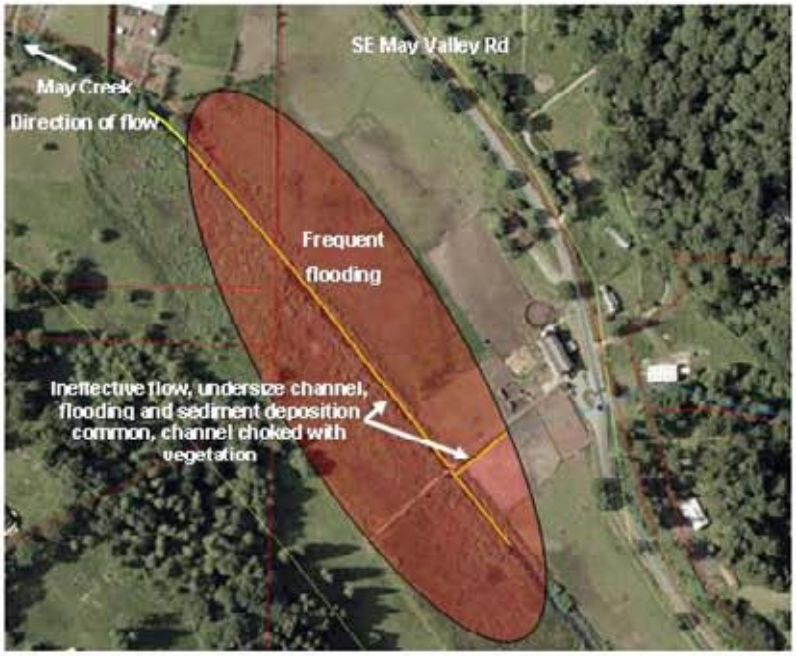
The proposed project is located between May Creek RM 4.65 and 4.90, in the west ½ of Section 2, T. 23 N., R. 5 E., W.M. in King County, Washington (Figure 14, Appendix A). The site extends between approximately 500 feet and 2000 feet upstream from the confluence of May Creek and Long Marsh Creek to a point approximately 250 feet upstream from Indian Meadow Creek.

Site Description

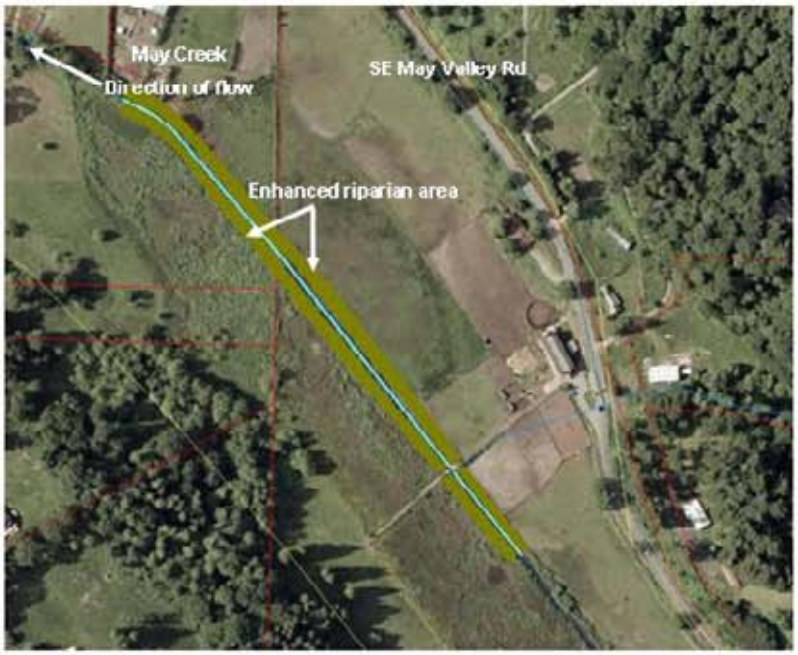
The site is located in a degraded wetland on the left and right bank of May Creek, presently being used as horse pasture. Based on the Conditions Report (1995), landuse activities in the area eliminated the conifer and deciduous-based forested wetland likely historically present at the site. The Report also considers May Creek to be an "underfit" stream flowing through an agricultural and livestock-raising region. May Creek throughout the May Valley was channelized throughout the May Valley and re-aligned sometime between 1910 and 1936 from its previous condition as a meandering, low-gradient stream ($\leq$ 0.2 percent slope) to its contemporary location which serves as a property boundary between valley landowners. This area of May Creek is characterized in the Action Plan (2001) and the conditions report as being subject to flooding, erosion, stream fish habitat, sediment deposition, wetland habitat and related problems (Figure 7, Appendix A).

The existing wetland is predominantly pasture grass with some reed canarygrass and willow immediately adjacent the creek. May Creek adjacent to the site flows in a low-gradient, undersized straight channel that continues to lose channel capacity because of sediment deposition and encroachment of reed canarygrass and other riparian vegetation. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. This area frequently floods. The channel has little habitat complexity, in-channel wood, or variability in substrate composition.

The GIS database developed by the project team supports these findings. The most prevalent features in this stream reach, identified using the GIS database, included channel constriction caused by the encroachment of vegetation and the accumulation of silt. Reed canarygrass was observed to be the primary riparian vegetation, and headwaters erosion problems were observed during 2006 and 2007 site visits (Figure 7, Appendix A).



Existing Conditions



Conceptual Drawing of riparian area enhancement and reed canarygrass abatement project

RED:\\10791005\00\December 2007 Draft CRP\Figure B-11 Project 11 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 11

FIGURE B-11

Project Description

Project 11 would primarily attempt to restore riparian forested area along both banks of May Creek with a buffer width of at least 25 feet. The existing May Creek channel would not be modified.

This project will reduce the levels of sediment deposition and vegetation constraining flow in this already undersized channel. The project will help to maintain a free-flowing stream channel by concentrating velocities within the channel margin rather that dissipating energy across the floodplain. The project would significantly improve riparian and wetland habitat and assist with fish passage through the area presently impaired by sediment and reed canarygrass. Improved passage through this reach would allow access upstream in May Creek where there are locally significant anadromous fish resource areas.

This project would use a combination of mechanical treatment and hand-removal of reed canarygrass shoots and rhizomes coupled with the high-density planting of native shrubs and trees. Those portions of May Creek where both banks of the creek could be treated would be prioritized. At least 20 feet of buffer zone would be heavily replanted with native trees and shrubs. Browse protection will be an important part of this project, both to avoid the potential effects from pasture animals as well as from beavers known to inhabit the valley.

The removal of reed canarygrass, restoration of native vegetation and the combined effect of creating a free-flowing stream channel are expected to have a variety of benefits to the project area. These anticipated benefits include:

- Floodwaters are anticipated to move off the floodplain at a higher rate, thereby making it possible for pasture land to dry out at a faster rate,
- Reduction in accumulation of silt, including in-channel and tributary confluence areas, from pasture areas and upstream sources,
- Increasing fish migration and habitat use by introducing shading with native plants and by reducing the degree of channel impingement caused by the accumulation of grass on the creek bottom and channel margin
- Improving riparian and wetland function, improving fish and wildlife habitat quality, and helping to control erosion.

Project Efficacy

Project 11 was modeled using horizontal variations in the channel roughness with the riparian buffer along the channel margins. This was modeled as a 20-foot wide swath on either side of the channel, with a Manning "n" coefficient of 0.12 (for very dense riparian roughness) and the channel "n" remaining 0.045. This was applied for the riparian buffer extents to concentrate the flows at and below bankfull stage in the channel. Results of the modeling indicated that this project would lower water surface elevation within the reach for the 2-year event of 150 cfs. The water surface was lowered by approximately 0.1 foot in the floodplain adjacent the project site. This project would also help to increase channel velocities along the reach. Predicted in-channel velocities increased as a result of the project. For example, the in-channel velocity at one modeling point increased from 1.48 ft/s to 1.61 ft/s, a nine percent relative increase. Increases in channel velocity may mitigate some of the sedimentation problems in the area.

Based on recent modeling of potential hydraulic effects, Project 11 was predicted to reduce flooding and increase velocities potentially reducing sedimentation problems in this reach. The project would also enhance 77,500 square feet of riparian habitat area. Results of the modeling indicate that this project in

combination with Project 10 would lower water surface elevation within the reach for the 2-year event of 150 cfs. The water surface was lowered by approximately 0.1 foot between stations 5993 and 6821. This project would also help to increase channel velocities along the reach. In-channel velocities marginally increase as a result of the project. For example, at one hydraulic model transect location, the in-channel velocity increases from 1.48 ft/s to 1.61 ft/s, a nine percent relative increase. These increases in channel velocity may mitigate some of the sedimentation problems in the area.

Potential Challenges and Limitations

This project would occur on lands owned by at least three private parties. The land is currently used for residential and livestock purposes. Some of the area used by livestock would need to be converted to enhanced wetland and riparian area, or at least fenced from use, for this project to succeed. It is unknown if these actions would be of interest to landowners. Landowners must grant permission for these projects to be implemented. At the time this report was written, there were uncertainties regarding landownership changes and contact information.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $89,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

Management of lands for ongoing livestock and other agricultural purposes is currently permissible under local, state and federal laws. Verbal approval to proceed with the project was obtained from King County and the U.S. Army Corps of Engineers in May of 2007. Project plans were developed during July and August of 2007. Site access challenges resulted in postponement of project implementation. Ongoing site access challenges continues to preclude any further permitting work, detailed project design, or construction activities for this project at this site.

PROJECT 12: INDIAN MEADOW CONFLUENCE AREA PROJECT

Project 12 would include the removal of reed canarygrass, and the construction of a pond, stream channel, and riparian habitat on the right bank of May Creek (Figure B-12). Additional details are available for this project as a result of predesign work completed for Projects 11 and 13. Project 12 was not selected as a priority project for predesign work because it was not anticipated to have the level of benefit or support as the other two projects. This project was identified as a Category K project during the prioritization process.

Site Location

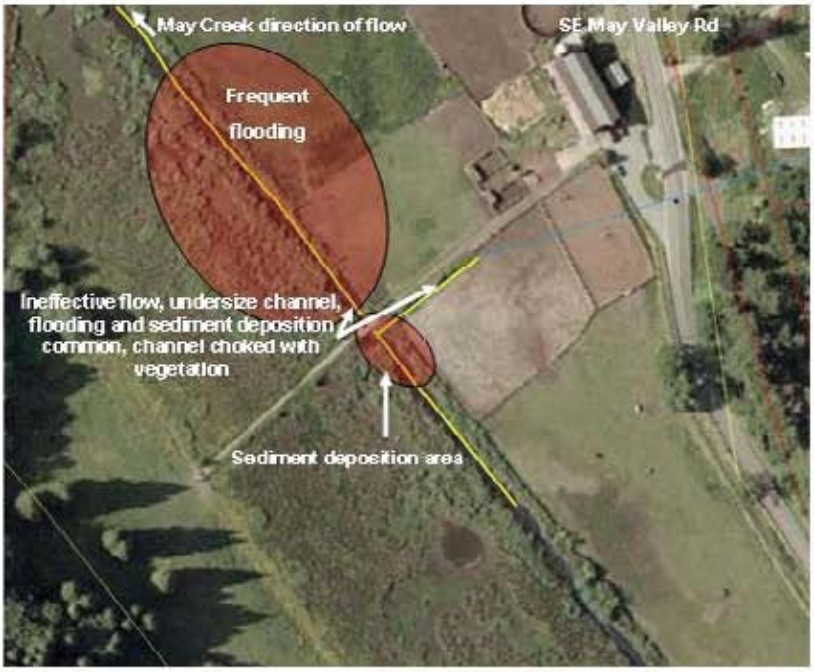
Project 12 is located at May Creek RM 4.85 in the west ½ of Section 2, T. 23 N., R. 5 E., W.M in King County, WA. This proposed project is located at the confluence on May Creek and Indian Meadow Creek on property currently owned and managed by a private landowner. The site is located near the lower end of May Valley, the westernmost property line being approximately 1500 feet upstream from the 148th Avenue SE bridge (Figure 14, Appendix A).

Site Description

The site is contained within a degraded wetland, located on the right (north) bank of May Creek. The land is currently used as horse pasture. Based on the Conditions Report, landuse activities in the May Valley eliminated a conifer and deciduous-based forested wetland, likely historically present at the site. The Condition Report also characterizes this area to be very low gradient ($\leq$ 0.2 percent slope) and as being an "underfit" stream flowing through an agricultural and livestock-raising region. May Creek was channelized and re-aligned throughout the May Valley sometime between 1910 and 1936. Its previous form as a meandering, low-gradient stream was transformed into a straight channel. May Creek remains a relatively straight channel with little habitat complexity, in-channel wood, or variability in substrate composition (Figure 12, Appendix A).

The wetland is predominantly pasture with some reed canarygrass and willow immediately adjacent the creek. This confluence area does not have a readily identifiable channel. Rather, reed canarygrass and sediment have accumulated at the site, eliminating the tributary channel and adding vegetation and sediment to the already impaired channel. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. This area frequently floods.

The project site is located immediately upstream from the low gradient section described in Project 11. This section of May Creek was previously the subject of restoration actions supported by King County. This area was planted with riparian vegetation and fenced to preclude pasture animals from approaching riparian plantings. During site visits, some May Valley landowners raised concerns that the riparian vegetation project resulted in berming of the creek banks, exacerbating flooding. Residents suggests that constructed berms were not allowing flood waters to return to the creek once flood levels have subsided.



Existing Conditions – scale 1:1000

Conceptual drawing of pond and riparian area

RED:\10\10791005\00\December 2007 Draft CR\Figure B-12 Project 12 JTW/M_T 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 12

FIGURE B-12

Project Description

Project 12 includes the installation of a pond and reed canarygrass abatement immediately adjacent to the confluence of May Creek and Indian Meadow Creek to create a sediment trap and off-channel habitat area. The existing May Creek channel would not be modified. This project would be designed to help reduce sediment deposition, remove vegetation constraining flow and help to maintain a free-flowing stream channel. These design elements should improve riparian and off-channel fish habitat and allow fish passage through the area upstream to other significant anadromous fish resource areas.

The project would include construction of an off-channel pond at the confluence of May Creek and Indian Meadow Creek and reed canarygrass abatement at the pond site. The perimeter of the pond would be planted with native wetland trees and shrubs. The pond would be constructed roughly in a oval shape of approximately 1,600 square feet in area, aligned perpendicular to May Creek. Pond banks would have a 4 to 1 slope around its perimeter in order to minimize erosion risk and to support riparian and wetland trees and shrubs. Material excavated to form the pond would be disposed in upland area of the subject property.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. Qualitatively speaking, reducing sediment loading from this unstable tributary would be expected to help reduce local flooding issues and improve downstream habitat. Further investigation into this project would be worthwhile. Quantitatively speaking, the project would create about 1,600 square feet of pool habitat, 70 linear feet of channel for fish and enhance 2,400 square feet of riparian habitat.

Potential Challenges and Limitations

The project is located within an active farm that currently experiences heavy use by horses and farm equipment traveling through the area. Some of the area used by livestock would need to be converted to riparian and off-channel habitat, or at least fence off, for this project to succeed. It is unknown if these actions would be of interest to landowners. Landowners must grant permission for these projects to be implemented. In addition, the sediment load from Indian Meadow Creek may be so excessive that the sediment trap/off-channel habitat pond would need to be maintained on a regular basis, or it would quickly fill and lose all function.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $33,900 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

We anticipate needing local, state, and federal authorization to proceed with this project. For instance, development of an off-channel pond will require a King County Clearing and Grading Permit. A related aspect of this activity is the potential to affect wetlands. We recommend pursuing approval from the U.S. Army Corps of Engineers under Nationwide Permit Number 27 (U.S. Army Corps of Engineers (ACOE) Section 404).

Actions proposed for this project will also need to go through State Environmental Policy Act (SEPA) approval. We recommend the use of a SEPA Checklist, and with concurrence from King County that this project should proceed this year, anticipate timely approval. The project will result in actions in Indian Meadow Creek. Therefore we may need authorization under the US Endangered Species Act (ESA), and may to need to complete a JARPA and secure Hydraulic Project Approval (HPA). It may be possible to expedite permitting through authorization from the US Army Corps may under Nationwide 27 and use of streamline permitting under the Washington State Department of Fish and Wildlife (WDFW Hydraulic Project Approval (HPA), SEPA Checklist, and Specific Project Information Forms (SPIF). It may also be necessary to consult with local Tribes (e.g. Muckelshoot Tribe) as the work would be in-channel and is proposed to have habitat enhancement value.

The following permits and approvals may also be required:

- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 13: COLASURDO OFF-CHANNEL POND/WETLAND ENHANCEMENT

Project 13 includes in installation of a new pond, reed canarygrass abatement and native plant restoration (Figure B-13). Project 13 would compliment Project IFP 2, were both project implemented together. Project 13 was identified as a Category N project during the prioritization process.

This project was selected as a pilot project for inclusion in the Pre-Design Report (GeoEngineers 2007) in an attempt to begin mitigating some of the negative effects of flooding, erosion, and the highly invasive weed, reed canarygrass. Project details are also presented in the Pre-Design Report. It is one of four projects selected for pilot project implementation in 2007 and 2008. As a result, the following is a more detailed overview of this project, as compared to the majority of the other projects in this CRP. The detail is provided based on the additional work that the project team completed during the predesign process.

Site Location

The proposed project is located at May Creek RM 5.2 in south 1/2 of Section 2, T. 23 N., R. 5 E., W.M. in King County, Washington. This project is located in the southeast portion of a private property located at 10736 154th Place. The site is located approximately 1500 feet above the confluence of May Creek and Indian Meadow Creek from the 148th Avenue SE bridge (Figure 14, Appendix A).

Site Description

The site is an active horse pasture on left bank of May Creek. Based on the Conditions Report, landuse in the area virtually eliminated wetlands likely historically present at the site. The Conditions Report also describes the creek as very low gradient ($\leq$ 0.2 percent slope) and is described in the Conditions Report (1995) as being an "underfit" stream flowing through an agricultural and livestock-raising region. May Creek was channelized and re-aligned throughout the May Valley sometime between 1910 and 1936. Its previous form as a meandering, low-gradient stream was transformed into a straight channel which serves as a property boundary between some valley landowners. To date it remains a relatively straight channel with little habitat complexity, in-channel wood, or variability in substrate composition (Figure 12, Appendix A).

The remaining wetland is predominantly pasture with some reed canarygrass and willow immediately adjacent the creek. The riparian area was enhanced in the mid 1990s, and has created some additional flood attenuation, nutrient assimilation, and habitat value. The enhanced riparian area has helped improve channel function and sediment transport processes. The section of May Creek upstream from Project 11 but downstream from Project 13, where riparian enhancements were previously made, is relatively free flowing and has reasonable fish passage and aquatic habitat for such a low-gradient stream. This area does, however, occasionally flood.

The project site is located on the southwest side of May Creek immediately upstream from the low gradient section described in Project 11. This section of May Creek is functioning somewhat better than other sections of the creek. It has moderate stream velocities that, at the time of the last site visit in 2007, were capable of moving fine sediment downstream, thus maintaining a small to medium gravel substrate and limited channel complexity. Unlike many areas of May Creek, the floodplain is slightly perched above the creek, making it possible to store water, if the proposed pond is constructed.

This section of May Creek was previously the subject of restoration actions supported by King County. This area was planted with riparian vegetation and fenced to preclude pasture animals from approaching riparian plantings. The May Valley Environmental Council (MVEC) has previously raised concerns that the riparian vegetation project resulted in berming of the creek banks. MVEC suggests that constructed berms were not allowing flood waters to return to the creek once flood levels have subsided.

Existing Conditions – scale 1:1000

Conceptual drawing of pond and riparian area

RED:\10\0791005\00\December 2007 Draft CR\Figure E-13 Project 13 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 13

FIGURE B-13

Project Description

Project 13 includes the installation of a pond to create an off-channel habitat area on the left bank of May Creek. The existing May Creek channel would not be modified. The wetland pond would be approximately 0.25 acres in area in the south-east portion of a private property adjacent May Creek. The perimeter of the pond would be planted with native wetland and riparian trees and shrubs. The pond would be constructed roughly in an oval shape of approximately 175 feet in length by 60 feet in width, aligned parallel with May Creek. Pond banks would have a 20:1 side slope around its perimeter in order to minimize erosion risk and to support riparian and wetland trees and shrubs. Material excavated from the pond would be disposed in upland area of the subject property.

Construction of the pond is expected to provide both direct and indirect flood reduction benefits. Direct flood reduction benefits include providing of an area for floodwaters to drain from the southeast portion of the property. This would also help reduce the levels of sediment deposition and help maintain a free-flowing stream channel. If the pond were connected to the main channel, the project would improve riparian and off-channel fish habitat.

This project could be implemented with at least two alternative designs. Design one (1) could consider connecting the off-channel pond through a channel located at the downstream (northwest) end of the pond. Design two (2) would consider connecting the pond to May Creek through points both upstream (southeast) and downstream (northwest) ends of the pond.

Project Efficacy

The effects of Project 13 and 14 were modeled together. Project 14 is a storm water detention basin described in more detail later in this document. The wetland feature was modeled assuming a 1-foot deep swale section with 20:1 side slope. Flows in the wetland were assumed ineffective (i.e. disconnected from May Creek) until the overbank elevation was exceeded, then skimming flow over the wetland would take place. Modeling results showed that this project will have minimal effect on local water surface elevations— 0.02 foot decrease for the 150 cfs event. Reach average velocities in the project vicinity were projected to decrease from 1.32 ft/s to 1.28 ft/s for the 150 cfs flow rate.

The storm water runoff was modeled for the wetland enhancement Project 13 using the typical methodology proposed on other similar projects in the scope. The drainage area for this wetland enhancement project is 0.77 acres. The storm water runoff will be reduced from 0.1 cfs to 0.043 cfs from the site, a 56 percent reduction.

Based on modeling results, Project 13 was projected to provide minimal help reduce flooding effects, and have little effect on velocities in May Creek adjacent to the site. In addition to flood-related effects, the project will create about 3,500 square feet of wetland and enhance approximately 30,000 square feet of riparian and wetland buffer area.

Potential Challenges and Limitations

The project is located within an active farm. The project area is presently heavily used by horses. Some of the area used by livestock would need to be converted to the riparian and off-channel habitat area, or at least fenced, for this project to succeed. It is unknown if these actions would be of interest to landowners. Landowners must grant permission for these projects to be implemented. The landowner may desire the area to be used as a stock-water pond. While this would reduce direct effects on livestock on May Creek, it would likely reduce the utility of the pond as an off-channel habitat.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $15,400 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

We anticipate needing local, state, and federal authorization to proceed with this project. Development of an off-channel pond on the Colasurdo family property will require a King County grade and fill permit. Grade and fill actions would likely affect wetlands. We recommend pursuing approval from the U.S. Army Corps of Engineers under Nationwide Permit Number 27. This project will also need to go through State Environmental Policy Act (SEPA) approval. We recommend the use of a SEPA checklist. The project would not initially result in-water construction nor in the placement of fill in the creek. Work along the streambank and within the ordinary high water mark of the creek would a JARPA in order to obtain hydraulic project approval, SEPA approval, and ESA concurrence. It may also be possible to expedite permitting through streamlined HPA, SEPA Checklist, and Specific Project Information Forms (SPIF). In-channel work may necessitate consultation with ESA authorities and the local Tribes (e.g. Muckelshoot Tribe) as the work is proposed to have habitat enhancement value.

Since a portion of the work may be completed below the ordinary high water mark (OHWM) and would result in fill to a critical area, the following permits and approvals may also be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 14: COLASURDO STORMWATER DETENTION POND

Project 14 proposes to help address flooding in the project vicinity by reducing stormwater flows to the May Valley (Figure B-14). Project 14 may complement the projected effects of Project 13 if also implemented. This project was identified as a Category J project during the prioritization process.

Site Location

Project 14 is located at May Creek RM 5.25 in the south half of Section 2, T. 23 N., R. 5 E., W.M. in the King County, Washington (Figure 3). The site is located approximately 1800 feet above the confluence of May Creek and Indian Meadow Creek in the southeast portion of the private property located at 10736 154th Place (Figure 14, Appendix A).

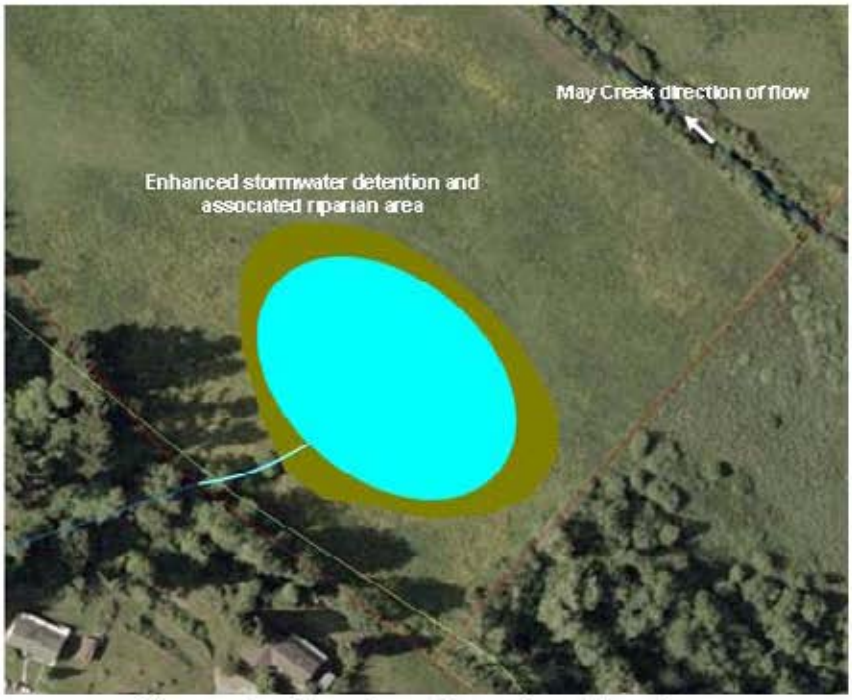
Site Description

The site is an active horse pasture on the left (south) bank of May Creek. Based on information in the Conditions Report (King County 1995), landuse in the area virtually eliminated the forested wetlands likely historically present at the site. The report also states that the Creek is very low gradient ($\leq$ 0.2 percent slope) and is described in the Conditions Report (1995) as being an "underfit" stream flowing through an agricultural and livestock-raising region. May Creek was channelized and re-aligned throughout the May Valley sometime between 1910 and 1936. Its previous form as a meandering, low-gradient stream was transformed into a straight channel which serves as a property boundary between some valley landowners. To date it remains a relatively straight channel with little habitat complexity, in-channel wood, or variability in substrate composition (Figure 7, Appendix A).

The wetland is currently predominantly pasture with some reed canarygrass and willow immediately adjacent the creek. This section of May Creek is relatively free flowing and has reasonable fish passage. This area occasionally floods. An unnamed stormwater drainage enters the property from the southwest. The stormwater accumulates in a depression located in the southern corner of the property. Excessive rainfall and stormwater flows exceed the capacity of the depression and flood the pasture.

The proposed stormwater detention pond project is located on the southwest side of May Creek upstream from the low gradient section described in Project 11 and upslope from the wetland project described in Project 13. Just downstream from Projects 13 and 14 is a section of May Creek that is functioning somewhat better than other sections of the creek. It has moderate stream velocities that, at the time of the last site visit in 2007 were capable of moving fine sediment downstream, thus maintaining a small to medium gravel substrate and some channel complexity. The section of May Creek immediately adjacent Project 13 has low velocities and reed canarygrass encroaching on the channel, like may areas. Unlike many areas of May Creek, the floodplain in this area of the valley is slightly perched above the creek, making it possible to store water, if the proposed stormwater pond was constructed.

Existing Conditions – scale 1:1000



Conceptual drawing of pond and riparian area

RED:\JM\37\10050\00\December 2007 Draft CRP\Figure E-14 Project 14 JTM/MLT 12/17/07

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Conceptual Drawing Project 14

FIGURE B 14

Project Description

This project would expand the storage capacity of the shallow depression in the southern-most corner of the property that is acting as a stormwater detention area. The existing stormwater flow originates in the Renton Plateau Subarea to the south of May Valley and is then detained in this shallow depression. The existing pond would be excavated to encompass an area of approximately 0.5 acres to 0.86 acres. Pond banks would have a 4:1 slope around the perimeter in order to minimize erosion risk and to support riparian and wetland trees and shrubs. Material excavated to form the pond would be disposed in the upland area of the subject property. Riparian and wetland trees and shrubs would be planted around the pond, with the exception of stockwater access points. The existing May Creek channel would not be modified. No work would be done on this project within 250 feet of May Creek.

This project would help reduce flooding and sediment deposition in May Creek by reducing the frequency of flooding caused when the capacity of the detention area is exceeded. The section of May Creek adjacent and downstream from the detention pond site is presently impaired by sediment deposition, encroaching reed canarygrass, and frequent flooding. This project would not provide significant direct habitat benefits. The project would, however, reduce the sediment load and flooding events and reduce further degradation of channel conditions and reduction of fish passage. This project would also serve as a stockwater pond, reducing the direct effects on livestock on May Creek and the riparian area.

Project Efficacy

As previously mentioned, the hydraulic effectiveness of projects 13 and 14 were modeled together. There is already a storm water depression in the area which seasonally fills with water. The estimated length is 100 feet and width 200 feet from GIS mapping analysis for an existing pond footprint of 0.45 acres. The increase in detention size could possibly bring it up to 0.86 acres. If the existing pond were three feet deep and it was excavated to six feet in depth, the total capacity change would be 230,000 cubic feet and the pond could retain 304,000 cubic feet of water. Analysis of regional gaging data provided by King County at the May Creek/Coal Creek Parkway crossing, reveals that a typical rainfall event producing a flood peak of 77 cfs, produces on the order of 22 million cubic feet of water runoff. This pond could retain approximately one percent of that runoff. So, locally, it could certainly retain any flood water inflows in the area. This pond was not quantified in the HEC-RAS analysis.

Based on modeling results, Project 14 would have some localized flood mitigation benefits. The project will also restore about 24,000 square feet of riparian habitat.

Potential Challenges and Limitations

The project is located within an active farm. The project area is presently heavily used by horses. Some of the area used by livestock would need to be converted to the riparian and off-channel habitat area, or at least fenced, for this project to succeed. It is unknown if these actions would be of interest to landowners. Landowners must grant permission for these projects to be implemented. The landowner may desire the area to be used as a stock-water pond. This would reduce direct effects on livestock on May Creek, but may reduce the capacity of the pond if horse traffic increases sediment loading to the pond.

Planning-Level Cost Estimates

Estimated Construction Costs: $169,700 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

Local, state, and federal permit or regulatory authorization will likely be needed prior to proceeding with this project. This project will require a grade and fill permitting. We recommend pursuing approval from the U.S. Army Corps of Engineers under Nationwide Permit Number 27. Actions proposed for this project will also need to go through State Environmental Policy Act (SEPA) approval. We recommend the use of a SEPA Checklist. The project will not result in actions in the creek nor in the placement of fill in the creek or within 250 feet of the creek. Therefore we do not anticipate needing authorization under the US Endangered Species Act (ESA), JARPA, the Hydraulic Code or related aquatic resource protection regulations.

PROJECT 15: MAY CREEK SIDE-CHANNEL PROJECT

Project 15 proposes to help address flooding and fish passage by creating a side-channel to May Creek near the confluence of May Creek and Tributary 291-A (Figure B-15). Fish passage improvements made as part of this project would complement fish passage improvements proposed as part of Project 16 or Project IFP 3, were these other projects implemented. Project 15 was identified as a Category D project during the prioritization process.

Site Location

Project 15 is located between Creek RM 5.53 and RM 5.65 on May Creek, approximately 1,000 feet downstream from the 164th Avenue bridge crossing near River Mile (Figure 15, Appendix A). The downstream-most point of the project is located at the confluence of May Creek and tributary 291-A, continuing upstream for approximately 650 feet. The project would be constructed entirely on private properties located on the right bank of May Creek.

Site Description

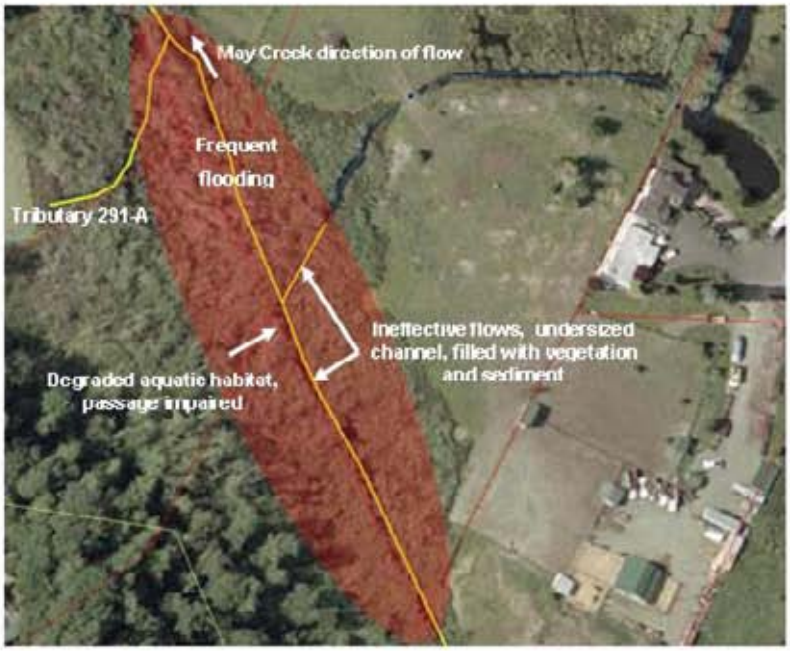
The site is a degraded wetland on both banks of May Creek, and is presently being used for residential and horse pasture purposes. Based on the Conditions Report (King County 1995), landuse changes in the area degraded the coniferous and deciduous-based forested wetland likely historically present at the site. This portion of May Creek is described in the Conditions Report (King County 1995) and the Action Plan (King County 2001) as an "underfit" stream flowing through an agricultural and livestock-raising region. It is also reported as being subject to flooding, erosion, stream fish habitat, sediment deposition due to the low gradient and prevalence of fine sediment, wetland habitat and related problems (Figure 8, Appendix A).

The existing wetland is predominantly reed canarygrass and willow. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. This area frequently floods, has degraded aquatic habitat, and poses a partial barrier to locally significant fish use areas in 291-A and the County-Cabbage Creek drainages located upstream. This section of May Creek does not have a readily identifiable channel because reed canarygrass and sediment have accumulated, virtually eliminating the channel.

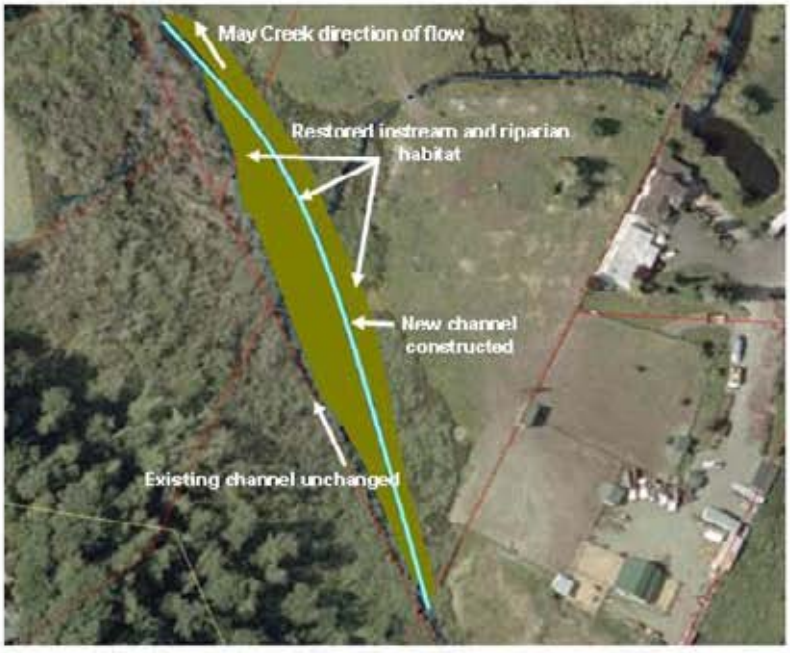
The GIS database developed by the project team supports these findings. The most prevalent features identified on this segment using the GIS database included channel constriction caused by the encroachment of vegetation and the accumulation of silt (Figure 8, Appendix A).

Project Description

Project 15 would construct a new side-channel on the right bank of the existing May Creek channel. Reed canarygrass abatement and planting of native wetland vegetation would help restore riparian area and help maintain effective flows and sediment transport processes. The existing May Creek channel and riparian area would not be modified. This project would help reduce flooding and sediment deposition in May Creek by improving flow and sediment conveyance. This project would improve fish habitat a number of ways. It would create upstream passage where current conditions are, at best, a partial barrier to fish passage. This project would also help create aquatic and riparian habitat where presently reed canarygrass and saturated soils produce an ill-defined channel. This may also improve water temperatures by increasing conveyance and providing full channel shading. Both sediment and vegetation would need to be removed from the project site to create the new side-channel.



Existing Channel Conditions



Conceptual Drawing of Restored Channel and Riparian Area

RED:\\10791005\00\December 2007 Draft CRP\Figure B-15 Project 15 JTM/MLT 12/17/07

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Conceptual Drawing Project 15

FIGURE B-15

Project Efficacy

Modeling of Project 15 was completed assuming that a high flow bypass channel would be created that would be approximately 650 feet in length, have a 10-foot bottom-width, and side slope with a 3:1 ratio with two foot depth. For modeling purposes a Manning's "n" of 0.045 was used for the main channel and bypass channel and a Manning's "n" of 0.06 was used in the channel overbank areas for the proposed project.

Model results predicted that this project would lower water surface elevations by 0.4 feet in the side channel area at a design flow of 150 cfs flow. The water level drawdown effects were predicted to propagate upstream and should alleviate some local flooding problems. Local velocities will decrease from 2.45 ft/s to 1.84 ft/s for the 2-year event, which could result in added sedimentation problems in the reach if both channels were to remain in use by the creek. The purpose of this project is to allow existing sedimentation to claim what remains of the existing channel while the constructed channel would provides the primary fish passage and flow conveyance corridor.

Potential Challenges and Limitations

The project is located within a number of active farm parcels. Landowners must grant permission for these projects to be implemented. Some of the area used by livestock would need to be converted to the riparian and side-channel habitat area for this project to succeed. It is unknown if these actions would be of interest to landowners. Saturated soils and heavy vegetation may make channel construction and riparian restoration efforts challenging, time consuming, and more expensive as compared with other habitat restoration projects. Planning-Level Cost Estimates

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $85,100 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion, and perhaps all, of the project will be completed below the ordinary high water mark (OHWM) and require placing fill in a critical area. As a result, the following permits and approvals will likely be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 16: 291-A CONFLUENCE AREA PROJECT

Project 16 is primarily a tributary channel restoration and fish passage project. As part of the project reed canarygrass abatement and native plant restoration would occur, similar to several other projects being proposed as part of this CRP (Figure B-16). Dense stands of reed canarygrass monocultures have developed at the confluence of Tributary 291-A and May Creek, contributing to flooding, excessive channel siltation, impairment of fish passage, degradation of fish habitat, and loss of riparian and wetland function. This project was identified as a Category H project during the prioritization process.

This project was selected as a pilot project to be completed in 2007 or 2008 in an attempt to begin mitigating flooding and some of the effects of the highly invasive reed canarygrass. Additional project details can be found in the Pre-Design Report (GeoEngineers 2007). As a result of this project being included in the Pre-Design Report, the following is a more detailed overview of this project as compared to the majority of the other projects in this CRP. The detail is provided based on the additional work that the project team completed during the pre-design analysis phase early in 2007.

Site Location

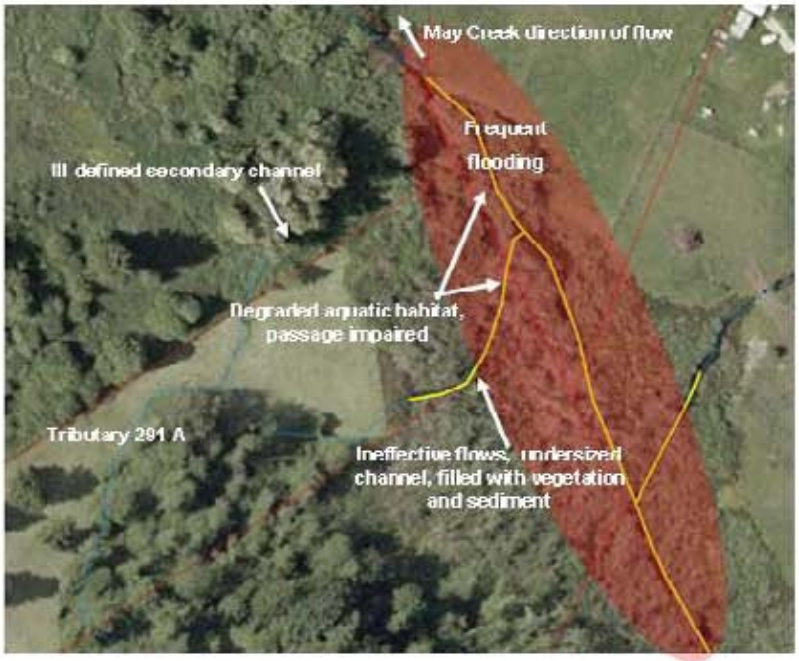
Project 16 is located at the confluence of May Creek with 291-A, including the lower 400 feet of Tributary 291-A (RM 0 to RM 0.1). The project would occur entirely on private properties located approximately 1,000 feet downstream from the 164th Avenue bridge crossing near RM 5.5 on May Creek (Figure 15, Appendix A).

Site Description

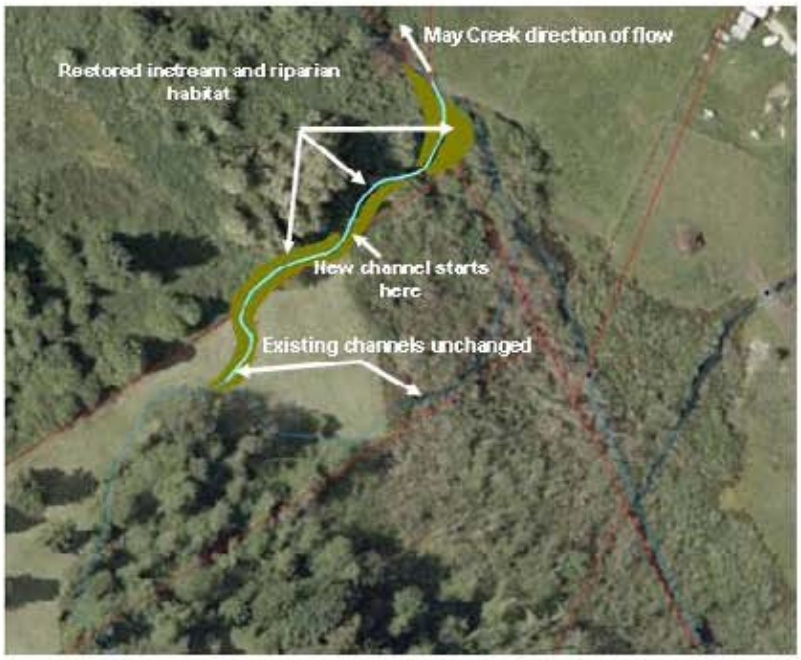
The site is a degraded wetland on the left (south) bank of May Creek. The Conditions Report (King County 1995) indicates that landuse changes in the area eliminated the conifer and deciduous-based forested wetland likely historically present at the site. This portion of May Creek is described in the Conditions Report and the Action Plan (King County 2001) as an "underfit" stream flowing through an agricultural and livestock-raising region. It is also characterized as being subject to flooding, erosion, stream fish habitat, sediment deposition due to the low gradient and prevalence of fine sediment, wetland habitat and related problems. 291-A is identified in the Action Plan (2001) as a locally significant area because of the high habitat use by coho salmon and cutthroat trout.

The existing wetland is predominantly reed canarygrass, willow, and shrubs. Reed canarygrass and sediment have accumulated at the site, virtually eliminating the channel in the lower portion of Tributary 291-A and in May Creek. This area no longer functions as a forested wetland, but it does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. This area frequently floods, has degraded aquatic habitat, and poses a partial barrier to locally significant fish use in 291-A and access to upstream LSRA in the County-Cabbage Creek drainage (Figure 8, Appendix A).

The GIS database developed by the project team supports these findings. The most prevalent features identified in this area using GIS were channel constrictions caused by the encroachment of vegetation and the accumulation of silt (Figure 8, Appendix A).



Existing Channel Conditions



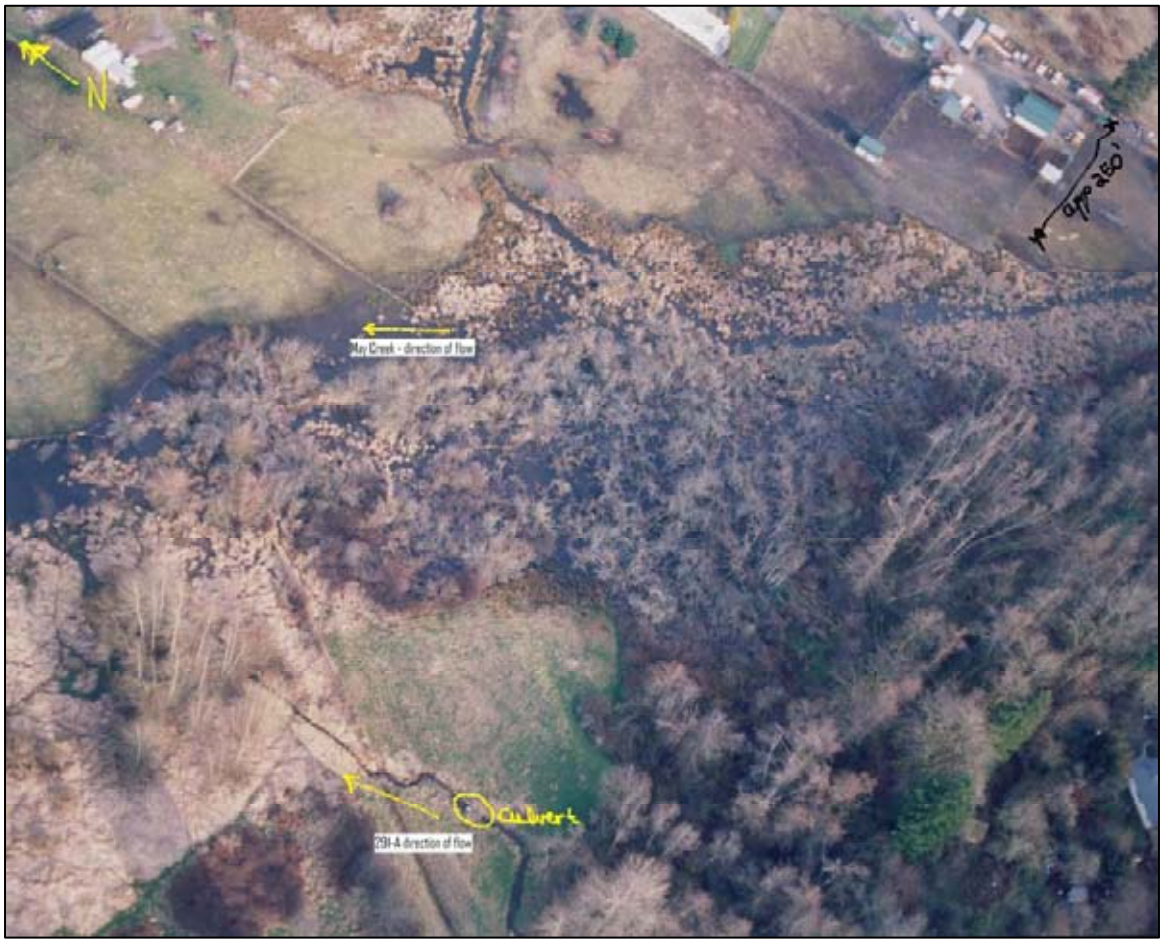
Conceptual Drawing of Restored Channel and Riparian Area

RED:\101\10791005\00\December 2007 Draft CRP\Figure B-16 Project 16 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 16

FIGURE B-16



There is no clearly defined confluence area between Tributary 291-A and May Creek due to obstruction by reed canarygrass.

Project Description

Project 16 would create a new channel for Tributary 291-A to directly connect the tributary to an open channel section of May Creek. The riparian area would be restored along the tributary by removing reed canarygrass and planting native wetland and riparian plant species to help maintain effective flows and sediment transport processes. The existing May Creek channel and riparian area would not be modified as part of this project, but would be converted to an open channel through Project 15.

Creating the new channel would help reduce flooding and sediment deposition in May Creek by improving flow and sediment conveyance. This project would improve fish habitat a number of ways. The new channel would remove the partial or complete barrier to fish passage caused by the obscured nature of the current channel. This project would also directly improve aquatic and riparian habitat by removing reed canarygrass and saturated soils and by creating a defined channel. This project may also improve water temperatures by increasing conveyance and providing full channel shading.

Anticipated benefits of Project 16 include:

- Enhanced passage of fish (coho and cutthroat) up Tributary 291-A (a Locally Significant Resource Area, LSRA),
- Enhanced fish habitat in confluence area (rearing habitat in low-velocity mixing zone),
- Better containment of flood waters in channel and pond,
- Silt reduction including in-channel and tributary confluence area, and
- Floodwaters are anticipated to move out of 291-A and off the floodplain at a higher rate.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this unstable tributary would be expected to help reduce local flooding issues and improve downstream habitat. In addition, development of a clear passage corridor and confluence area between Tributary 291-A and May Creek would better enable coho salmon (Oncorhynchus kisutch) and cutthroat trout (O. clarki) access to a Locally Significant Resource Area (LSRA) as identified in the Action Plan (King County 2001). Further investigation into this project would be worthwhile. Quantitatively speaking, the project would create about 200 linear feet of channel for fish and enhance 8000 square feet of riparian habitat.

Potential Challenges and Limitations

The project is located on two parcels. Both landowners must provide permission to construct this project. Access to view the area was granted by one landowner, but permissions have been more difficult to obtain from the neighbor. Some of the area would need to be converted from current uses to the riparian and side-channel habitat area for this project to succeed. It is unknown if these actions would be of interest to landowners. Saturated soils and heavy vegetation may make channel construction and riparian restoration efforts challenging, time consuming, and more expensive as compared with other habitat restoration projects.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $63,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

Work will be completed below the OHWM and will result in placing fill in a critical area. As a result, the following permits and approvals, therefore, will likely be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 17: MAY CREEK BEAVER MANAGEMENT DEMONSTRATION PROJECT

Project 17 is primarily a flood control and fish passage project, achieved through manipulation of an existing beaver dam located a short distance downstream from the 164th Avenue SE bridge crossing (Figure B-17). This project was identified as a Category A project during the prioritization process.

Site Location

Project 17 is located on May Creek near RM 5.8. The site is located approximately 500 feet downstream of 164th Avenue SE (Figure 15, Appendix A).

Site Description

The site has an open, flowing channel with several beaver dams. Riparian enhancement work was been completed on the north (right) bank of May Creek at the project site. The beaver dams in this section of May Creek generally control the water surface elevation. During a February 2007 site visit, it appeared that a beaver dam backed up water and flooded lands at the site to a point above the 164th Avenue SE bridge. This backwater effect is likely contributing to sediment deposition upstream from the dams and may be aggravating flood-flow problems at the 164th Avenue SE bridge. May Creek has excellent fish habitat downstream from one beaver dam with quality flows, velocities, and substrate types and heavy shading from mature riparian vegetation. Beaver dams, however, may be acting as a partial barrier to upstream fish migration.

The water surface elevation of May Creek below the 164th Avenue SE bridge is controlled by the beaver dam located downstream from the bridge.

Existing Channel Conditions

Conceptual drawing of beaver management project

REF:\\JM\37\10005\00\December 2007 Draft CRP\Figure E-17 Project 17 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 17

FIGURE B 17

Project Description

This project would address flooding and fish passage problems at the site by notching the beaver dam or by installing a "Beaver Deceiver". The notched beaver dam would be expected to increase conveyance and reduce the water surface elevation of May Creek behind the dam. This project would augment work that appears to have already been completed at the site. During an October 15, 2007 site visit, OTAK noted that the beaver dam at the site of proposed Project 17 was previously notched. This project proposes to increase the width of an existing 4-foot wide by 2-foot deep notch in the beaver dam to a width of eight feet.

Indication of previous notching of the beaver dam downstream from the 164th Street SE bridge crossing of May Creek.

The "Beaver Deceiver", or similar non-invasive beaver management device would be installed to manage the elevation of water behind the beaver dam and the flow of water through the structure, without notching or removing the dam or beavers see: http://dnr.metrokc.gov/wlr/Dss/beavers/construction-sequence.htm. The beaver management project would be designed to maintain a water level that would minimize flooding effects upstream, maintain quality downstream habitat and allow fish passage to the other high value fish resource areas in the Country-Cabbage Creek drainage located upstream.

Project Efficacy

Although both the "Beaver Deceiver" and notching project are viable options for mitigating flow through the beaver dam, only the beaver dam notching was modeled at this time. The beaver dam notching project was simulated by raising the channel bed 2 feet in the HEC-RAS model to simulate the effect of the existing beaver dam. Model results suggested that there would be significant backwater effects propagating upstream. Notching was simulated in the HEC-RAS model by utilizing the notching geometry recorded in the field. This geometry was a 4-foot notch width and a 2-foot notch depth at the beaver dam crest.

HEC-RAS analysis indicates that this notching would lower local water surface elevations 0.6 feet for the 2-year event. The model predicted that water surface elevations at the 164th Avenue SE bridge crossing would be lowered 0.2 feet. The model suggested that notching would increase local velocities from 5.74 ft/s to 6.91 ft/s for the 150 cfs 2-year flood event. The HEC-RAS model produces locally high velocities in the vicinity of the beaver dam upstream and downstream of the dam. The HEC-RAS model predicts velocities in the 2 to 3 ft/s range for the 150 cfs flow.

Further notching is suggested for this dam through the construction of an 8-foot notch reduced to the existing grade. Model results suggest than an 8-foot notch would reduce the backwater by 0.5 feet at the 164th bridge crossing, greatly helping local flooding problems. With an 8 foot wide notch, modeling suggests that local velocities at the beaver dam would decrease from 5.74 ft/s to 4.76 ft/s. However reach average velocities were predicted to increase from 1.93 ft/s to 3.03 ft/s. Overall water level drawdown effects would propagate nearly 3,000 feet upstream in this scenario.

Potential Challenges and Limitations

Beavers were nearly extinct in North American due to trapping through the 1800's. Any actions taken in or around beavers and beaver habitat will require coordination with area biologists. Historical beaver management practices primarily relied on trapping and removal. Some landowners still prefer this method, and non-lethal trapping is still a permitting activity in some areas of the state. Landowners must grant permission for these projects to be implemented. This project would need to be completed on lands owner by multiple parties. It may be a challenge to get all parties to agree on a preferred method of beaver management at this site. The "beaver deceiver" and notching will have to be monitored regularly, to insure that the beavers have not prevented flow through these structures.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $15,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

The work will be completed below the OHWM and will require placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 18: 164TH AVENUE SE CONVEYANCE PROJECT

Project 18 was developed in an effort to alleviate flooding problems at the 164th Avenue SE bridge crossing site, and to reduce backwater effects that may be worsening flooding in the project area. This project proposes to improve conveyance under the 164th Avenue SE road utilizing a high-flow channel and culvert on the right (north) bank of May Creek (Figure B-18). This project was identified as a Category B project during the prioritization process.

Site Location

Project 18 is located at May Creek RM 5.9. The site is located at the intersection of 164th Avenue SE and May Creek in King County, Washington (Figure 16, Appendix A).

Site Description

The site includes degraded wetlands on both the upstream and downstream sides of the 164th Avenue SE bridge and is effected by beaver dams on the downstream side of the bridge (Project 17). Based on the Conditions Report, landuse changes in the area eliminated the coniferous and deciduous-based forested wetlands likely historically presenting the valley, including at the site. The remnant wetland is predominantly reed canarygrass and willow. This section of May Creek is an undersized channel with ongoing loss of channel capacity as the result of sediment deposition and encroachment of reed canarygrass and other riparian shrubs. This area no longer functions as a forested wetland, but does have some flood attenuation, nutrient assimilation, and habitat value as a degraded wetland. The area frequently floods (Figure 9, Appendix A).

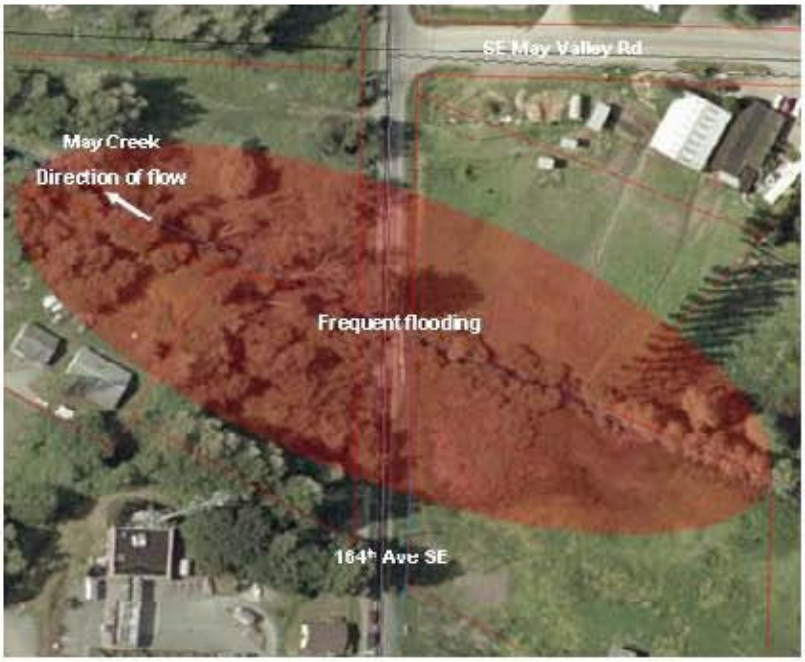
Project Description

Project 18 would construct a new high-flow channel under 164th Avenue SE, to the right of May Creek, to accommodate high flows without altering the existing bridge or channel alignment. The existing May Creek channel would not be modified. This project would be designed to help convey flood water and sediment past 164th Avenue SE. This would reduce flooding, sediment deposition, and loss of channel capacity upstream from 164th Avenue SE. The project would help to maintain a free-flowing stream channel in May Creek.

Project Efficacy

This project was modeled as a high flow bypass culvert on the 164th crossing, consisting a 10-foot wide by 4-foot tall culvert.

Analysis of the efficacy of the bypass culvert was modeled concurrent with the beaver mitigation project, due to the close spatial proximity. The upstream culvert invert was placed at an elevation of 316 feet and the downstream invert was placed at 315.5 feet. The model predicted that the overall effect of this project was a reduction in local velocities and a reduction in water surface elevation at the bridge crossing. The local velocity at the upstream side of the bridge crossing is reduced from 2.55 ft/s to 2.12 ft/s for the 2-year 150 cfs flow rate. When coupled with the beaver mitigation project, this bypass channel could be expected to lower the water surface elevation 0.47 feet at the upstream side of the bridge for the 150 cfs flow. Independent from the beaver management project, the bridge culvert project was predicted to offer little change in water surface elevations at the bridge crossing. However, the reduction in water surface elevation when coupled with beaver management could help alleviate flooding upstream of the bridge as well as addressing any current freeboard issues at the bridge crossing. The flood reduction benefits were modeled to extend approximately 2,300 feet upstream from the bridge.



Existing Conditions

Conceptual Drawing of high-flow channel and culvert

RED:\101079100500\December 2007 Draft CR\Figure B-18 Project 18 JTW/M_T 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 18

FIGURE B-18

Potential Challenges and Limitations

Work in this area would need to be well coordinated to minimize the effects on traffic using 164th Avenue SE. This road is heavily used and long-term closure would not be well received by residents or others that frequently use this road. King County may already be considering bridge or road improvements in the area. Coordination with county roads staff would be required to avoid duplication of effort or competing projects. The project would also include action on lands presently used of residential and animal pasture purposes. Landowners would need to grant permission for these projects to be implemented.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $160,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require in placing fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 19: TRIBUTARY 291-B CONFLUENCE AREA PROJECT

Project 19 would require the removal of reed canarygrass, and the construction of a wetland pond and buffer area and stream channel on the left (south) bank of May Creek at the present location of Tributary 291-B (Figure B-19). The purpose of the project would be to improve management of stormwater runoff from Tributary 291-B, located just upstream from the 164th Avenue SE bridge crossing. Benefits of Project 19 may be significantly improved with the concurrent implementation of Projects 17, 18, and IFP 3. Project 19 was identified as a Category L project during the prioritization process.

Site Location

Project 19 is located at May Creek RM 5.9 to RM 5.96. The site is located immediately upstream from the 164th Avenue SE crossing at the confluence of Tributary 291-B and May Creek (Figure 16, Appendix A).

Site Description

Based on information in the Conditions Report, landuse changes in the area eliminated the forested wetland likely historically present at the site. The site is currently a degraded wetland on both banks of May Creek and is predominantly vegetated with reed canarygrass and willow. The site is used as a livestock pasture.

The lower portions of Tributary 291-B do not have a readily identifiable channel (Figure 9, Appendix A). May Creek, however currently has an open, flowing channel immediately upstream from the 164th Avenue SE bridge. Reed canarygrass and sediment have accumulated at the site eliminating the lower portion of 291-B and a short distance upstream on May Creek.

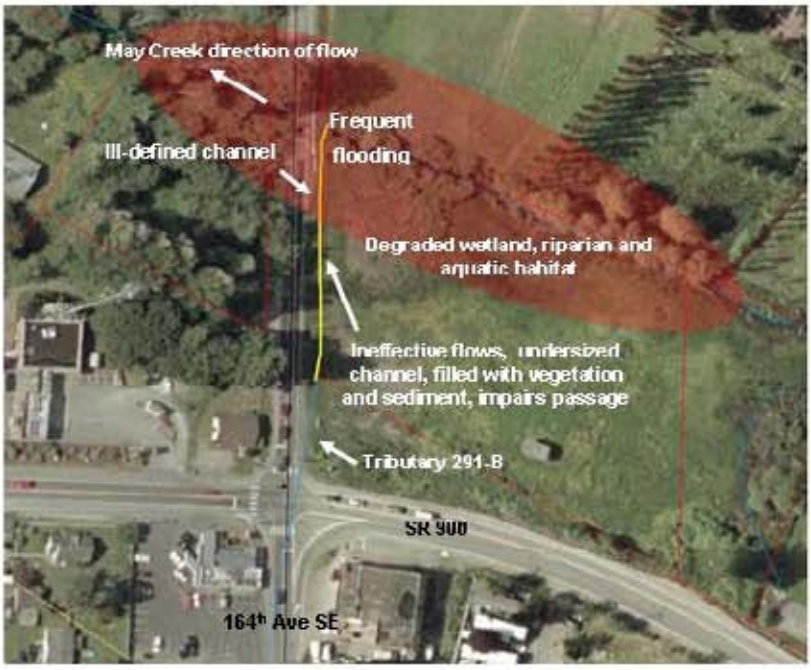
Project Description

Implementation of Project 19 would result in the construction of a new channel connecting Tributary 291-B to the left bank of the open channel section of May Creek. Tributary 291-B would be routed through a constructed wetland and enhanced buffer area to help attenuate stormwater flows and sediment contributions from Tributary 291-B. The wetland would also be enhanced to help assimilate high flows and sediment loads in May Creek. The existing riparian area would be improved to help maintain effective flows to reduce flooding and improve sediment transport processes to reduce sediment deposition. The existing May Creek channel would not be modified as part of this project. The improved riparian and wetland areas would also provide better fish habitat. The new channel would improve fish passage upstream. This project would also improve water temperatures by increasing conveyance and providing full channel shading.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits associated with changes to Tributary 291-B. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this unstable tributary would be expected to help reduce local flooding issues and improve downstream habitat. Further investigation into this project would be worthwhile. Quantitatively speaking, the project would enhance approximately 5,000 square feet of riparian habitat, 4,300 square feet of emergent wetland, and almost 21,000 square feet of wetland buffer area.

The potential benefits of wetland buffers proposed as part of Projects 19 and 20 were modeled simultaneously. Project 19, an estimated 0.58 acre wetland and buffer area, was modeled as approximately 120 feet wide and 280 feet long oriented in a longitudinal direction along May Creek. The wetland buffers were modeled using the same methodology as was used for other wetland buffer projects described earlier in the CRP, generally using the HEC-RAS model.



Existing Channel Conditions

Conceptual Drawing of Restored Channel and Riparian Area

REF: M:\JM\37\10005\00\December 2007 Draft CRP\Figure E-19 Project 19 JTM/MLT 12/17/07

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Conceptual Drawing Project 19

FIGURE B 19

Hydraflow modeling results indicated that the 2-year storm runoff for the Project 19 site would be reduced 52 percent from 0.084 cfs to 0.04 cfs. Flood attenuation calculations indicate that this wetland complex (combined Project 19 and 20) would have the potential to attenuate approximately 2 percent of the total stormwater volume of a typical event with a peak flow of 78 cfs.

Model results suggest that water surface elevations upstream of the 164th Street crossing would not be affected by this project for the 2-year event, assuming that Projects 18 and 17 were not implemented. Channel velocities were predicted to slightly decrease from 0.34 ft/s to 0.27 ft/s. The predicted channel velocities were very low in this reach, even without implementation of this project. New survey data did not extend more than 50 feet upstream of the bridge crossing. Therefore, old FEMA cross section data was utilized in this reach. Field observations made during a February 2007 site visit confirmed, however, that backwater effects of the beaver dam extended upstream from Project 19.

Potential Challenges and Limitations

The project is located adjacent to 164th Avenue SE. Construction work would benefit from ease of site access, but may congest the highly used intersection at 164th Avenue SE and SR-900. Some of pasture land would be converted from current uses to the constructed channel, riparian habitat and wetland area. It is unknown if these actions would be of interest to the landowner. Landowners must grant permission for these projects to be implemented. Saturated soils at the project location may make construction of the channel, wetland and riparian areas challenging, time consuming, and more expensive as compared with other habitat restoration projects.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $61,600 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require fill placement in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 20: STORMWATER/SEDIMENT RETENTION AREA

Project 20 would require the removal of reed canarygrass, and the construction of a wetland pond, stream channel and buffer on the left (south) bank of May Creek at the present location of an unnamed stormwater drain (Figure B-20). The purpose of the project would be to improve management of stormwater runoff at this site located just upstream from the 164th Avenue SE bridge crossing. Benefits of Project 20 may be significantly improved with the concurrent implementation of Projects 17, 18, 19, and IFP 3. This project was identified as a Category L project during the prioritization process.

Site Location

Proposed Project 20 is located at a point adjacent May Creek near RM 6.0 (Figure 16, Appendix A). The site is located approximately 500 feet upstream from the 164th Avenue SE crossing over May Creek in King County, Washington.

Site Description

The proposed site is a stormwater drainage area that crosses the property through degraded wetland. Based on the Conditions Report, landuse changes in the area eliminated the forested wetland likely historically present at the site. The area is presently used as a livestock pasture. The stormwater flow does not flow to May Creek through a readily discernable channel because reed canarygrass and sediment have accumulated at the site. May Creek is a relatively open, flowing channel adjacent the project area. The area frequently floods (Figure 9, Appendix A).

Project Description

This project would create a new tributary stream channel, wetland and wetland buffer at the site, connecting the existing stormwater drainage swale to the open channel of May Creek. The stormwater drainage system would be routed through a constructed wetland and enhanced buffer area to attenuate stormwater flows, sediment and nutrient runoff. The wetland would also be situated and improved to help assimilate high flows and sediment loads in May Creek. The existing riparian area would be improved to help maintain effective flows to reduce flooding and improve sediment transport processes to reduce sediment deposition. The existing May Creek channel would not be modified. The improved riparian and wetland areas would also help improve fish habitat. This project may also help improve water temperatures in May Creek by increasing conveyance and providing full channel shading.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits associated with changes to the stormwater drain. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this unstable tributary would be expected to help reduce local flooding issues and improve downstream habitat. Further investigation into this project would be worthwhile. Quantitatively speaking, the project would enhance approximately 15,000 square feet of riparian area, 33,000 square feet of wetland buffer, and create approximately 7,500 square feet of emergent wetland habitat.

Potential benefits of wetland buffers were modeled for Projects 19 and 20 simultaneously. Project 20, an estimated 0.93 acre wetland and buffer area, was estimated as approximately 120 feet wide and 300 feet long also oriented in a longitudinal direction along May Creek. The wetland buffers were modeled using the same methodology as was used for other wetland buffer projects described earlier in the CRP, generally using the HEC-RAS model.

Existing Conditions

Conceptual Drawing of Wetland and Riparian Restoration Area

RED:\10\10791005\00\December 2007 Draft CRP\Figure B-20 Project 20 JTM/MLT 12/17/07

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Conceptual Drawing Project 20

FIGURE B-20

Hydraflow modeling results indicated that the 2-year storm runoff for Project 20 would be reduced 54 percent from 0.125 cfs to 0.057 cfs. Flood attenuation calculations indicate that this wetland complex (both Project 19 and Project 20) would have the potential to attenuate approximately 2 percent of the total stormwater volume of a typical event a peak flow of 78 cfs.

Model results suggest that water surface elevations upstream of the 164th Street crossing would not be affected by this project for the 2-year event, assuming that Projects 18 and 17 were not implemented. Channel velocities were predicted to slightly decrease from 0.34 ft/s to 0.27 ft/s. The predicted channel velocities were very low in this reach, even without implementation of these projects. New survey data did not extend more than 50 feet upstream of the bridge crossing. Therefore, old FEMA cross section data was utilized in this reach. Field observations made during the February 2007 site visit suggest, however, that backwater effects of the beaver dam may extended upstream to Project 20 at certain flows.

Potential Challenges and Limitations

The project is located along SR 900. Construction may benefit from ease of site access but may congest the highly used SR-900. Much of the land would be converted to the constructed channel, riparian habitat and wetland area. Landowners would need to grant permission for this project to proceed. It is unknown if these actions would be of interest to the landowners. Saturated soils and heavy vegetation may make channel construction and riparian restoration efforts challenging, time consuming, and more expensive as compared with other habitat restoration projects.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Conceptual Designs and Planning-Level Cost Estimates

Estimated Construction Costs: $119,400 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require placement of fill in a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project also is expected to disturb over 1 acre of ground. As a result, additional permitting steps will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES) to secure a Construction Stormwater General Permit.

PROJECT 21: HENDRIX CREEK CONFLUENCE AREA PROJECT

Project 21 would require the removal of reed canarygrass, and the construction of a wetland pond and buffer area and stream channel on the left (south) bank of May Creek at the present location of Hendrix Creek (Figure B-21). The purpose of the project would be to improve management of stormwater runoff from Hendrix Creek as well as floodwater and sediment in May Creek. Benefits of Project 21 may be enhanced with the concurrent implementation of Project 22 and IFP 3. Project 21 was identified as a Category K project during the prioritization process.

Site Location

Project 21 is located between RM 6.2 and RM 6.45 on the left (south) bank of May Creek, where there should be a confluence area with Hendrix Creek (Figure 16, Appendix A).

Site Description

Based on the Conditions Report (King County 1995), landuse changes in the area has degraded the coniferous and deciduous-based forested wetland likely historically present at the site. The site is located on the left (south) bank of May Creek in a residential area open space that gets limited use. The existing wetland is primarily reed canarygrass and willow. May Creek is an open, flowing channel in the project area.

In the lower portions of Hendrix Creek there is no readily identifiable channel (Figure 10, Appendix A). May Creek, however currently has an open, flowing channel in the area upstream from the 164th Avenue SE bridge. Reed canarygrass and sediment have accumulated at the site eliminating the lower portion of Hendrix Creek.

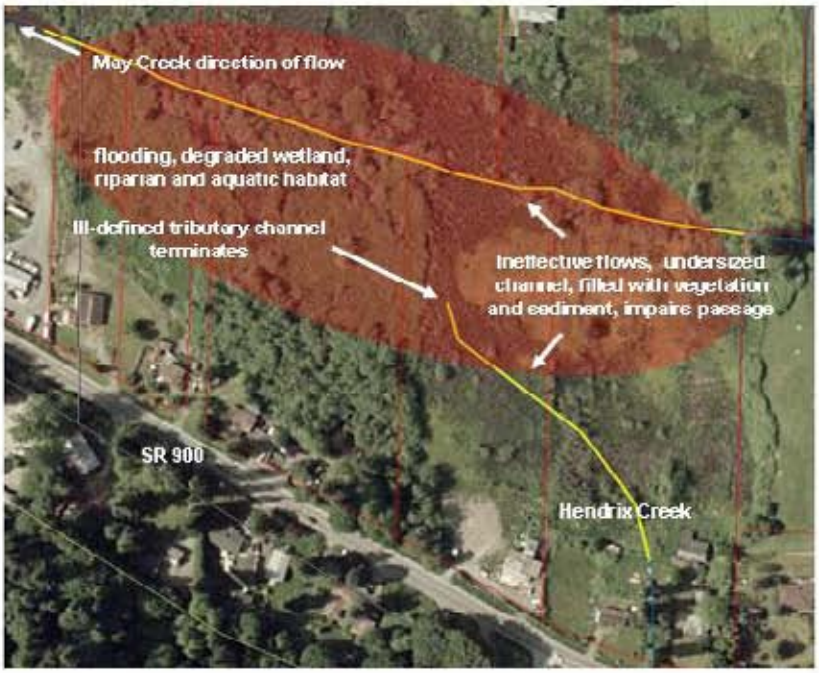
Project Description

Project 21 would create a wetland complex, buffer area, creek channel and enhanced riparian corridor adjacent to May Creek. The wetland would be designed to help assimilate high flows and sediment loads from both Hendrix Creek and May Creek. The riparian area would be enhanced to help maintain effective flows and sediment transport processes in the mainstem May Creek. The existing May Creek channel would not be modified. The intent of the project would be to help reduce flooding and sediment deposition in May Creek by improving flow and sediment conveyance. The improved riparian and wetland areas should also provide better fish habitat. This project may also improve water temperatures by increasing conveyance and providing full channel shading.

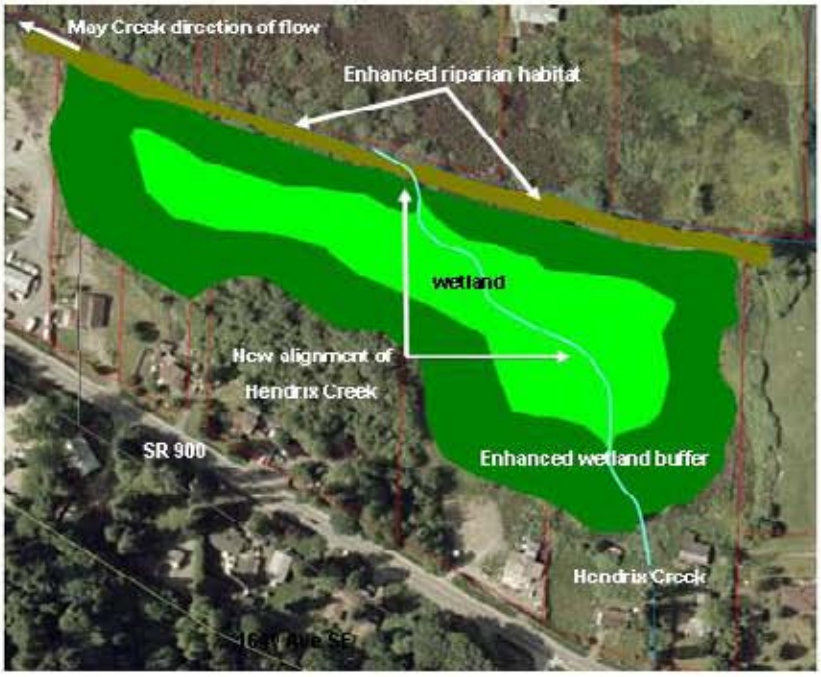
Project Efficacy

Projects 21 and 22 were modeled concurrently to determine project efficacy, due to their close spatial proximity to one another.

Project 21 was modeled as an 8.3 acre wetland and wetland buffer complex located on the left (south) bank of May Creek, approximately 1,650 ft upstream of the 164th Street bridge crossing. This wetland was modeled to buffer both inflowing Hendrix Creek flows and to attenuate downstream flood waves in the riparian zone of May Creek. Project 21 extends 1,000 feet in the longitudinal direction of May Creek and was modeled with an approximate width of 250 feet in the perpendicular direction. Project 22 was modeled as a 5.9 acre wetland and wetland buffer on the right (north) bank of May Creek, extending 1,600 feet longitudinally and 250 feet, parallel to May Creek. Both projects were modeled with standard procedures used for similar projects described in this CRP.



Existing Conditions



Conceptual Drawing of Tributary, Wetland and Riparian Restoration Area

RED:\1\1\1375\10050\00\December 2007 Draft CRP\Figure E-21 Project 21 JTM/MLT 12/17/07

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Conceptual Drawing Project 21

FIGURE B 21

Hydraflow results indicated that land use change associated with Project 21 would reduce stormwater runoff from the site from 0.84 cfs to 0.39 cfs for the 2-year event a 54 percent reduction. The combined wetland complex associated with Projects 21 and 22 represent the largest proposed stormwater attenuation site on the project list. Attenuation volume calculations indicate that these two wetland complexes have the potential to attenuate up to 9.4 percent of the flood runoff volume for a typical storm hydrograph for the stream producing a peak flow of 78 cfs. This would be a significant attenuation of peak flood, indeed.

Results suggested that Projects 21 and 22 would lower local velocities, based on a 150 cfs design flow, from 2.62 ft/s to 0.5ft/s in the downstream portion of the project and the water surfaces would increase very slightly (0.1 ft). In the upstream portion of the project velocities would not be lowered as severely.

The velocity reductions predicted in the upper portion of the reach of May Creek, adjacent Projects 21 and 22 would be lowered from approximately 3.0 ft/s to 2.4 ft/s for the 150 cfs flow. In the upper reach model results indicate that local flood levels should be lowered by 0.4 feet on average with maximum water surface lowering of 0.8 feet. The implementation of this project should alleviate some local flooding problems in this area, but the significantly reduced velocities may result in sedimentation of the channel.

Potential Challenges and Limitations

A significant area of land would be converted to the riparian habitat and wetland complex area. It is unknown if these actions would be of interest to the landowners. Landowners would need to grant permission for these projects to proceed. Saturated soils may make stream channel, wetland, wetland buffer, and riparian area construction efforts challenging, time-consuming, and expensive as compared with other habitat restoration projects in this CRP. This project would disturb well over 1 acre of area, necessitating additional permitting and regulatory considerations.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $362,000 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require placement of fill into to a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

The project would also disturb over 1 acre of ground. As a result, additional permitting will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES) to secure a Construction Stormwater General Permit.

PROJECT 22: NORTH HENDRIX WETLAND COMPLEX

Project 22 would require the removal of reed canarygrass, and the construction of a wetland pond and buffer area on the right (north) bank of May Creek (Figure B-22). The purpose of the project would be to attenuate floodwater and sediment in May Creek. Benefits of Project 22 may be enhanced with the concurrent implementation of Project 21 and IFP 3. Project 22 was identified as a Category K project during the prioritization process.

Site Location

Project 22 is located adjacent May Creek between RM 6.18 and RM 6.42. The site is located on the right bank (north) of May Creek across from Hendrix Creek (Figure 16, Appendix A).

Site Description

Based on the Conditions Report (King County 1995), landuse changes in the project area degraded the coniferous and deciduous-based forested wetland likely historically present at the site. The site presently functions as a degraded wetland on the north (right) bank of May Creek, in a residential area open space that gets limited use. The existing wetland is primarily reed canarygrass and willow. May Creek is an open, flowing channel in the project area, although the project site frequently floods (Figure 9, Appendix A).

Project Description

Project 22 would create a wetland complex, buffer area, and enhanced riparian corridor adjacent May Creek. The purpose of the wetland would be to help assimilate high flows and sediment loads in May Creek. The riparian area would be enhanced to help maintain effective flows and sediment transport processes. The existing May Creek channel would not be modified. In addition to addressing flooding and sedimentation problems, Project 22 would strive to improve riparian and wetland habitat areas, thereby potentially improving fish habitat. This project may also improve water temperatures by increasing conveyance and providing full channel shading.

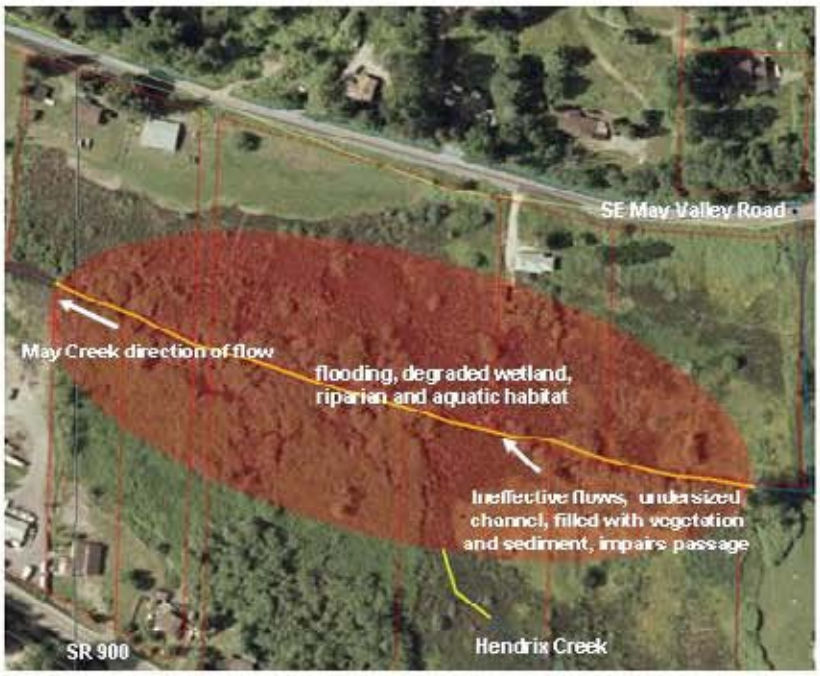
Project Efficacy

Projects 21 and 22 modeled concurrently to evaluate efficacy, due to their close spatial proximity to one another.

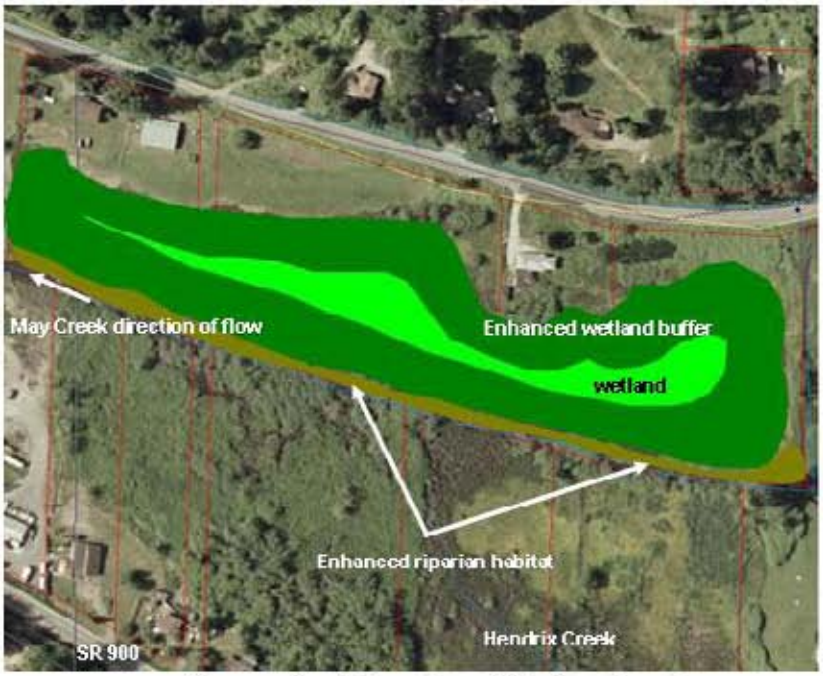
Project 22 was modeled as a 5.9 acre wetland and wetland buffer on the right (north) bank of May Creek, extending 1,600 feet longitudinally and 250 feet in the perpendicular direction., approximately 1,650 feet upstream of the 164th Street bridge crossing. This wetland was modeled to buffer both inflowing Hendrix Creek stream flows and to attenuate downstream flood waves in the riparian zone of May Creek. Both projects were modeled with standard procedures used for similar projects described in this CRP.

Hydraflow results indicate that land use change associated with Project 22 would result in a decrease in stormwater runoff from 0.64 cfs to 0.29 cfs, a 54 percent decrease. The combined wetland complex associated with Proejcts 21 and 22 represent the largest proposed stormwater attenuation site on the project list. Attenuation volume calculations indicate that these two wetland complexes have the potential to attenuate up to 9.4 percent of the flood runoff volume for a typical storm hydrograph for the stream producing a peak flow of 78 cfs. This would be a significant attenuation of peak flood, indeed.

Results indicate that Projects 21 and 22 would lower local velocities, based on a 150 cfs design flow, from 2.62 ft/s to 0.5ft/s in the downstream portion of the project and the water surfaces would increase very slightly (0.1 ft). In the upstream portion of the project velocities would not be lowered as severely.



Existing Conditions



Conceptual Drawing of Wetland and
Riparian Restoration Area

RED:\1317\10005\00\December 2007 Draft CRP\Figure E-22 Project 22 JTM/MLT 12/17/07

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Conceptual Drawing Project 22

FIGURE B 22

The velocity reductions predicted in the upper portion of the reach of May Creek, adjacent to Projects 21 and 22 would be lowered from approximately 3.0 ft/s to 2.4 ft/s for the 150 cfs flow. In the upper reach model results indicate that local flood levels should be lowered by 0.4 feet on average with maximum water surface lowering of 0.8 feet. The implementation of this project should alleviate some local flooding problems in this area, but the significantly reduced velocities may result in sedimentation of the channel.

Potential Challenges and Limitations

A significant area of land would be converted to the riparian habitat and wetland complex area. It is unknown if these actions would be of interest to the landowners. Landowners would need to grant permission for these projects to proceed. Saturated soils may make stream channel, wetland, wetland buffer, and riparian area construction efforts challenging, time-consuming, and expensive as compared with other habitat restoration projects in this CRP. This project would disturb well over 1 acre of area, necessitating additional permitting and regulatory considerations.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $172,800 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require placement of fill into a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would likely disturb over 1 acre of ground. As a result additional permits will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES) to secure a Construction Stormwater General Permit.

PROJECT 23: COHO OFF-CHANNEL REARING HABITAT (OSBORN PROPERTY)

Project 23 would convert an existing swale adjacent to May Creek into an off-channel habitat area (Figure B-23). This project was designed primarily as a habitat improvement project, given its close, downstream proximity to Country and Cabbage Creeks. This project may become important if coho salmon populations increase as a result of habitat improvements thorough implementation of Project 24 and IFP 3. This project was identified as a Category M project during the prioritization process.

Site Location

Project 23 is located adjacent May Creek near RM 6.45. The site is located approximately 300 feet downstream from the confluence of May Creek and Country Creek (Figure 17, Appendix A).

Site Description

The site is adjacent to one of the few free flowing, hard bottomed sections of May Creek. The site is currently maintained by residents with lawn and garden close to the bank of May Creek. Reed canarygrass and sediment have accumulated just downstream of the site. Reed canarygrass is prevalent at the site, but has not constricted the channel or impaired flows. As is true elsewhere in the valley, this section of May Creek was channelized and has a linear east-west orientation. In spite of having been channelized, this section of May Creek has clear, cool running water. The substrate is firm with a mix of sand and small gravel. Some medium and large gravel is present, as is large woody debris, cut banks, and rootwads. Overall the instream habitat appears healthy (Figure 10, Appendix A).

Project Description

This project would create a small off-channel habitat area immediately adjacent to and just downstream from the confluence of May Creek and Country Creek. The existing May Creek channel would not be modified as it is functioning reasonably well. The proposed project would create an off-channel rearing area and improve habitat for coho salmon and other salmonids known to use the Country-Cabbage Creek drainage.

The project is not expected to have significant flood attenuation, sediment reduction or erosion control benefits. Riparian vegetation planted at the site is expected to protect passage through this reach by helping to maintain the free flowing section of May Creek. The riparian vegetation will also help moderate water temperatures by shading May Creek.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. There was insufficient data to model potential hydraulic or hydrologic benefits for this project at this time. Qualitatively speaking, there are few pool habitat areas in the May Valley segment of May Creek. Coho salmon (O. kisutch) prefer to rear in deep, coldwater habitat early in life. While it is unlikely that this project would provide significant hydraulic or hydrologic benefits, such a project could be coupled with other proposed projects, such as Project 24 to achieve a combined habitat improvement/flood reduction objective. Further investigation into this project seems warranted. Quantitatively speaking, the project would create about 200 linear fee of new side-channel habitat and 1,000 square feet of pool habitat, and approximately 1,500 square feet of enhanced riparian habitat.

Existing Conditions

Conceptual Drawing of off-channel coho rearing habitat area

RED:\10\10791005\00\December 2007 Draft CRP\Figure B-23 Project 23 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 23

FIGURE B-23

Potential Challenges and Limitations

The landowner would need to grant permission for this project to proceed. The project area presently shows the effects of lawn and garden maintenance. Some of the area would be converted to riparian and off-channel habitat. It is unknown if these actions would be of interest to landowners. In addition, the current landowner may be in the process of selling the property. It is not known if and when a change in ownership might occur. This uncertainty makes it difficult to establish a timeline for implementation of such a project.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Project-Level Cost Estimates

Estimated Construction Costs: $27,300 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require placing fill into a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 24: LOWER COUNTRY CREEK ENHANCEMENT PROJECT

Project 24 is and aquatic habitat restoration project associated with three culvert replacement projects proposed in the Country-Cabbage Creek drainage (Figure B-24). These projects are proposed for two reasons. First, historic changes to the alignment of Country and Cabbage Creeks have created unstable channels that area subject to flooding, erosion and other problems. Second, the Action Plan (King County 2001) has identified the Country-Cabbage Creek drainage as a Locally Significant Resource Area (LSRA) based on a high level of habitat utilization by coho Salmon (O. kisutch) and cutthroat trout (O. clarki). This project was identified as a Category I project during the prioritization process.

Site Location

Project 24 is within Country Creek, just upstream from its confluence with May Creek near RM 6.5 (Figure 17, Appendix A). The site is located within the lower 700 feet of Country Creek (RM 0 to 0.15).

Site Description

The Country-Cabbage Creek drainage is one of the few free flowing, hard substrate tributaries to May Creek in the May Valley. The Country-Cabbage drainage has been identified by WDFW as a Locally Significant Resource Area due to high habitat use by coho Salmon (O. kisutch) and cutthroat trout (O. clarki). The site is presently used for lawn and garden by the residents and landscaping is maintained close to the bank of the creek, resulting is an overly narrow riparian corridor. As is true elsewhere in the valley, lower Country Creek was channelized. In spite of having been channelized, this section of creek has clear, cool running water. The substrate is firm with a mix of sand and small gravel. Some medium and large gravel is present, as is some woody debris. Overall the aquatic habitat appears relatively healthy, although simplified by channelization and clearing of riparian vegetation (Figure 10, Appendix A).

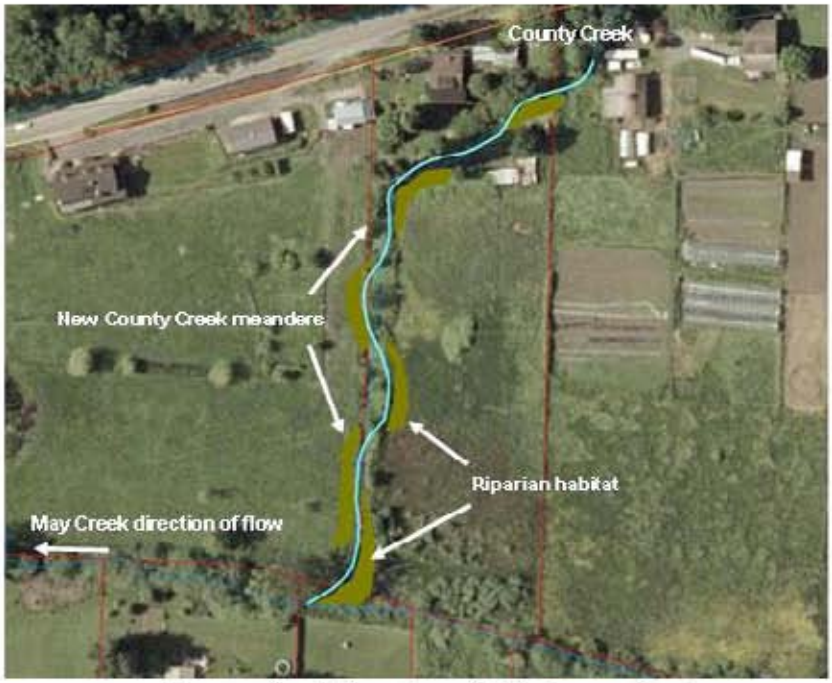
Project Description

Project 24 would restore a meandering creek orientation with a higher degree of habitat complexity and a corresponding riparian corridor to improve fish habitat. The project would use of combination of rock and wood bioengineered solutions to improve the coho salmon and cutthroat trout spawning and rearing habitat already present at the site. The project is also expected to have flood and erosion reduction benefits. With a linear orientation, high velocities are generated during high flows in the lower Country Creek periodically causing the creek to overflow its banks. Riparian vegetation planted at the site is expected to add further protection against erosion, flooding, and departures form the channel. Riparian vegetation would also help to moderate water temperatures by shading lower Country Creek. The existing May Creek channel in the confluence area would not be modified as it is functioning reasonably well.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this tributary would be expected to help reduce local flooding issues and improve downstream habitat. In addition, improving the passage corridor Country Creek and May Creek and increasing habitat complexity in lower Country Creek would better enable coho salmon (O. kisutch) and cutthroat trout (O. clarki) to make better use of this high fish use area (Figure 5, Appendix A). Further investigation into this project would be worthwhile. Quantitatively speaking, the project would create about 750 linear feet of instream habitat improvements and enhance approximately 8,000 square feet of riparian habitat.

Existing Conditions



Conceptual Drawing of off-channel coho rearing habitat area

REF:\\1317510050\00\December 2007 Draft CRP\Figure E-24 Project 24 JTM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 24

FIGURE B 24

Potential Challenges and Limitations

Landowners would need to grant permission for this project to proceed. The project area presently shows the effects of lawn and garden maintenance. Some of the area would be converted to riparian and off-channel habitat. It is unknown if these actions would be of interest to landowners. It will be necessary to work with area biologists including representatives of local Tribes and WDFW to avoid impacts to existing, well-functioning habitat in the project area.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $74,600 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM, and will require placement of fill into a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

PROJECT 25: CABBAGE CREEK CULVERT REPLACEMENT

Project 25 is primarily a culvert replacement project, similar to several other projects being proposed in this CRP. This project was identified as a Category H project during the prioritization process.

This project was selected as a pilot project to be implemented in 2007 or 2008 in an attempt to begin mitigating flooding and address some of the negative effects of erosion and downstream transport of sediment eroded from Cabbage Creek. This project was presented in a Pre-Design Report (GeoEngineers 2007). It is one of four projects identified as potential early-implementation projects proposed for implementation in 2007 and 2008. As a result, a more detailed overview is provided for this project, as compared to the majority of the other projects in this Appendix. The detail is provided for this project, based on the additional work that the project team completed during the predesign process in early 2007.

Site Location

Project 25 is located at the intersection of the SE May Valley Road and Cabbage Creek (Tributary 293). The culvert is located in the NW¼ NE¼ of Section 12, Township 23 N. Range 5 E., W.M., King County, Washington (Figure 17, Appendix A).

Cabbage Creek joins Country Creek prior to flowing into May Creek at approximately RM 6.5 (Conditions Report, King County 1995). The culvert to be replaced under SE May Valley Road is located at approximately RM 0.2 along the Country/Cabbage Creek drainage.

Site Description

Country and Cabbage Creeks drain a portion of the uplands to the north of May Valley known as the Highlands (Conditions Report, King County 1995). Historic maps do not show Cabbage Creek as a tributary to either Country or May Creek. The Conditions Report, however, identifies Cabbage Creek as having been diverted into Country Creek. The current alignment of Country and Cabbage Creeks shows the direction of flow as south-southeasterly perpendicular to SE May Valley Road. After passing under SE May Valley Road, both creeks orient in an east-west direction, roughly parallel to SE May Valley Road before crossing the north side of May Valley to a point of confluence with May Creek.

The Condition Report (King County 1995) describes the Country/Cabbage Creek drainage as having a fairly low gradient (one to seven percent) through the shared, compound alluvial fan from its confluence with May Creek upstream to approximately RM 0.2. Between RM 0.2 and the road crossing, Cabbage Creek is contained in an artificial channel parallel to SE May Valley Road. Upstream from the culvert, the creeks flow through steep bedrock slope with a steep gradient (greater than 15 percent). Cabbage and Country Creeks both upstream and downstream from the SE May Valley Road have been altered. These alterations have resulted in flooding, erosion, habitat degradation and fish passage problems (Figure 10, Appendix A).

The Country and Cabbage Creek stream channel, along the compound alluvial fan downstream from the road crossing, has alternating low (1) to high (12) width/depth ratio indicating incision or dredging into the compound alluvial fan. In spite of these alterations, the County/Cabbage Creek drainage is characterized as fairly stable, with relatively little watershed disturbance or risk of worsening conditions in the future (Conditions Report, King County 1995).

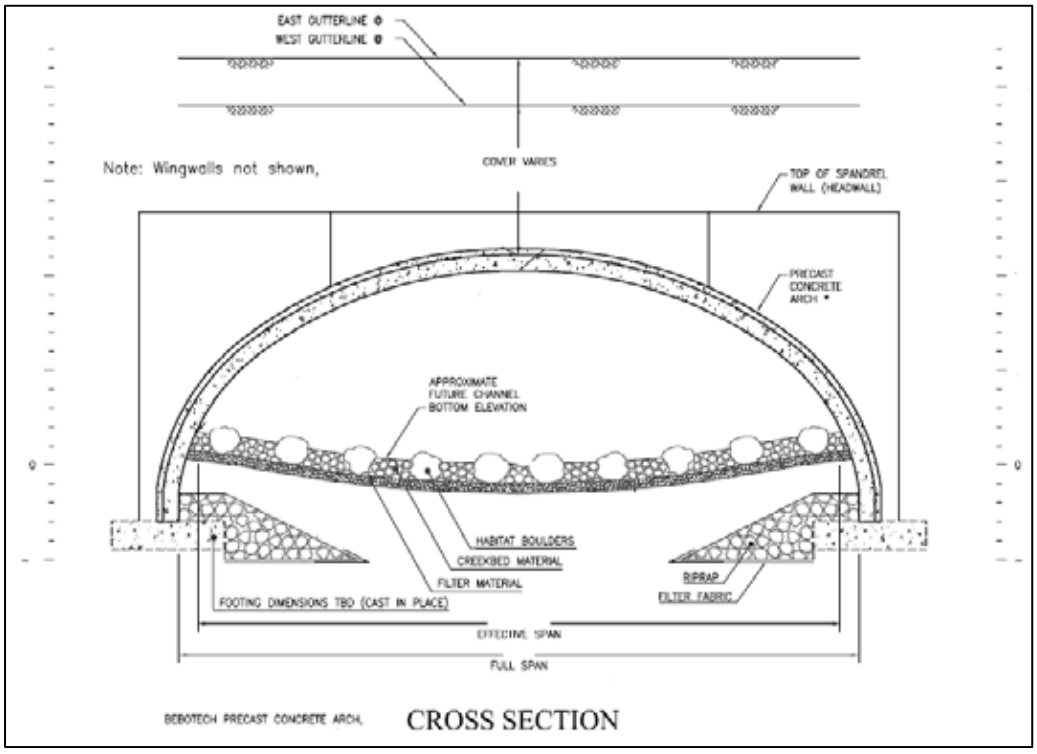
The existing 60 inch round diameter corrugated metal culvert (intake) at Cabbage Creek in the May Valley, Washington.

The existing corrugated metal culvert (outlet) at Cabbage Creek in the May Valley, Washington.

Project Description

This project proposes to replace the dysfunctional culvert on Cabbage Creek to provide some immediate relief to flood, fish passage, and fish habitat problems identified in the Action Plan (King County 2001). The replacement will be designed in accordance with the stream simulation methodology specified in the WDFW manual titled "Design of Road Culverts for Fish Passage" (Bates 2003). The new structure will be designed to facilitate fish passage and access to an additional 0.22 miles of habitat available above the culvert, up to a natural barrier. The project is also expected to reduce erosion, bank failure and flooding by aligning the channel to orient the stream in the direction of the downstream channel rather than perpendicular.

The proposed Cabbage Creek Culvert Replacement project includes the installation of a bottomless, concrete arch or similar structure to replace the existing culvert. The replacement culvert will be designed in accordance with the stream simulation methodology specified in the WDFW manual titled "Design of Road Culverts for Fish Passage" (Bates 2003). Stream simulation is a design process for creating natural stream processes within a culvert, with sediment transport, fish passage, flood and debris conveyance within the culvert intended to function as they would in a natural channel. The proposed structure will be located within the footprint of the existing SE May Valley Road prism. The roadway embankments in the vicinity of the wingwalls will require riprap to protect the embankments and wingwalls from scour.



Conceptual drawing of a pre-cast concrete arch bridge that could be used in place of the existing undersized culvert at Cabbage Creek in the May Valley, Washington.

The alignment of the proposed culvert may be skewed relative to the existing road prism. Skewing the culvert would shift the outlet towards the orientation (west-flowing) of Cabbage Creek below the culvert, to help reduce flooding and erosion caused by the current orientation of the stream downstream from the existing culvert. This alignment will also reduce the potential for downstream scour. If left uncorrected, higher stream flows through the existing culvert and residual scour of the south bank of the creek downstream from the culvert may necessitate aggressive streambank treatments such as berms and bank armoring to reduce bank erosion. While such action may temporarily address scour and low recurrence flooding problems, such actions would only perpetuate erosion, flooding, fish passage, and fish habitat problems.

A new streambed could be constructed inside the proposed culvert. A new channel could be lined with a gravel filter and substrate consisting of rounded gravel, cobbles, and boulders. In addition to protecting the structure and channel from scour and significant degradation, the larger elements of this substrate would create eddies to facilitate the upstream passage of fish. Footings for the proposed culvert would be set far enough below the proposed elevation of the stream channel to provide the necessary bearing capacity for the structure and adequate coverage for unanticipated scour and degradation. Footings would be protected from potential local scour with a layer of riprap.

If this project is implemented, construction crews should use a variety of Best Management Practices (BMPs) to control erosion and sediment transport throughout construction and continuing until the new vegetation has become established. Silt fences could be constructed around excavation areas and spoil stockpiles to reduce the introduction of fine sediments into adjacent waters. Straw blankets could be placed on exposed road prism slopes during construction to reduce erosion from direct precipitation. Disturbed road prism slopes could be hydroseeded and revegetated with native plants after final grading is completed. Trees that need to be removed during construction should be replaced at a 2:1 mitigation ratio.

The existing culvert is a corrugated metal pipe with a capacity of approximately 104 cfs and a capacity to convey flows up to the 25 year recurrence (Conditions Report 1995). These flow conveyance estimates made in 1995 may no longer represent the existing condition. Rather, the report predicted that future conditions would degrade to the point that flooding would occur at recurrence intervals closer to the 5-year event as a result of upslope development and sediment deposition in the culvert.

The corrugated metal pipe has a diameter of approximately 60 inches with a pitch of approximately 1 percent. During site visits made in 2007, the culvert flow conveyance capacity was observed to have been diminished as a result of deposition of sand and gravel, concentrated in the downstream end of the pipe. Cabbage Creek, upstream from the culvert, was measured to have a wetted width of approximately 48 inches and a bankfull width of approximately 96 inches.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this tributary would be expected to help reduce local flooding issues and improve downstream habitat. In addition, improving the passage corridor through Cabbage Creek would permit access to fish habitat present but not regularly accessed above the dysfunctional culvert. Increasing habitat complexity in Cabbage Creek would better enable coho salmon (O. kisutch) and cutthroat trout (O. clarki) to make better use of this Locally Significant Resource Area (LSRA) as identified in the Action Plan (King County 2001). Further investigation into this project would be worthwhile.

Potential Challenges and Limitations

This project is not anticipated to create any significant downstream impacts. The project is located above RM 6.5 on May Creek. Any changes to the movement of water or temporary displacement of substrate or sediment are expected to be dissipated in low-gradient reaches of May Creek in the May Valley. Localized challenges or considerations would include working with landowners to secure the necessary site access and easements, routing traffic during construction, timing construction to avoid or minimize impacts to priority habitat and species. Additional challenges would include securing the necessary funding and permits to complete the work.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

The proposed project would include the design, permitting and construction of a pre-fabricated, concrete arch or similar structure. The structure would be designed to accommodate flow up to the estimated 100-year recurrence interval, thereby significantly reducing the frequency of flooding and associated problems at the site. The structure would also be better aligned with the orientation of the existing downstream channel, reducing shear stress, erosion and the need for bank armoring presently required downstream from the existing culvert. The conceptual design illustrated above envisions use of a prefabricated, concrete arch with associated substrate and boulder habitat features proposed for this site.

Estimated Construction Costs: $160,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

If the culvert replacement project is deemed appropriate for implementation, culvert project design will be completed in accordance with the requirements outlines in the U.S. Army Corps of Engineers (COE) document titled “User’s Guide to the Programmatic Consultation for the Removal of Fish Passage Barriers” dated July 29, 2002. This guide represents the first chapter of the COE’s “Programmatic Biological Evaluation for Habitat Restoration/Rehabilitation Activities in the State of Washington for Species Listed or Proposed by the National Marine Fisheries Service and U.S. Fish and Wildlife Service under the Endangered Species Act,” approved by NOAA Fisheries on May 19, 2002 and the U.S. Fish and Wildlife Service on May 29, 2002. Although no threatened, endangered, or candidate fish species are know to utilize the Cabbage/Country Creek tributary to May Creek, sensitive fish species do utilize the canyon and delta sections of May Creek downstream from May Valley.

At least a portion of the proposed project will be completed below the ordinary high water mark. It is likely, therefore, that the following permits and regulatory compliance steps will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval, potential consultation with USFWS
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- WDFW Area biologist and Tribal Consultation

Project proponents may qualify for and elect to seek a Section 404 permit from the COE (using programmatic Section 7 consultation procedures as described in the above-referenced documents) and a streamlined Hydraulic Project Approval (HPA) from the Washington Department of fish and Wildlife (WDFW). Under the streamlined HPA process, the culvert project would be exempt from the Washington State Environmental Policy Act (SEPA) and local government permits and fees.

PROJECT 26: COUNTRY CREEK CULVERT REPLACEMENT

Project 26 is primarily a culvert replacement project, similar to several other projects being proposed in this CRP. There is a more detailed overview for this project, as compared to the majority of the other projects in this Appendix, because additional information was collected at the project site during the pre-design phase. The project is located in close proximity to Project 25, which was proposed for early implementation during the pre-design phase. The added detail is provided for this project, based on the additional work that the project team completed during the predesign process in early 2007. This project was identified as a Category H project during the prioritization process.

Site Location

Project 26 is located at the intersection of the SE May Valley Road and Country Creek (Tributary 292), approximately 0.2 RM upstream from the confluence of Country Creek with May Creek at RM 6.5. The culvert is located within the NW¼ NE¼ of Section 12, Township 23 N. Range 5 E.,W.M., King County, Washington (Figure 17, Appendix A).

Site Description

Country Creek drains a portion of the uplands to the north of May Valley known as the Highlands (Conditions Report, King County 1995). The Conditions Report identifies Country Creek as having been altered, to an alignment generally in a south-southeasterly perpendicular to SE May Valley Road. Prior to alteration, Country Creek likely followed a more direct path to its confluence with May Creek. Presently, Country Creek downstream from the culvert under the SE May Valley Road is oriented in an east-west direction, roughly parallel to SE May Valley Road.

The Condition Report (King County 1995) describes the Country Creek drainage as having a fairly low gradient (one to seven percent) across the compound alluvial fan from its confluence with May Creek upstream to approximately RM 0.2. Between RM 0.2 and the road crossing, Country Creek is contained in an artificial channel oriented parallel to SE May Valley Road. Upstream from the culvert, the creek flows through steep bedrock slope with a steep gradient (greater than 15 percent). Country Creek, upstream from the culvert, has been altered resulting in flooding, erosion, habitat degradation and fish passage problems throughout its length (Figure 10, Appendix A).

The Country Creek stream channel along the compound alluvial fan downstream from the road crossing has alternating low (1) to high (12) width/depth ratio indicating incision or dredging into the compound alluvial fan. In spite of these alterations, the County/Cabbage Creek drainage is characterized as fairly stable, with relatively little watershed disturbance or risk of worsening conditions in the future (Conditions Report, King County 1995).

Lower Country Creek is a relatively stable channel and is considered a Locally Significant Resource Area (LSRA) due to it use by Coho salmons and cutthroat trout for rearing purposes (Action Plan 2001, Conditions Report 1995). This section of creek, however, has been altered and has degraded habitat (see proposed Project 24).

The existing fiberglass culvert under the SE May Valley Road has a diameter of approximately 40 inches, is approximately 40 feet long, comprised of 3 sections of pipe, with a pitch of approximately 5 percent. During a July 2007 site visit, all flow in Country Creek was passing under the fiberglass culvert and through the road prism rather than through the culvert. Country Creek, upstream from the culvert, was observed to have a confined channel with a stone and mortar armored streambank. Riparian vegetation was primarily horsetail, salmonberry, cultivated shrubs and grass lawn. The upstream channel wetted width was approximately 12 inches, with an estimated bankfull width of 48 inches and bankfull depth of 55 inches.

The downstream channel stream-banks were found to be heavily armored with riprap, and covered with vegetation including: hazelnut, maple, salmonberry, blackberry, and reed canarygrass. The Country Creek channel downstream from the culvert was estimated to have a wetted width of 84 inches, a bankfull width of 144 inches, and a bankfull depth of 60 inches.

The existing fiberglass culvert at Country Creek (intake) is heavily armored with rock and mortar with degraded riparian habitat.

The existing 40 inch diameter fiberglass culvert (outlet) at
Country Creek located in the May Valley, Washington.

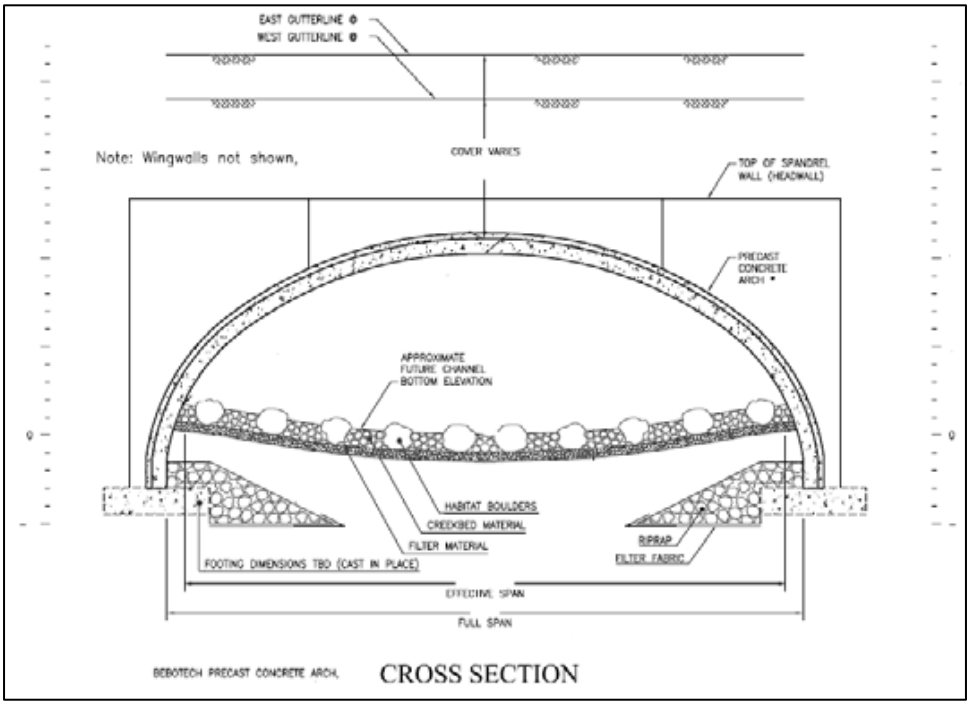
During a June 29, 2007 site visit numerous fish were observed in the pool located downstream of the culvert. Fish were not, however, found upstream of the culvert, nor were they found in the project vicinity a subsequent site visit in July.

Project Description

Project 26 would replace the dysfunctional culvert on Country Creek to provide some immediate relief to flood, fish passage, and fish habitat problems identified in the Action Plan (King County 2001). The replacement will be designed in accordance with the stream simulation methodology specified in the WDFW manual titled "Design of Road Culverts for Fish Passage" (Bates 2003). The new structure will be designed to facilitate fish passage and access to an additional 0.24 miles of habitat available above the culvert, up to a natural barrier. The project is also expected to reduce erosion, bank failure and flooding by aligning the channel to orient the stream in the direction of the downstream channel rather than perpendicular.

The existing culvert is a fiberglass reinforced pipe with a capacity of approximately 145 cfs and the ability to convey flows up to the 100-year recurrence (Conditions Report 1995). These flow conveyance estimates made in 1995 may no longer represent the existing condition. The proposed Country Creek

Culvert Replacement project would include the installation of a bottomless, concrete arch or similar structure to replace the existing culvert.



Conceptual drawing of a pre-cast concrete arch bridge proposed for use at the SE May Valley Road crossing over Country Creek.

The proposed project would include the design, permitting and construction of a pre-fabricated, concrete arch or similar structure. The structure would be designed to accommodate flow up to the estimated 100-year recurrence interval, thereby significantly reducing the frequency of flooding and associated problems at the site. The structure would also be better aligned with the orientation of the existing downstream channel, reducing shear stress, erosion and the need for bank armoring presently required downstream from the existing culvert. Above is a conceptual drawing of a prefabricated, concrete arch with associated substrate and boulder habitat features proposed for this site.

The proposed Country Creek Culvert Replacement project includes the installation of a bottomless, concrete arch or similar structure to replace the existing culvert. The replacement culvert will be designed in accordance with the stream simulation methodology specified in the WDFW manual titled "Design of Road Culverts for Fish Passage" (Bates 2003). Stream simulation is a design process for creating natural stream processes within a culvert, with sediment transport, fish passage, flood and debris conveyance within the culvert intended to function as they would in a natural channel. The proposed structure will be located within the footprint of the existing SE May Valley Road prism. The roadway embankments in the vicinity of the wingwalls will require riprap to protect the embankments and wingwalls from scour.

The alignment of the proposed culvert may be skewed relative to the existing road prism. Skewing the culvert would shift the outlet towards the orientation (west-flowing) of Country Creek below the culvert, to help reduce flooding and erosion caused by the current orientation of the stream downstream from the

existing culvert. This alignment will also reduce the potential for downstream scour. If left uncorrected, higher stream flows through the existing culvert and residual scour of the north bank of the Coxon/Patterson property may necessitate aggressive streambank treatments such as berms and bank armoring to reduce bank erosion. While such action may temporarily address scour and low recurrence flooding problems, such actions would only perpetuate erosion, flooding, fish passage, and fish habitat problems.

A new streambed could be constructed inside the proposed culvert. A new channel could be lined with a gravel filter and substrate consisting of rounded gravel, cobbles, and boulders. In addition to protecting the structure and channel from scour and significant degradation, the larger elements of this substrate would create eddies to facilitate the upstream passage of fish. Footings for the proposed culvert would be set far enough below the proposed elevation of the stream channel to provide the necessary bearing capacity for the structure and adequate coverage for unanticipated scour and degradation. Footings would be protected from potential local scour with a layer of riprap.

If this project is implemented construction crews should use a variety of Best Management Practices (BMPs) to control erosion and sediment transport throughout construction and continuing until the new vegetation has become established. Silt fences could be constructed around excavation areas and spoil stockpiles to reduce the introduction of fine sediments into adjacent waters. Straw blankets could be placed on exposed road prism slopes during construction to reduce erosion from direct precipitation. Disturbed road prism slopes could be hydroseeded and revegetated with native plants after final grading is completed. Trees that need to be removed during construction should be replaced at a 2:1 mitigation ratio.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this tributary would be expected to help reduce local flooding issues and improve downstream habitat. In addition, improving the passage corridor through Cabbage Creek would permit access to fish habitat present but not regularly accessed above the dysfunctional culvert. Increasing habitat complexity in Cabbage Creek would better enable coho salmon (O. kisutch) and cutthroat trout (O. clarki) to make better use of this Locally Significant Resource Area (LSRA) as identified in the Action Plan (King County 2001). Further investigation into this project would be worthwhile.

Potential Challenges and Limitations

This project is not anticipated to create any significant downstream impacts. The project is located above RM 6.5 on May Creek. Any changes to the movement of water or temporary displacement of substrate or sediment are expected to be dissipated in low-gradient reaches of May Creek in the May Valley.

Localized challenges or considerations would include working with landowners to secure the necessary site access and easements, routing traffic during construction, timing construction to avoid or minimize impacts to priority habitat and species. Additional challenges would include securing the necessary funding and permits to complete the work.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any

impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning Level Cost Estimates

Estimated Construction Costs: $160,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

If the culvert replacement project is deemed appropriate for implementation, culvert project design will be completed in accordance with the requirements outlines in the U.S. Army Corps of Engineers (COE) document titled "User's Guide to the Programmatic Consultation for the Removal of Fish Passage Barriers" dated July 29, 2002. This guide represents the first chapter of the COE's "Programmatic Biological Evaluation for Habitat Restoration/Rehabilitation Activities in the State of Washington for Species Listed or Proposed by the National Marine Fisheries Service and U.S. Fish and Wildlife Service under the Endangered Species Act," approved by NOAA Fisheries on May 19, 2002 and the U.S. Fish and Wildlife Service on May 29, 2002. Although no threatened, endangered, or candidate fish species are know to utilize the Country Creek tributary to May Creek, sensitive fish species do utilize the canyon and delta sections of May Creek downstream from May Valley.

A portion of the proposed project will be completed below the ordinary high water mark. It is likely, therefore, that the following permits and regulatory compliance steps will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval, potential consultation with USFWS
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- WDFW Area biologist and Tribal Consultation

Project proponents may qualify for and elect to seek a Section 404 permit from the COE (using programmatic Section 7 consultation procedures as described in the above-referenced documents) and a streamlined Hydraulic Project Approval (HPA) from the Washington Department of fish and Wildlife (WDFW). Under the streamlined HPA process, the culvert project would be exempt from the Washington State Environmental Policy Act (SEPA) and local government permits and fees.

PROJECT 27: COUNTY-CABBAGE CREEK CULVERT REPLACEMENT

Project 27 is primarily a culvert replacement project, similar to several other projects being proposed in this CRP. There is a more detailed overview for this project, as compared to the majority of the other projects in this Appendix, because additional information was collected at the project site during the pre-design phase. The project is located in close proximity to Project 25 and 26. Project 25 was proposed for early implementation during the pre-design phase. The added detail is provided for this project, based on the additional work that the project team completed during the predesign process in early 2007. This project was identified as a Category H project during the prioritization process.

Site Location

This project is located approximately 150 feet downstream from the confluence of County and Cabbage Creeks near the intersection of the SE May Valley Road and Country Creek (Tributary 292). The project is approximately 0.2 RM upstream from the confluence of Country Creek with May Creek at RM 6.5. The culvert is located within the NW¼ NE¼ of Section 12, T 23 N. R 5 E.,W.M. in King County, Washington (Figure 17, Appendix A).

Site Description

Country and Cabbage Creeks drain a portion of the uplands to the north of May Valley known as the Highlands (Conditions Report, King County 1995). The Condition Report describes the Country Creek drainage as having a fairly low gradient (one to seven percent) across the compound alluvial fan from its confluence with May Creek upstream to approximately RM 0.2. Between RM 0.2 and the road crossing, Country Creek is contained in an artificial channel oriented parallel to SE May Valley Road.

The Country Creek stream channel along the compound alluvial fan downstream from the road crossing has alternating low (1) to high (12) width/depth ratio indicating incision or dredging into the compound alluvial fan. In spite of these alterations, the County/Cabbage Creek drainage is characterized as fairly stable, with relatively little watershed disturbance or risk of worsening conditions in the future (Figure 10, Appendix A).

Lower Country Creek is a relatively stable channel and is considered a Locally Significant Resource Area (LSRA) due to it use by Coho salmons and cutthroat trout for rearing purposes (Action Plan 2001, Conditions Report 1995). This section of creek, however, has been altered and has degraded habitat (see proposed Project 24).

A private driveway over Country Creek provides landowners access to that portion of the May Valley located south of the SE May Valley Road, as well as County and Cabbage Creeks. There is an existing 50-inch diameter smooth concrete culvert that is approximately 20 feet long, with a 12 inch smooth concrete overflow culvert located on the south side of the 50 inch culvert. The upstream channel wetted width was approximately 60 inches, with an estimated bankfull width of 240 inches and bankfull depth of 72 inches.

The downstream end of the 50 inch concrete culvert include a corrugated metal pipe culvert has been crushed by excessive force applied to a poorly designed road bed and prism around the culvert. The Country Creek channel downstream from the partially crushed corrugated metal pipe culvert was found to have a riparian streambank dominated by blackberry with an estimated wetted width of 120 inches, bankfull width of 360 inches, and bankfull depth of 96 inches.

Together, these structures serve as the creek crossing. Country Creek upstream the concrete culvert intake was observed to be heavily armored and densely vegetated with hardtack, blackberry, and salmonberry.

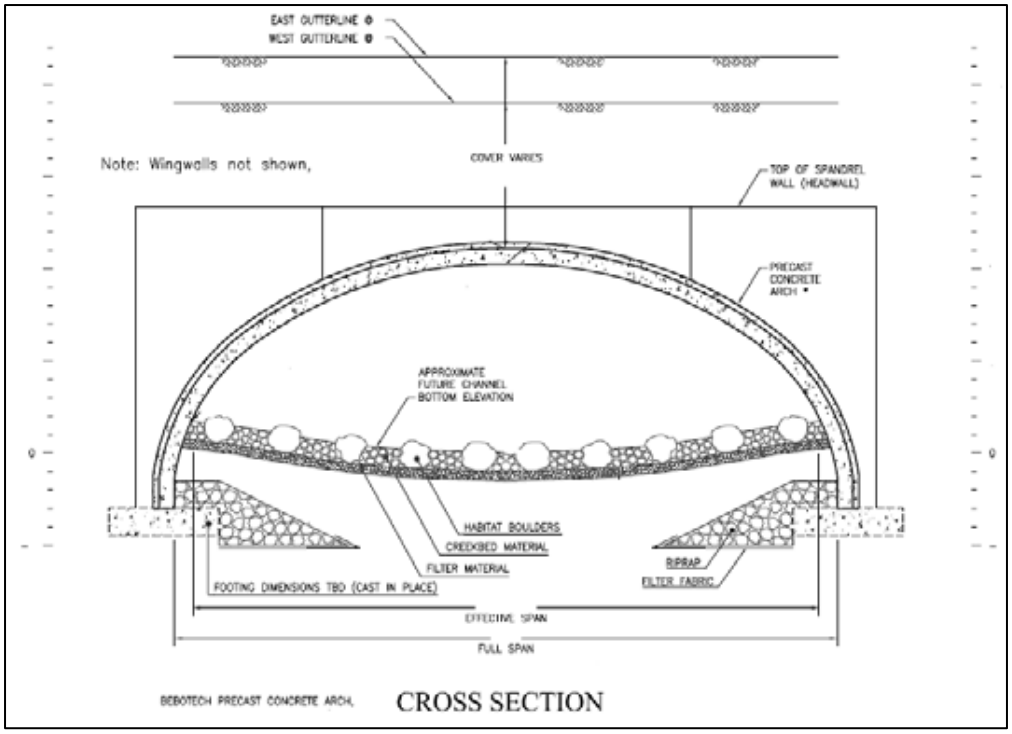
The existing 50 inch smooth concrete culvert (intake) at Country Creek located in the May Valley, Washington.

The existing fiberglass culvert at Country Creek (outlet) is heavily armored with rock and mortar with degraded riparian habitat.

Project Description

Project 27 would replace the dysfunctional culvert on Country Creek to provide some immediate relief to flood, fish passage, and fish habitat problems identified in the Action Plan (2001). The replacement will be designed in accordance with the stream simulation methodology specified in the WDFW manual titled "Design of Road Culverts for Fish Passage" (Bates 2003). The new structure will be designed to facilitate fish passage and access to an additional 0.24 miles of habitat available above the culvert, up to a natural barrier. The project is also expected to reduce erosion, bank failure and flooding by aligning the channel to orient the stream in the direction of the downstream channel rather than perpendicular.

The proposed Country Creek Culvert Replacement project includes the installation of a bottomless, concrete arch or similar structure to replace the existing culvert. The replacement culvert will be designed in accordance with the stream simulation methodology specified in the WDFW manual titled "Design of Road Culverts for Fish Passage" (Bates 2003). Stream simulation is a design process for creating natural stream processes within a culvert, with sediment transport, fish passage, flood and debris conveyance within the culvert intended to function as they would in a natural channel. The proposed structure will be located within the footprint of the existing road prism providing access to private lands south of the SE May Valley Road and the County/Cabbage Creek drainages. The roadway embankments in the vicinity of the wingwalls will require riprap to protect the embankments and wingwalls from scour.



Conceptual drawing of a pre-cast concrete arch bridge that could be used in place of the existing culvert passing Country Creek under a private drive.

The culvert will be aligned to minimize the potential for downstream scour. If left uncorrected, higher stream flows through the existing culvert and residual scour of the north (right) bank may undermine the SE May Valley Road, and the south (left) bank would erode private property. Such erosion would necessitate aggressive streambank treatments such as berms and bank armoring to reduce bank erosion, particularly to avoid failure of the SE May Valley Road. While such streambank protection action may

temporarily address scour and low recurrence flooding problems, such actions would only perpetuate existing erosion, flooding, fish passage, and fish habitat problems in the area.

A new streambed could be constructed inside the proposed culvert. A new channel could be lined with a gravel filter and substrate consisting of rounded gravel, cobbles, and boulders. In addition to protecting the structure and channel from scour and significant degradation, the larger elements of this substrate would create eddies to facilitate the upstream passage of fish. Footings for the proposed culvert would be set far enough below the proposed elevation of the stream channel to provide the necessary bearing capacity for the structure and adequate coverage for unanticipated scour and degradation. Footings would be protected from potential local scour with a layer of riprap.

If this project is implemented construction crews should use a variety of Best Management Practices (BMPs) to control erosion and sediment transport throughout construction and continuing until the new vegetation has become established. Silt fences could be constructed around excavation areas and spoil stockpiles to reduce the introduction of fine sediments into adjacent waters. Straw blankets could be placed on exposed road prism slopes during construction to reduce erosion from direct precipitation. Disturbed road prism slopes could be hydroseeded and revegetated with native plants after final grading is completed. Trees that would need to be removed on the south (left) bank of Country Creek construction should be replaced at a 2:1 mitigation ratio.

Project Efficacy

This project is very conceptual in nature. Site specific survey work and hydraulic modeling would need to be completed to estimate the potential project benefits. There was insufficient data to model potential hydraulic or hydrologic benefits at this time. Qualitatively speaking, reducing sediment loading from this tributary would be expected to help reduce local flooding issues and improve downstream habitat. In addition, improving the passage corridor through Cabbage Creek would permit access to fish habitat present but not regularly accessed above the dysfunctional culvert. Increasing habitat complexity in Cabbage Creek would better enable coho salmon (O. kisutch) and cutthroat trout (O. clarki) to make better use of this Locally Significant Resource Area (LSRA) as identified in the Action Plan (King County 2001). Further investigation into this project would be worthwhile.

Potential Challenges and Limitations

This project is not anticipated to create any significant downstream impacts. The project is located above RM 6.5 on May Creek. Any changes to the movement of water or temporary displacement of substrate or sediment are expected to be dissipated in low-gradient reaches of May Creek in the May Valley.

Localized challenges or considerations would include working with landowners to secure the necessary site access and easements, routing traffic during construction, timing construction to avoid or minimize impacts to priority habitat and species.

Additional challenges would include securing the necessary funding and permits to complete the work. Much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning Level Cost Estimates

Estimated Construction Costs: $160,200 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

If the culvert replacement project is deemed appropriate for implementation, culvert project design will be completed in accordance with the requirements outlines in the U.S. Army Corps of Engineers (COE) document titled "User's Guide to the Programmatic Consultation for the Removal of Fish Passage Barriers" dated July 29, 2002. This guide represents the first chapter of the COE's "Programmatic Biological Evaluation for Habitat Restoration/Rehabilitation Activities in the State of Washington for Species Listed or Proposed by the National Marine Fisheries Service and U.S. Fish and Wildlife Service under the Endangered Species Act," approved by NOAA Fisheries on May 19, 2002 and the U.S. Fish and Wildlife Service on May 29, 2002. Although no threatened, endangered, or candidate fish species are know to utilize the Cabbage/Country Creek tributary to May Creek, sensitive fish species do utilize the canyon and delta sections of May Creek downstream from May Valley.

At least a portion of the proposed project will be completed below the ordinary high water mark. It is likely, therefore, that the following permits and regulatory compliance steps will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval, potential consultation with USFWS
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- WDFW Area biologist and Tribal Consultation

Project proponents may qualify for and elect to seek a Section 404 permit from the COE (using programmatic Section 7 consultation procedures as described in the above-referenced documents) and a streamlined Hydraulic Project Approval (HPA) from the Washington Department of fish and Wildlife (WDFW). Under the streamlined HPA process, the culvert project would be exempt from the Washington State Environmental Policy Act (SEPA) and local government permits and fees.

PROJECT 28: WETLAND HABITAT ENHANCEMENT PROJECT (WSDOT SOUTH)

Project 28 would require the removal of reed canarygrass and the construction of a wetland pond and buffer area on the right (north) bank of May Creek (Figure B-28). The purpose of the project would be to attenuate floodwater and sediment in May Creek. This project was identified as a Category G project during the prioritization process.

Site Location

Project 28 is located adjacent to May Creek between RM 6.75 and RM 6.95 (Figure 18, Appendix A). The site is located on the left (south) bank on a parcel owner by the Washington Department of Transportation (WSDOT).

Site Description

The proposed project is approximately 8.4 acres in area. Based on the Conditions Report (King County 1995), landuse changes in the area eliminated the forested wetland likely historically present at the site. The site is a degraded wetland on the south (left) bank of May Creek primarily vegetated with reed canarygrass and willow. The area is presently open space and residential area with limited use. May Creek is an open, flowing channel in the project area (Figure 10, Appendix A).

Project Description

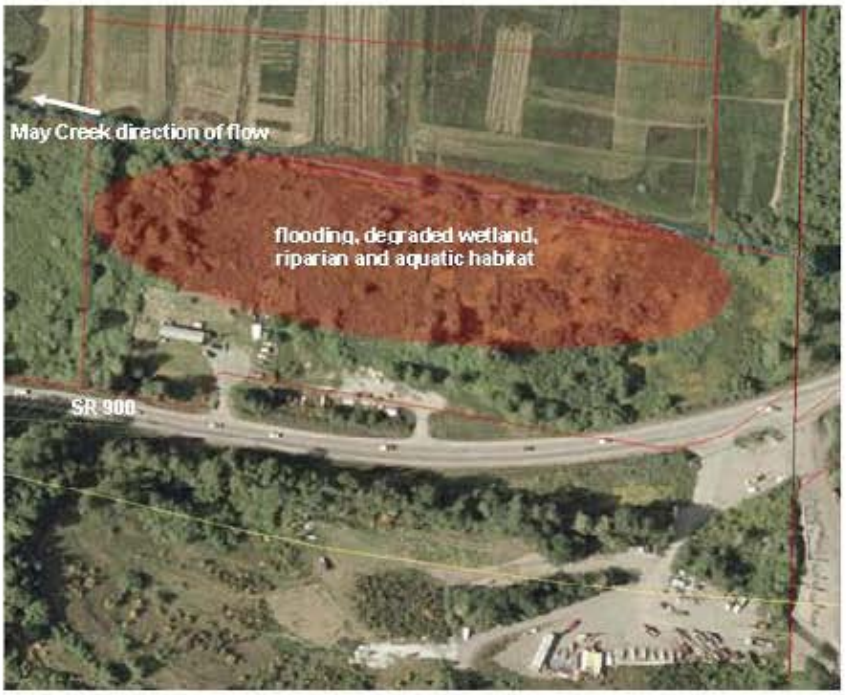
This project would create a forested wetland complex, buffer area, and enhanced riparian corridor adjacent May Creek. The wetland would be designed to help assimilate high flows and sediment loads in May Creek. The riparian area would be restored to help maintain effective flows and sediment transport processes. The existing May Creek channel would not be modified. These actions would help reduce flooding and sediment deposition in May Creek by improving flow and sediment conveyance. This project would help protect upstream fish passage. The improved riparian and wetland areas will also provide better fish habitat. The new corridor would improve fish passage upstream. This project would also improve water temperatures by increasing conveyance and providing full channel shading.

Project Efficacy

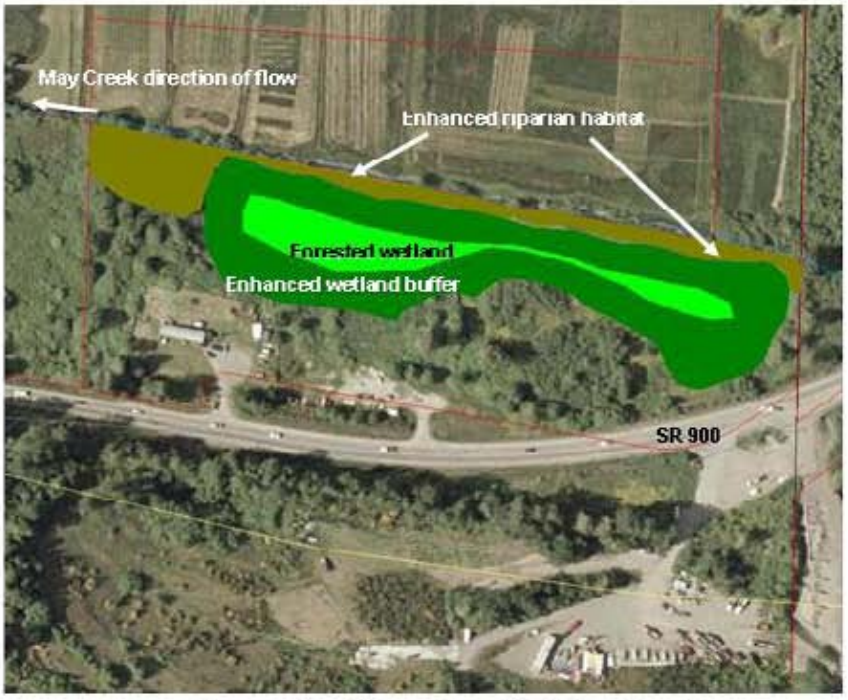
This Project would seek to re-create a forested wetland buffer area on the left bank side of May Creek immediately downstream of the Renton-Issaquah Highway (SR 900). The site is 2.97 acres and extends 950 feet lengthwise in the longitudinal direction and has 200 feet of width in the perpendicular direction to May Creek streamflow. It was modeled with standard wetland enhancement modeling procedures established in this analysis. The project begins approximately 350 feet downstream of culvert underneath SR 900.

Model results indicate that the water surface elevation will drop approximately 0.2 feet for the 2-year flood event, possibly alleviating some flooding problems. Modeling results indicate channel velocities will decrease from 2.48 ft/s to 1.79 ft/s for the 150 cfs flow. Hydraflow modeling results indicate that site runoff from the 2-year precipitation event decrease from 0.32 cfs to 0.145 cfs a 55 percent decrease.

In summary, proposed Project 28 would provide some level of flood relief. In addition, the project would enhance approximately 44,000 square feet of riparian buffer area, 33,100 square feet of wetland, and 96,200 square feet of enhanced wetland buffer area.



Existing Conditions



Conceptual Drawing of Wetland and Riparian Restoration Area

RED:\10\10791005\00\December 2007 Draft CRP\Figure B-25 Project 28 JM/MLT 12/17/07

GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 28

FIGURE B-25

Potential Challenges and Limitations

A significant area of land would be converted to the riparian habitat and wetland complex area. It is unknown if these actions would be of interest to the Washington Department of Transportation, on who's property the project would be located. Saturated soils and heavy vegetation may make channel construction and riparian restoration efforts challenging, time consuming, and more expensive as compared with other habitat restoration projects. This project would disturb well over 1 acre of area, necessitating additional permitting and regulatory considerations.

Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates Planning Level Cost Estimates

Estimated Construction Costs: $86,400 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require the placement of fill into to a critical area. As a result, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

Also, this project is expected to disturb over 1 acre of ground. As a result, additional permitting will be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES), securing a Construction Stormwater General Permit.

PROJECT 29: DETENTION PROJECT – NORTH FORK MAY CREEK (WSDOT EAST)

Project 29 is primarily a stormwater detention project located on the right (north) bank of the North Fork of May Creek (Figure B-29). The purpose of the project would be to attenuate floodwater and sediment being transported to May Creek via the North Fork of May Creek. This project was identified as a Category L project during the prioritization process.

Site Location

Project 29 is located on the North Fork of May Creek, between RM 7.02 and RM 7.15 (Figure 18, Appendix A). The proposed project is located immediately upstream from the SR-900 bridge crossing May Creek.

Site Description

The project is approximately 4.75 acres in area. The area is presently open space with little apparent use (Figure 11, Appendix A). The North Fork of May Creek bisects the site and is an open, flowing channel with a reasonable mix of sediment particle types, habitat complexity and woody debris. Habitat in this section of channel appears to be functioning reasonably well. The North Fork of May Creek exhibits a moderate gradient, and the stream channel has a hard bottom of mixed sands and gravels.

Project Description

The existing ground in the vicinity of Project 29 acts as a natural detention feature. This project proposes expanding this natural detention feature, while creating some adjacent habitat in the area. This project would create two high-flow detention basins configured as bioswales or similar structures. The basins would be designed to help assimilate high flows and sediment loads for the North Fork May Creek. The riparian area would be improved to help maintain effective flows and sediment transport processes. The existing May Creek channel would not be modified. These actions would help reduce flooding and sediment deposition in May Creek by improving flow and sediment conveyance. This project would directly improve riparian habitat through the enhancement of these habitat features. This project would also improve water temperatures by providing dense riparian vegetation adjacent the channel.

Project Efficacy

Hydraflow was utilized to make some simple estimates of geometric changes to the land topography in this area and the anticipated changes in storage volume if the existing ground were excavated to some extent to create the detention features. The scenario was modeled by assuming the square footage of the existing detention evident on the aerial GIS photograph (Figure 18, Appendix A). The existing north detention feature was measured to be approximately 75 x 75 feet with a depth of three feet and 5:1 side slopes, the new geometry of this feature was estimated from the design drawings to be 150 x 100 feet excavated to 6-feet of depth with 5:1 side slopes. The existing south detention feature was measured to be approximately 60 x 60 feet with 5:1 side slopes and an assumed bottom depth of three feet, the new geometry of this feature was estimated from the conceptual design drawings to be 85 x 85 feet with 5:1 side slopes and excavated to six feet of depth. These geometric changes would provide 181,000 cubic feet of additional storage, and 223,000 cubic feet of storage overall. This storage capacity is approximately 1 percent of the measured discharge on May Creek for a storm with a five day duration and a peak discharge of 77 cfs. Hydrologic routing was performed for this detention basin. Results of this analysis indicate that this detention basin will have minimal flood-wave attenuation impacts on frequent flooding events. This is due to the long-duration steady inflow of the upstream hydrographs and the relatively small size of the proposed storm water detention feature.

Existing Conditions

Conceptual drawing of detention basins

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GeoEngineers
Earth Science + Technology

Conceptual Drawing Project 29

FIGURE B 26

In summary, the project may provide some localized stormwater flood control but would not substantially mitigate downstream flooding issues.

Potential Challenges and Limitations

A significant area of land would be converted to the retention area. It is unknown if these actions would be of interest to the Washington Department of Transportation, on who's property the project would be located. In the Action Plan (2001) this site may have been identified as remnant forested wetland. If the site is, indeed, remnant forested wetland it would not be appropriate to construct detention basins or other structures. A wetland delineation would be completed to determine if this is a remnant forested wetland. This project would disturb well over 1 acre of area, necessitating additional permitting and regulatory considerations. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $345,900 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require placing fill into a critical area, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would disturb over 1 acre of ground. As a result, additional permit would be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES), securing a Construction Stormwater General Permit.

PROJECT IFP1: INEFFECTIVE FLOW PROJECT 1 – 287D TO INDIAN MEADOW CREEK

Project IFP 1 treats ineffective flow areas within the mainstem channel from 287D/E to Indian Meadow Creek using direct channel modifications of the stream cross-section and channel profile. The project uses mechanical methods to create a positive channel slope where the channel currently exhibits extremely flat and/or negative slopes (Figure IFP 1, see Conceptual Channel Profile insert). The purpose of the project is to increase water and sediment conveyance through the channel, thereby reducing the duration of flooding and improving fish passage. This project was identified as a Category E project during the prioritization process.

Site Location

Project IFP 1 is located on the mainstem May Creek between RM 4.28 and RM 4.89 (Figure 14, Appendix A), between the 287D/E and Indian Meadow Creek confluence areas. The segment of creek to be treated begins approximately 0.1 RM downstream from the 148th Avenue SE bridge and includes the mainstem May Creek throughout a reach extending upstream approximately 3,200 feet to a point just upstream from the confluence of May Creek and Indian Meadow Creek. This project intersects, or runs adjacent to, Projects 4, 5, 6, 7, 8, 10, 11, and 12 (Figure 14, Appendix A).

Site Description

This project is located in the upper-most portion of Reach 1 and the lowermost portion of Reach 2. The upper portion of the site is currently used as horse pasture and the lower portion of the site is open space. It is reported in the Conditions Report (King County 1995) that landuse changes in the area included elimination of a conifer and deciduous-based forested wetland likely historically present at the site. A portion of the wetland is still present at the site (see Figure 5, Appendix A); however, the existing remnant wetland is dominated by reed canarygrass and willow with limited other wetland or riparian species. The section of May Creek flowing through the wetland has minimal flow and sediment conveyance capacity as the result of ongoing sediment deposition and encroachment of reed canarygrass in the channel. Although this area no longer functions as a forested wetland, it does still provide some value in terms of flood attenuation, nutrient assimilation, and habitat value in its degraded condition (see Figure 6 and 7, Appendix A).

Recent preliminary hydraulic modeling completed by OTAK (2006) as part of this project revealed areas of ineffective flow in this reach of May Creek, suggesting that issues identified in the Action Plan can be expected to persist unless addressed. This ineffective flow area can be attributed to slow flow velocities (average 1.4 ft/sec) and the accumulation of sediment within the channel upstream of bridge constrictions and crossings.

Project Description

This project would address ineffective flow and fish passage barrier issues along an approximately 3,220 foot section of May Creek. Ineffective flows would be addressed through the mechanical manipulation of the channel cross-section area and longitudinal profile (Figure IFP 1). Sediment and vegetation would be mechanically removed from the channel to create a more uniform longitudinal stream profile throughout the site, providing a relatively uniform channel bottom width, and reducing roughness in the channel by removing all encroaching vegetation.

Based on measurements of reference reaches along May Creek where flows were found to be effective, the average channel bottom width was determined to be 15-feet with 1.5:1 (horizontal:vertical) side slopes. This project would recreate a channel bottom width and side slopes to match the reference reach

channel dimensions. As a result, implementation of IFP1 would establish an overall positive channel slope of 0.0011. This would replace a channel longitudinal profile that currently exhibits extremely flat and negative slopes for the majority of the segment length.

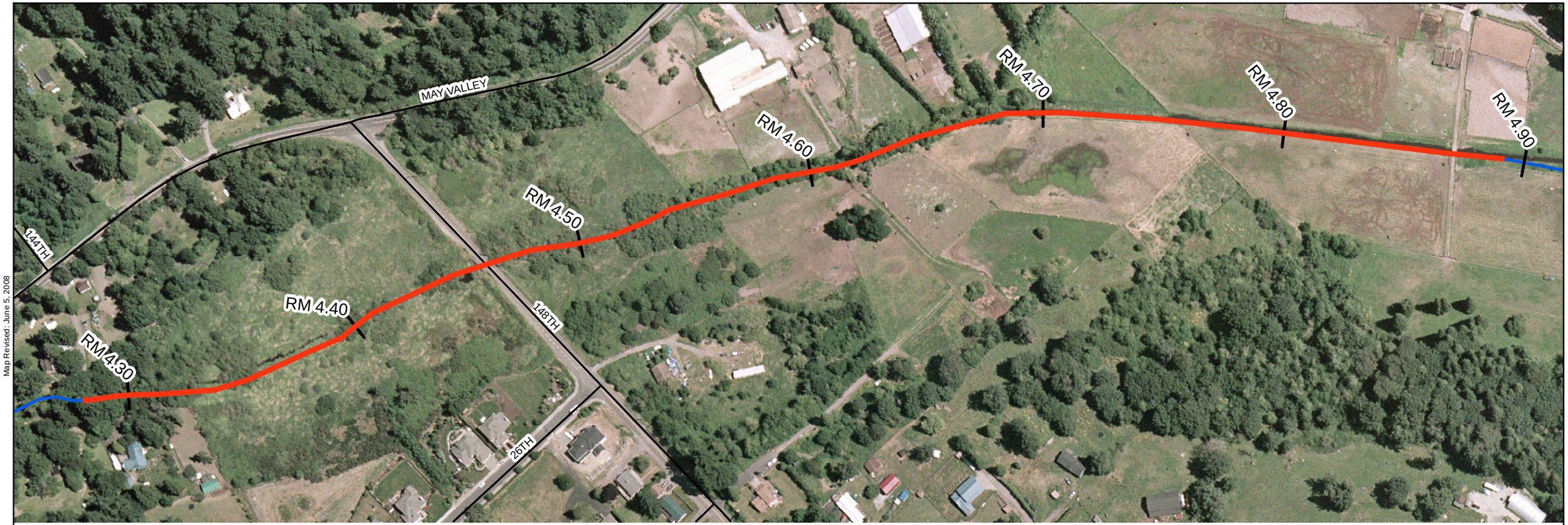
A typical proposed cross section is illustrated on Figure IFP 1 (see Conceptual Cross Section insert). Channel side slopes will be recreated at a 1.5:1 (horizontal:vertical), up to the point of intersection with the existing floodplain. By constructing the channel side slopes in this manner the area disturbance would be minimized, floodplain fill would be avoided, and the design would aid in vegetation retention. During the redefining of this channel most of the instream vegetation will be removed. It is also recommended that vegetation be removed approximately within 5 feet of both the left and right channel banks during construction of this project.

Project Efficacy

If IFP 1 were implemented, the channel profile would be more uniform to promote better downstream conveyance of both water and sediment. The removal of in-channel vegetation would also benefit the project by reducing choking and blocking of the channel, while also improving fish passage conditions. The proposed project would increase overall channel velocity and in-channel conveyance and would reduce frequent bank overtopping and broad, shallow flooding during high recurrence events. The project may also reduce water temperatures, improve sediment conveyance, and provide more suitable stream habitat for fish and wildlife.

GeoEngineers used HEC-RAS hydraulic models developed by OTAK (OTAK 2006) to evaluate the efficacy of IFP 1. The evaluation was based on a conceptual project design as described in the project description section above. Based on modeling results this project would be expected to help mitigate the ineffective flow area in this segment. As described in the main body of the Conceptual Restoration Plan, IFP 1 would improve the ineffective flow ranking from an overall ranking of 3.6 (moderate ineffective flow) down to a ranking of 2.4 (average ineffective flow). This project would also help alleviate the flooding of May Creek in the direct vicinity of the project. During 2-year flows the in-channel conveyance would be expected to increase from 49 to 89 percent. This means that less water would overtop the channel banks. Another hydraulic benefit of this project is that it would increase flow velocities from 1.4 ft/sec to 2.0 ft/sec which would help convey more sediment through the segment and reduce the ability of vegetation to re-grow within the channel.

The project benefits just described are based on model results of conditions immediately following implementation of the project. As IFP 1 does not address upslope sediment loading and hydrologic issues, the benefits of IFP 1 would be expected to decrease over time, as the May Creek channel would be expected to infill with sediment and reed canarygrass over time. Several other projects are proposed for implementation in the area of IFP 1 that would complement IFP 1. Projects 4, 5, 6, 7, 8, 10, 11, and 12 are all located in the vicinity of IFP 1, and include elements of riparian and wetland enhancement that would better address long-term, river process issues in the reach. Therefore, the short-term benefits of IFP 1 reducing flood duration, sedimentation and habitat degradation would be prolonged through the concurrent implementation of other projects in the vicinity of IFP 1.



Map Revised: June 5, 2008

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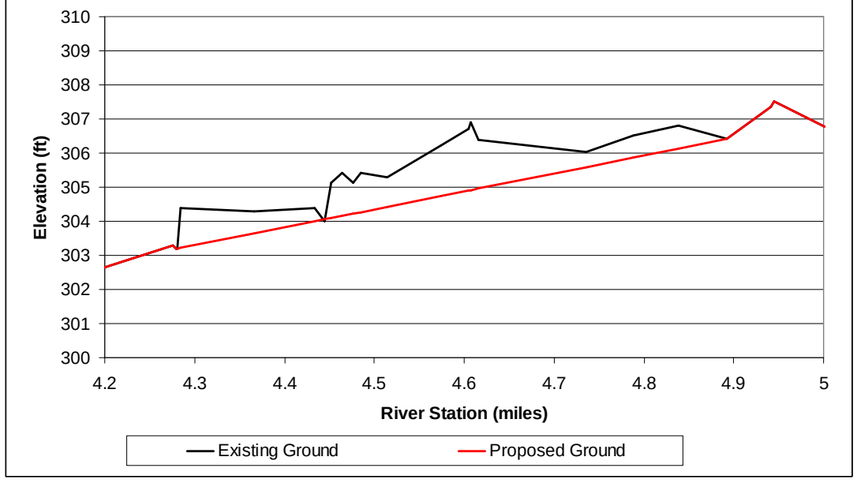
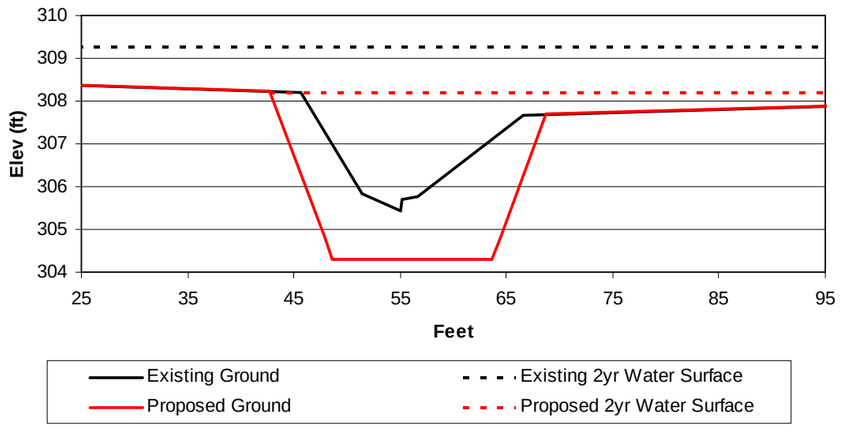
Redmond

Conceptual Channel Profile: IFP 1



Conceptual Cross Section: IFP 1 (RM 4.485)



Map Legend

- Project Length
- Roads
- May Cr. / River Mile (RM)

N W E S

200 0 200

Feet

Conceptual Drawings
Ineffective Flow Project 1 (IFP 1)

May Creek, King County, Washington

GeoEngineers

Figure IFP 1

Reference: USGS EDC Ortho Urban aerial photos provided by the USGS Seamless data server. The May Creek stream layer and roads were provided by King County.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for infomation purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record oth this communication.

Potential Challenges and Limitations

The single greatest challenge and limitation to IFP 1 is the ephemeral nature of the solution proposed. While IFP 1 would be expected to immediately address flood duration, conveyance, fish passage, and other issues, the benefits would be expected to be short-lived. Improvements made to channel performance through the mechanical manipulation of channel cross-section and profile would be expected to degrade over time as each runoff event conveys new sediment into the May Valley. As the May Valley is naturally a sediment deposition zone, and as sediment sources in the headwaters of the May Valley remain unmitigated, May Creek would be expected to fill back in. Therefore, the implementation of IFP 1, absent any other action, would not be expected to serve a long-term solution to the flood duration, sedimentation, fish passage, or other issues in this section of May Creek. Unless this project is augmented by upstream and perhaps downstream solutions offered in Projects 1through 29 and through implementation of stormwater and sediment control solutions in May Valley headwaters areas, the short-term flooding and fish passage benefits realized through implementation of IFP1 will be lost.

Another potential challenge to implementation of this project is the need to work with a large number of private landowners and land managers to fully implement project IFP 1. The project encompasses a reach of May Creek approximately 3,200 feet long. The project would need to be implemented throughout this length for expected benefits to be realized. Landowners must grant permission for these projects to be implemented. It is unknown if these actions would be of interest to the landowners.

Another challenge to this project is the fact that a large amount of channel would be disturbed below the Ordinary High Water Mark (OHWM). The proposed removal of silty substrate and vegetation from within the channel would be expected to cause concern among regulatory agencies, including WDFW and the Tribes. Additional regulatory constraints may be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically a forested wetland (Conditions Report, King County 1995), and continues to maintain wetland and other critical habitat functions in its present, degraded condition. Wetland delineation would need to be completed to determine the extent of wetland features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $179,700 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

The majority of the project would involve work below the OHWM and will require placing fill into a critical area, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would disturb over 1 acre of land. As a result, additional permits would be required, including an ACOE Section 404 project-specific permit, a Construction Stormwater General Permit and permits required under Ecology's National Pollutant Discharge Elimination System (NPDES).

PROJECT IFP 2: INEFFECTIVE FLOW PROJECT 2 - UPPER COLASURDO PASTURE

Project IFP 2 treats ineffective flow areas within the mainstem channel of May Creek by creating an overall positive channel slope where the channel currently exhibits extremely flat and negative slopes. The project uses mechanical methods to create a positive channel slope where the channel currently exhibits extremely flat and/or negative slopes (Figure IFP 2, see Conceptual Channel Profile insert). The purpose of the project is to increase water and sediment conveyance through the channel, thereby reducing the duration of flooding and improving fish passage. This project was identified as a Category E project during the prioritization process

Site Location

Project number IFP 2 is located on the mainstem May Creek between RM 5.05 and RM 5.3 (Figure 14, Appendix A). The proposed project reach is generally located between the upper-most private bridge located on the Colasurdo property and a point just upstream from the eastern-most Colasurdo fence line, a distance of approximately 1,320 feet. This ineffective flow project runs adjacent to Projects 13 and 14 (Figure 14, Appendix A).

Site Description

This project is located in the upstream-most portion of Reach 2 and a small portion of Reach 3. The site traverses a wetland (see Figure 5, Appendix A) and is currently used primarily as horse pasture. It is reported in the Conditions Report (King County 1995) that historic landuse in the area eliminated a previously existing conifer and deciduous-based forested wetland at the site. A portion of the wetland is still present at the site (see Figure 5, Appendix A); however, the existing remnant wetland is dominated by reed canarygrass and willow with limited other wetland or riparian species. The section of May Creek flowing through the wetland has minimal flow and sediment conveyance capacity as the result of ongoing sediment deposition and encroachment of reed canarygrass in the channel. Although this area no longer functions as a forested wetland, it does still provide some value in terms of flood attenuation, nutrient assimilation, and habitat value in its degraded condition (see Figure 7, Appendix A).

Recent preliminary hydraulic modeling completed by OTAK (2006) as part of this project revealed areas of ineffective flow in this reach of May Creek, suggesting that issues identified in the Action Plan can be expected to persist unless addressed. This ineffective flow area can be attributed to slow flow velocities (average 1.4 ft/sec) and the accumulation of sediment within the channel upstream of bridge constrictions and crossings.

Project Description

This project would address ineffective flow and passage barrier issues in an approximately 1,320 foot section of May Creek. Ineffective flows would be addressed through the mechanical manipulation of the channel cross-section area and longitudinal profile (Figure IFP 2). Sediment and vegetation would be mechanically removed from the channel to create a more uniform longitudinal stream profile throughout the site, providing a relatively uniform channel bottom width, and reducing roughness in the channel by removing all encroaching vegetation.

Based on measurements of reference reaches along May Creek where flows were found to be effective, the average channel bottom width was determined to be 15-feet with 1.5:1 (horizontal:vertical) side slopes. This project would recreate a channel bottom width and side slopes to match the reference reach channel dimensions. As a result, implementation of IFP 2 would establish an overall positive channel

slope of 0.0005. This would replace a channel longitudinal profile that currently exhibits negative slopes for the majority of the segment length intermixed with short steep sections.

A typical proposed cross section is illustrated on Figure IFP-2 (see Conceptual Cross Section insert). Channel side slopes will be recreated at a 1.5:1 (horizontal:vertical), up to the point of intersection with the existing floodplain. By constructing the channel side slopes in this manner the area of disturbance would be minimized, floodplain fill would be avoided, and the design would aid in vegetation retention. During the redefining of this channel most of the instream vegetation will be removed. It is also recommended that vegetation be removed approximately within 5 feet of both the left and right channel banks during construction of this project.

Two other projects are proposed in the vicinity of project IFP 2. One project, Project 13, proposes to enhance riparian habitat and wetland buffer along the south (left) bank adjacent a portion of IFP 2. Such a project may well provide for the need to remove vegetation from the 5 feet adjacent the stream bank in this section of the project, if IFP 2 is implemented. Some form of vegetated buffer will be necessary to delay any necessary routine maintenance to control vegetation within the channel for the first few years.

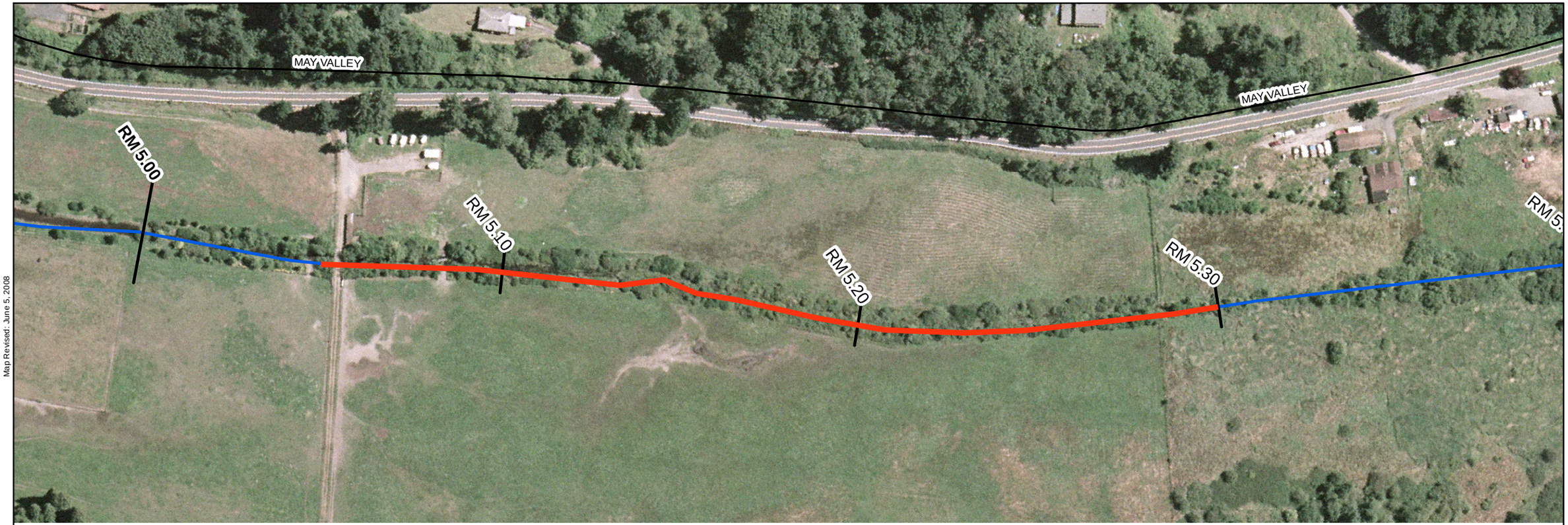
Project Efficacy

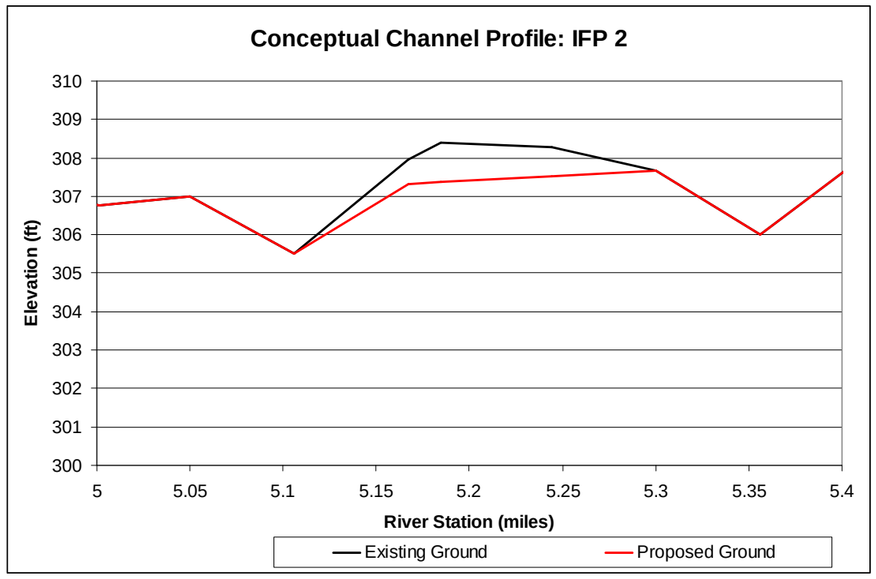
If IFP 2 were implemented, the channel profile would be more uniform to promote better downstream conveyance of both water and sediment. The removal of in-channel vegetation would also benefit the project by reducing choking and blocking of the channel, while also improving fish passage conditions. The proposed project would increase overall channel velocity and in-channel conveyance and would reduce frequent bank overtopping and broad shallow flooding during high recurrence events. The project may also reduce water temperatures, improve sediment conveyance, and provide more suitable stream habitat for fish and wildlife.

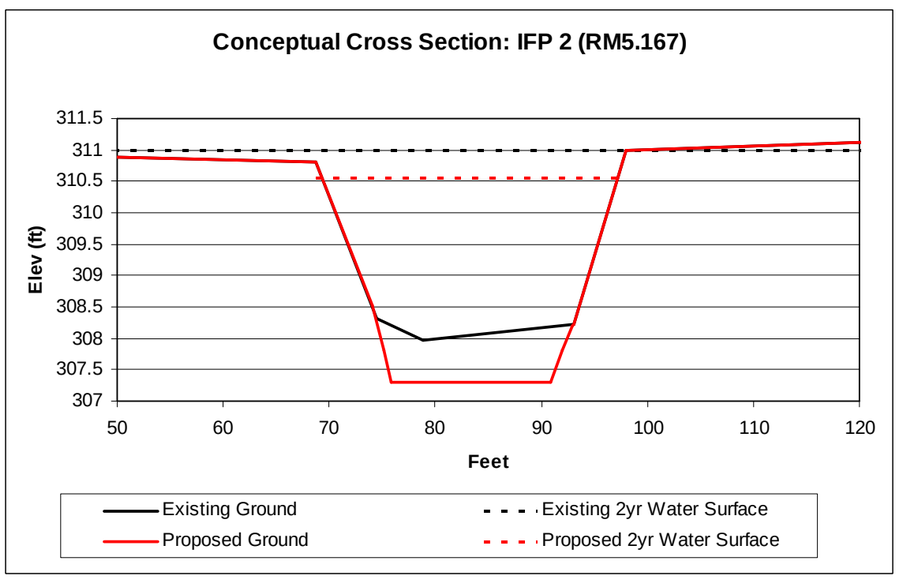
GeoEngineers used HEC-RAS hydraulic models developed by OTAK (OTAK 2006) to evaluate the efficacy of IFP 2. The evaluation was based on a conceptual project design as described in the project description section, above. Based on modeling results this project would be expected to help mitigate the ineffective flow area in this segment. As described in the main body of the Conceptual Restoration Plan, IFP 2 would improve the ineffective flow ranking from an overall ranking of 3.2 (moderate ineffective flow, down to a ranking of 2.4 (average ineffective flow). It should be noted, however, that the improved ranking was calculated based on the assumption that IFP 1 would be implemented at the same time.

This project would also help alleviate the flooding of May Creek in the direct vicinity of the project. During the 2-year flows the in-channel conveyance would increase from 73 to 91 percent which means that less water would overtop channel banks. Another hydraulic benefit of this project is that it would slightly increase velocities from 1.7 ft/sec to 1.9 ft/sec which would help convey more fine sediment through the reach and help reduce the re-growth of vegetation within the channel.

The project benefits just described are based on model results of conditions immediately following implementation of the project. As IFP 2 does not address upslope sediment loading and hydrologic issues, the benefits of IFP 2 would be expected to decrease over time, as the May Creek channel would be expected to infill with sediment and reed canarygrass over time. Other projects proposed for implementation in the vicinity of this area would complement IFP 2, including elements of riparian and wetland enhancement, that would better address long-term, river process issues in the reach. Therefore, the short-term benefits of IFP 2 reducing flood duration and enhancing fish passage throughout the reach to high habitat-use areas located upstream from the project would be prolonged through the concurrent implementation of other projects.







Map Legend

- Project Length
- Roads
- May Cr./ River Mile (RM)

N W E S

200 0 200
Feet

Conceptual Drawings
Ineffective Flow Project 2 (IFP 2)

May Creek, King County, Washington

GeoEngineers

Figure IFP 2

Reference: USGS EDC Ortho Urban aerial photos provided by the USGS Seamless data server. The May Creek stream layer and roads were provided by King County.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for infomation purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record oth this communication.

Map Revised: June 5, 2008

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Redmond

Potential Challenges and Limitations

The single greatest challenge and limitation to IFP 2 is the ephemeral nature of the solution proposed. While this project is expected to immediately address flood duration, conveyance, fish passage, and other issues, the benefits are expected to be short-lived. Improvements made to channel performance through the mechanical manipulation of channel cross-section and profile would be expected to degrade over time as each runoff event conveys new sediment into the May Valley. As the May Valley is naturally a sediment deposition zone, and as sediment sources in the headwaters of the May Valley remain unmitigated, May Creek would be expected to fill back in. Therefore, the implementation of IFP 2, absent any other action, would not be expected to serve a long-term solution to the flood duration, sedimentation, fish passage, or other issues in this section of May Creek. Unless this project is augmented by upstream and perhaps downstream solutions offered in Projects 1 through 29 and through implementation of stormwater and sediment control solutions in May Valley headwaters areas, the short-term flooding and fish passage benefits realized through implementation of IFP 2 will be lost.

Another potential challenge to implementation of this project is the need to work with a large number of private landowners and land managers to fully implement project IFP 2. The project encompasses a reach of May Creek approximately 3,200 feet long. The project would need to be implemented throughout this length for expected benefits to be realized. Landowners must grant permission for these projects to be implemented. It is unknown if these actions would be of interest to the landowners.

Another challenge to this project is the fact that a large amount of channel would be disturbed below the Ordinary High Water Mark (OHWM). The proposed removal of silty substrate and vegetation from within the channel would be expected to cause concern among regulatory agencies, including WDFW and the Tribes. Additional regulatory constraints may be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically a forested wetland (Conditions Report, King County 1995), and continues to maintain wetland and other critical habitat functions in its present, degraded condition. Wetland delineation would need to be completed to determine the extent of wetland features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $58,220 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly

Permitting

A substantial portion of the work would be completed below the OHWM and will require placing fill into a critical area, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would disturb well over 1 acre of area, necessitating additional permitting and regulatory considerations. Additional regulatory constraints may also be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically forested wetland (Conditions Report, King County 1995) or contains other critical areas. A wetland delineation and critical areas assessment would need to be completed to determine the extent and function of wetland and other habitat features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

PROJECT IFP-3: INEFFECTIVE FLOW PROJECT 3 - 291-A TO HENDRIX CREEK

Project IFP 3 treats ineffective flow areas within the mainstem channel from 291A to Hendrix Creek using direct channel modifications of the stream cross-section and channel profile. The project uses mechanical methods to create a positive channel slope where the channel currently exhibits extremely flat and/or negative slopes (Figure IFP 3, see Conceptual Channel Profile insert). The purpose of the project is to increase water and sediment conveyance through the channel, thereby reducing the duration of flooding and improving fish passage. This project was identified as a Category E project during the prioritization process.

Site Location

Project number IFP 3 is located on the mainstem May Creek between RM 5.48 and RM 6.53 (Figure 15 and 16, Appendix A) between Tributary 291A and County/Cabbage Creek. The creek segment to be treated represents a distance of approximately 1.05 river miles (5,575 feet). This ineffective flow project runs adjacent to Projects 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24 (Figure 15 and 16, Appendix A).

Site Description

This project area includes most of Reach 3, all of Reach 4, and the lowermost portion of Reach 5. The site traverses a wetland (see Figure 5, Appendix A) and is currently used as horse pasture and as wetland open space. It is reported in the Conditions Report (King County 1995) that historic land use in the area eliminated a previously existing conifer and deciduous-based forested wetland. A portion of the wetland is still present at the site (see Figure 5, Appendix A); however, the existing remnant wetland is dominated by reed canarygrass and willow with limited other wetland or riparian species. The section of May Creek flowing through the wetland has minimal flow and sediment conveyance capacity as the result of ongoing sediment deposition and encroachment of reed canary grass in the channel. Although this area no longer functions as a forested wetland, it does still provide some value in terms of flood attenuation, nutrient assimilation, and habitat value in its degraded condition (see Figure 8 and 9, Appendix A). In addition, the lower-most section of IFP 3, located adjacent projects 15 and 16 has previously been identified as a high fish habitat use area (Action Plan, King County 2001).

Recent preliminary hydraulic modeling completed by OTAK (2006) as part of this project revealed areas of ineffective flow in this reach of May Creek, suggesting that issues identified in the Action Plan can be expected to persist unless addressed. This ineffective flow area can be attributed to slow flow velocities (average 1.4 ft/sec) and the accumulation of sediment within the channel upstream of bridge constrictions and crossings.

Project Description

This project would address ineffective flow and passage barrier issues in an approximately 5,575 foot section of May Creek. Ineffective flows would be addressed through the mechanical manipulation of the channel cross-section area and longitudinal profile (Figure IFP 3). Sediment and vegetation would be mechanically removed from the channel to create a more uniform longitudinal stream profile throughout the site, providing a relatively uniform channel bottom width, and reducing roughness in the channel by removing all encroaching vegetation.

Based on measurements of reference reaches along May Creek where flows were found to be effective, the average channel bottom width was determined to be 15-feet with 1.5:1 (horizontal:vertical) side slopes. This project would recreate a channel bottom width and side slopes to match the reference reach channel dimensions. As a result, implementation of IFP 3 would establish an overall positive channel

slope of 0.0017. This would replace a channel longitudinal profile that currently exhibits flat and negative slopes for the majority of the segment length intermixed with short moderately steep sections.

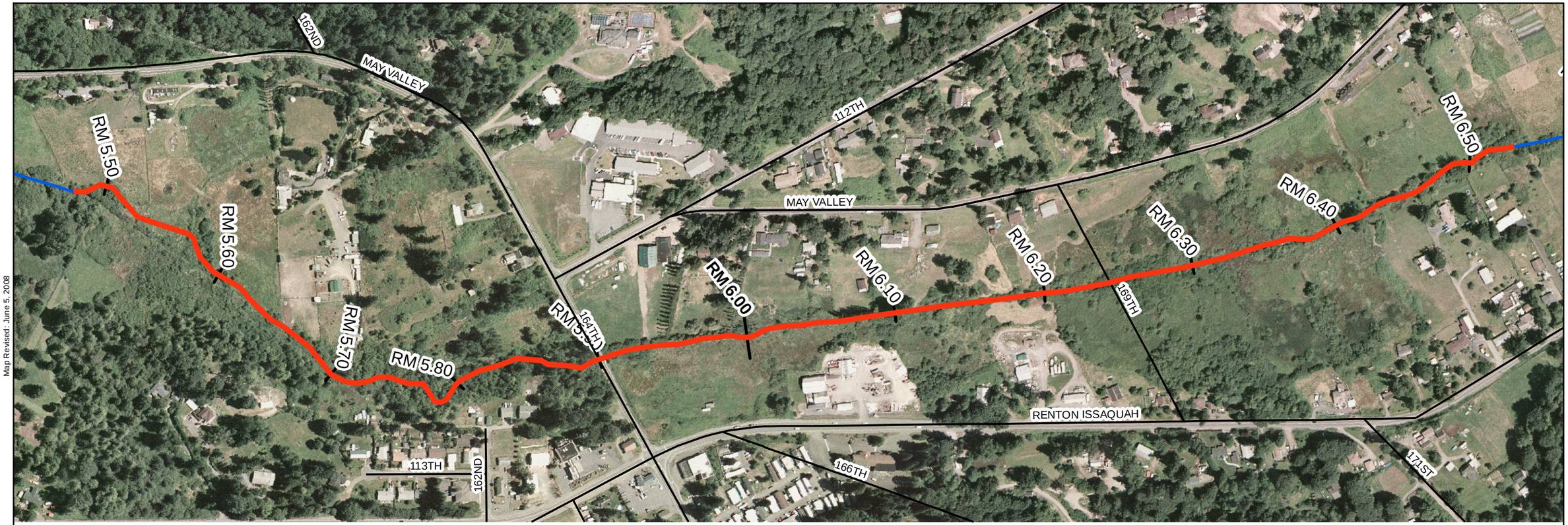
A typical proposed cross section is illustrated on Figure IFP-3 (see Conceptual Cross Section insert). Channel side slopes will be recreated at a 1.5:1 (horizontal:vertical), up to the point of intersection with the existing floodplain. By constructing the channel side slopes in this manner the area of disturbance would be minimized, floodplain fill would be avoided, and the design would aid in vegetation retention. During the redefining of this channel most of the instream vegetation will be removed. It is also recommended that vegetation be removed approximately within 5 feet of both the left and right channel banks during construction of this project. Other projects proposed in the vicinity of project IFP 3 could support the need for riparian vegetation restoration. Projects 15, 19, 20, 21 and 22 include riparian enhancement along May Creek for most of the length of the IFP 3 site. Such projects may well provide for the need to remove vegetation from the 5 feet adjacent the stream bank in this section of the project, if IFP 3 is implemented. Some form of vegetated buffer will be necessary to delay any necessary routine maintenance to control vegetation within the channel for the first few years.

Project Efficacy

If IFP 3 were implemented, the channel profile would be more uniform to promote better downstream conveyance of both water and sediment. The removal of in-channel vegetation would also benefit the project by reducing choking and blocking of the channel, while also improving fish passage conditions. The proposed project would increase overall channel velocity, and in-channel conveyance and would reduce frequent bank overtopping and broad shallow flooding during high recurrence events. The project may also reduce water temperatures, improve sediment conveyance, and provide more suitable stream habitat for fish and wildlife.

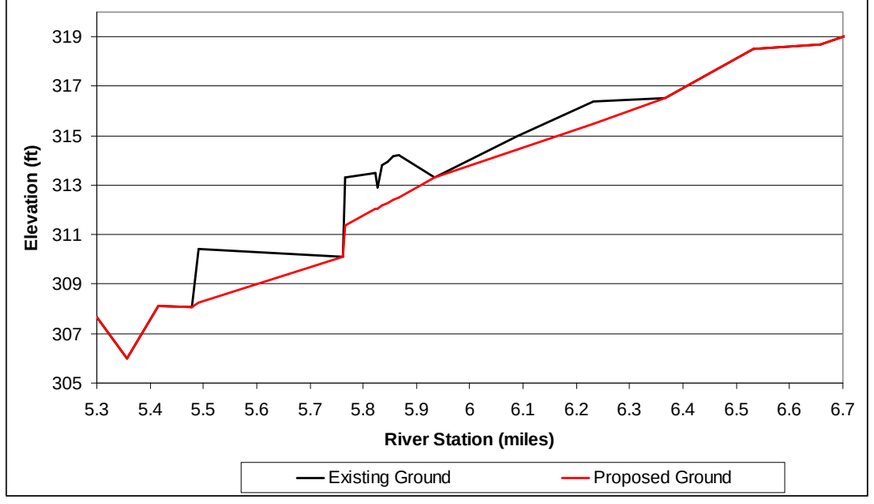
Recent preliminary hydraulic modeling completed by OTAK (2006) as part of this project revealed that this segment of May Creek contains some minor ineffective flow areas. The modeling indicated that ineffective flow in this reach of May Creek is also slightly increased due to proposed projects downstream (IFP 1 and IFP 2). Based on the distance between the three sites, the physical characteristics of the sites, and comparison of modeling results upstream and downstream, it is expected that the increase in ineffective flow in IFP 3 is negligible. The ineffective flow area associated with IFP 3 can be attributed to frequent shallow flooding and the accumulation of sediment within the channel upstream of a bridge constriction and crossing as well as at the mouths of tributaries.

GeoEngineers used HEC-RAS hydraulic models developed by OTAK (OTAK 2006) to evaluate the efficacy of IFP 3. The evaluation was based on a conceptual project design as described in the project description section above. Based on modeling results this project would be expected to help mitigate the ineffective flow area in this segment. As described in the main body of the Conceptual Restoration Plan, IFP 3 would improve the ineffective flow ranking from an overall ranking of 2.8 (average ineffective flow) down to a ranking of 1.9 (minor ineffective flow), if done simultaneously with IFP 1 and IFP 2. It should be noted, however, that this improved ranking assumes that IFP 1 and IFP 2 are implemented at the same time. This mitigation project would also help alleviate the flooding of May Creek in the direct vicinity of the project. During the 2-year flows the in-channel conveyance would increase from 66 to 91 percent which means that less water would escape the channel. Another hydraulic benefit of this project is that it would maintain existing flow velocities in the range of 2.8 ft/sec to 2.6 ft/sec which would help more sediment through the reach and reduce the ability of vegetation to re-grow within the channel.

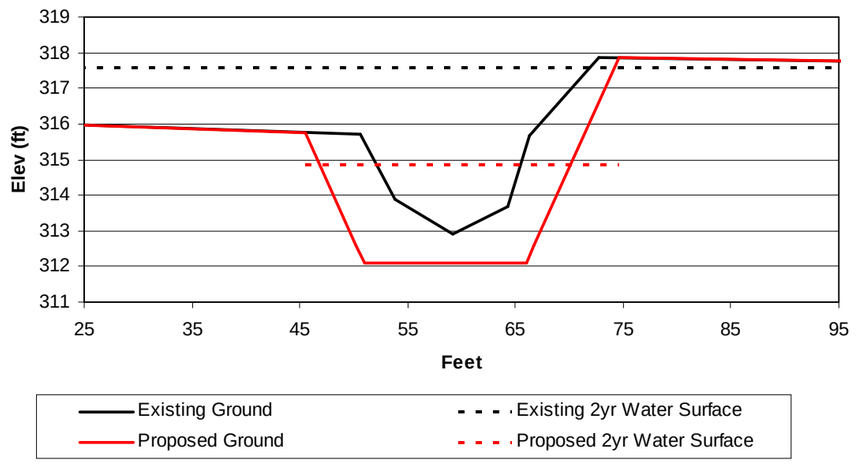


Map Revised: June 5, 2008

Conceptual Channel Profile: IFP 3



Conceptual Cross Section: IFP 3 (RM 5.862)



Map Legend

- Project Length
- Roads
- May Cr. / River Mile (RM)

200 0 200
Feet

Conceptual Drawings
Ineffective Flow Project 3 (IFP 3)

May Creek, King County, Washington

GeoEngineers

Figure IFP 3

Reference: USGS EDC Ortho Urban aerial photos provided by the USGS Seamless data server. The May Creek stream layer and roads were provided by King County.

Notes:
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Redmond

Potential Challenges and Limitations

The single greatest challenge and limitation to IFP 3 is the ephemeral nature of the solution proposed. While IFP 3 would be expected to immediately address flood duration, conveyance, fish passage, and other issues, the benefits would be expected to be short-lived. Improvements made to channel performance through the mechanical manipulation of channel cross-section and profile would be expected to degrade over time as each runoff event conveys new sediment into the May Valley. As the May Valley is naturally a sediment deposition zone, and as sediment sources in the headwaters of the May Valley remain unmitigated, May Creek would be expected to fill back in. Therefore, the implementation of IFP 3, absent any other action, would not be expected to serve a long-term solution to the flood duration, sedimentation, fish passage, or other issues in this section of May Creek. To have value, implementation of IFP-3 must be supplemented with other projects described in this Conceptual Restoration Plan. The flood and habitat-related benefits of IFP 3 are expected to be short-lived and must, therefore, be augmented with longer-term solutions such as those described in Projects 1 through 29.
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Another potential challenge to implementation of this project is the need to work with a large number of private landowners and land managers to fully implement project IFP 3. The project encompasses a reach of May Creek approximately 5,575 feet long. The project would need to be implemented throughout this length for expected benefits to be realized. Landowners must grant permission for these projects to be implemented. It is unknown if these actions would be of interest to the landowners.

Another challenge to this project is the fact that a large amount of channel would be disturbed below the Ordinary High Water Mark (OHWM). The proposed removal of silty substrate and vegetation from within the channel would be expected to cause concern among regulatory agencies, including WDFW and the Tribes. Additional regulatory constraints may be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically a forested wetland (Conditions Report, King County 1995), and continues to maintain wetland and other critical habitat functions in its present, degraded condition. Wetland delineation would need to be completed to determine the extent of wetland features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $356,900 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly

Permitting

A substantial portion of the work would be completed below the OHWM and would be expected to result in fill being placed in a critical area. Therefore, the following permits and approvals would likely be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would disturb over 1 acre of ground. As a result, additional permit would be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES), securing a Construction Stormwater General Permit.

PROJECT IFP4: INEFFECTIVE FLOW PROJECT 4 – NORTH FORK MAY CREEK

Project IFP 4 treats ineffective flow areas within the North Fork May Creek using direct channel modifications of the stream cross-section and channel profile. The project uses mechanical methods to create a positive channel slope where the channel currently exhibits flat and/or negative slopes (Figure IFP 4, see Conceptual Channel Profile insert). The purpose of the project is to increase water and sediment conveyance through the channel, thereby reducing the duration of flooding and improving fish passage. This project was identified as a Category E project during the prioritization process.

Site Location

Project IFP 4 is located on the mainstem May Creek and the North Fork May Creek between RM 6.95 and RM 7.30 (Figure 18, Appendix A). The project area begins approximately 250 feet downstream of the Renton-Issaquah (SR 900) bridge crossing May Creek and extends upstream into the North Fork May Creek approximately 1,600 feet, for a total length of approximately 1,850 feet. This ineffective flow project runs adjacent to Project 29 (Figure 18, Appendix A).

Site Description

This project is located in the uppermost portion of Reach 5 and the lowermost portion of Reach 6 encompassing the North Fork May Creek. The site traverses a wetland (see Figure 5, Appendix A) and is currently maintained as open space, including a Washington State Department of Transportation environmental protection area. It is reported in the Conditions Report (King County 1995) that historic landuse in the area degraded a previously existing conifer and deciduous-based forested wetland. A portion of the wetland is still present at the site (see Figure 5, Appendix A); however, the existing remnant wetland is dominated by reed canarygrass and willow with limited other wetland or riparian species., with a small portion of forested wetland remaining on the north side of May Creek downstream from the SR-900 bridge crossing. The upper-most section of IFP 4, located upstream from Project 29 has previously been identified as a high fish habitat use area (Action Plan, King County 2001). See Figure 5 (Appendix A) for the location of the high fish habitat use area. The section of May Creek flowing through the wetland has minimal flow and sediment conveyance capacity as the result of ongoing sediment deposition and encroachment of reed canarygrass in the channel. Although this area no longer functions as a forested wetland, it does still provide some value in terms of flood attenuation, nutrient assimilation, and habitat value in its degraded condition (Figure 11, Appendix A).

Recent preliminary hydraulic modeling completed by OTAK (2006) as part of this project revealed areas of ineffective flow in this reach of May Creek, suggesting that issues identified in the Action Plan can be expected to persist unless addressed. This ineffective flow area can be attributed to slow flow velocities (average 1.4 ft/sec) and the accumulation of sediment within the channel upstream of bridge constrictions and crossings.

Project Description

This project would address ineffective flow and passage barrier issues in an approximately 1,850 foot section of May Creek. Ineffective flows would be addressed through the mechanical manipulation of the channel cross-section area and longitudinal profile (Figure IFP 4). Sediment and vegetation would be mechanically removed from the channel to create a more uniform longitudinal stream profile throughout the site, providing a relatively uniform channel bottom width, and reducing roughness in the channel by removing all encroaching vegetation.

Based on measurements of reference reaches along May Creek where flows were found to be effective, the average channel bottom width was determined to be 15-feet with 1.5:1 (horizontal:vertical) side slopes. This project would recreate a channel bottom width and side slopes to match the reference reach channel dimensions. As a result, implementation of IFP 4 would establish an overall positive channel slope of 0.0047. This would replace a channel longitudinal profile that currently exhibits flat and negative slopes over the majority of the segment length intermixed with short steep sections.

A typical proposed cross section is illustrated on Figure IFP-4 (see Conceptual Cross Section insert). Channel side slopes will be recreated at a 1.5:1 (horizontal:vertical), up to the point of intersection with the existing floodplain. By constructing the channel side slopes in this manner the area disturbance would be minimized, floodplain fill would be avoided, and the design would aid in vegetation retention. During the redefining of this channel most of the instream vegetation will be removed. It is also recommended that vegetation be removed approximately within 5 feet of both the left and right channel banks during construction of this project.

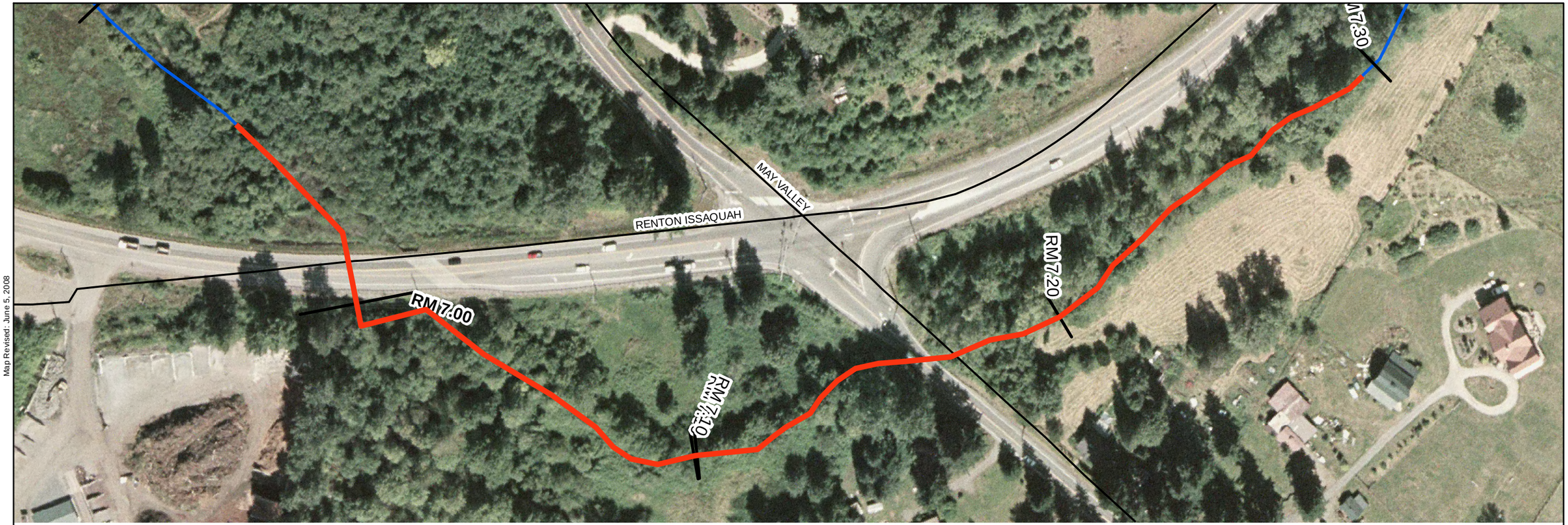
Project Efficacy

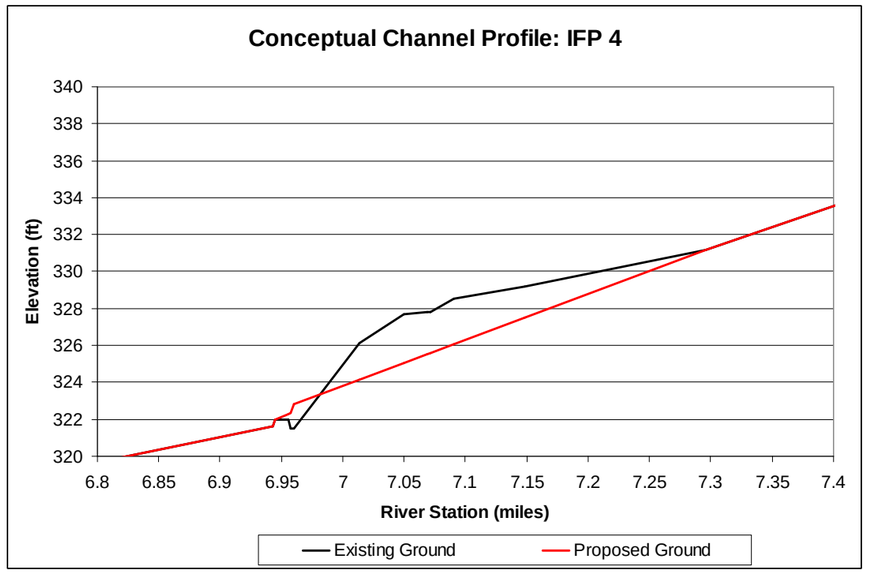
If IFP 4 were implemented, the channel profile would be more uniform to promote better downstream conveyance of both water and sediment. The removal of in-channel vegetation would also benefit the project by reducing choking and blocking of the channel, while also improving fish passage conditions. The proposed project would increase overall channel velocity, in-channel conveyance and reduce frequent bank overtopping and broad shallow flooding during high recurrence events. The project may also reduce water temperatures, improve sediment conveyance, and provide more suitable stream habitat for fish and wildlife.

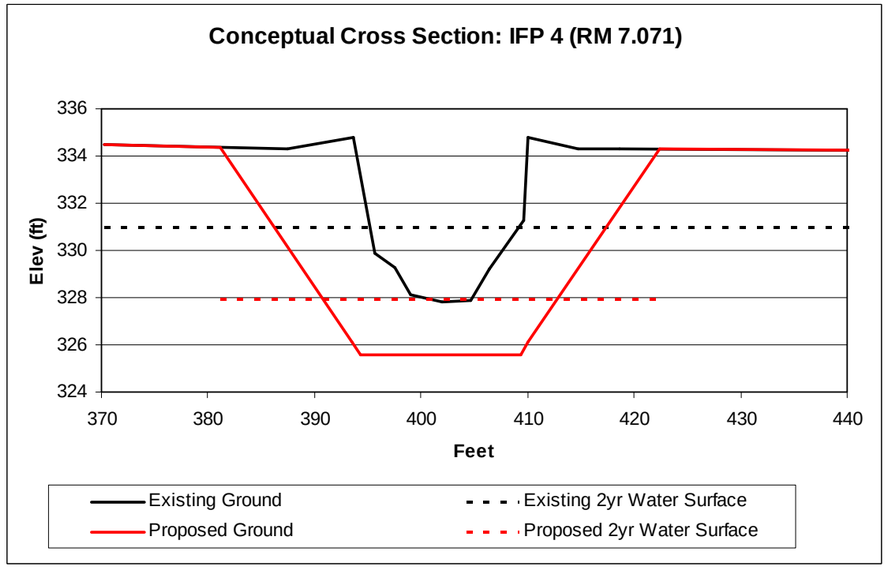
GeoEngineers used HEC-RAS hydraulic models developed by OTAK (OTAK 2006) to evaluate the efficacy of IFP 4. The evaluation was based on a conceptual project design as described in the project description section, above. Based on modeling results this project would be expected to help mitigate the ineffective flow area in this area of the May Valley. As described in the main body of the Conceptual Restoration Plan, IFP 4 would improve the ineffective flow ranking from an overall ranking of 3.1 (moderate ineffective flow) down to a ranking of 0.8 (no ineffective flow). This mitigation project would also help alleviate the flooding of May Creek in the direct vicinity of the project. During the 2-year flows the in-channel conveyance would increase from 59 to 99 percent which means that less water would overtop the channel banks. With the increase in a more uniform channel slope and an actual defined channel flow velocities would increase from 2.7 ft/sec to 3.9 ft/sec which would help convey more sediment through the segment and could create some scour and deposition holes to increase habitat diversity. The increase in velocity would also help reduce the ability of vegetation to re-grow within the channel.

Potential Challenges and Limitations

The single greatest challenge and limitation to IFP 4 is the ephemeral nature of the solution proposed. While IFP 4 would be expected to immediately address flood duration, conveyance, fish passage, and other issues, the benefits would be expected to be short-lived. Improvements made to channel performance through the mechanical manipulation of channel cross-section and profile would be expected to degrade over time as each runoff event conveys new sediment into the May Valley. As the May Valley is naturally a sediment deposition zone, and as sediment sources in the headwaters of the May Valley remain unmitigated, May Creek would be expected to fill back in. Therefore, the implementation of IFP 4, absent any other action, would not be expected to serve as a long-term solution to the flood duration, sedimentation, fish passage, or other issues in this section of May Creek. To have value, implementation of IFP-4 must be supplemented with other projects described in this Conceptual Restoration Plan. The flood and habitat-related benefits of IFP 4 are expected to be short-lived and must, therefore, be augmented with longer-term solutions such as those described in Projects 1 through 29.







Map Legend

- Project Length
- Roads
- May Cr. / River Mile (RM)

N W E S

200 0 200

Feet

Map Revised: June 5, 2008

Path: P:\10\10791005\00\GIS\MXD\Dredge4.mxd

Redmond

Reference: USGS EDC Ortho Urban aerial photos provided by the USGS Seamless data server. The May Creek stream layer and roads were provided by King County.

Notes:
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Conceptual Drawings
Ineffective Flow Project 4 (IFP 4)

May Creek, King County, Washington

GeoEngineers

Figure IFP 4

Another potential challenge to implementation of this project is the need to work with a number of private landowners and land managers to fully implement project IFP 4. The project encompasses a reach of May Creek approximately 1,850 feet long. The project would need to be implemented throughout this length for expected benefits to be realized. Landowners must grant permission for these projects to be implemented. It is unknown if these actions would be of interest to the landowners.

Another challenge to this project is the fact that a large amount of channel would be disturbed below the Ordinary High Water Mark (OHWM). The proposed removal of silty substrate and vegetation from within the channel would be expected to cause concern among regulatory agencies, including WDFW and the Tribes. Additional regulatory constraints may be imposed on the proposed project due to the fact that much of May Creek in the May Valley was historically a forested wetland (Conditions Report, King County 1995), and continues to maintain wetland and other critical habitat functions in its present, degraded condition. Wetland delineation would need to be completed to determine the extent of wetland features at the site. Any impacts to stream buffers, wetlands and wetland buffers would need to be mitigated if the project were permitted and implemented.

Planning-Level Cost Estimates

Estimated Construction Costs: $186,900 (See Appendix C for details). Design, construction observation and permitting costs are not included as these costs can vary significantly.

Permitting

A portion of the work will be completed below the OHWM and will require placing fill into a critical area, the following permits and approvals likely will be required:

- U.S. Army Corps of Engineers (ACOE) Section 404
- Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval
- Washington State Department of Ecology (Ecology) 401 Water Quality Certification
- King County Clearing and Grading Permit
- SEPA Checklist, with King County lead
- King County Critical Areas Review
- Compliance with the King County Shoreline Regulations
- Tribal and WDFW area biologist consultation

This project would disturb over 1 acre of ground. As a result, additional permit would be required, including ACOE Section 404 project-specific permitting and requirements under Ecology's National Pollutant Discharge Elimination System (NPDES), securing a Construction Stormwater General Permit.

GeoEngineers

APPENDIX C
PLANNING-LEVEL COST ESTIMATES

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	PROJECT 1		PROJECT 2		PROJECT 3		PROJECT 4		PROJECT 5	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP													
Clearing and Grubbing	AC	$ 8,000.00	14.05	0.5	$ 4,000.00	0.1	$ 800.00	0.5	$ 4,000.00	0.5	$ 4,000.00	0.6	$ 4,800.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS													
Remove Pavement	SY	$ 22.00	420		$ -	70	$ 1,540.00		$ -		$ -		$ -
Sawcut Asphalt Concrete	LF	$ 3.50	300		$ -	50	$ 175.00		$ -		$ -		$ -
GRADING AND EXCAVATION													
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678		$ -	100	$ 3,000.00		$ -		$ -		$ -
Channel Excavation	CY	$ 18.00	28668	360	$ 6,480.00		$ -	410	$ 7,380.00	570	$ 10,260.00	470	$ 8,460.00
Fine Grading	CY	$ 25.00	2940		$ -		$ -		$ -		$ -		$ -
MINERAL AGGREGATES													
Crushed Surface Base Course	TN	$ 28.00	3980		$ -	30	$ 840.00		$ -		$ -		$ -
Boulders	TN	$ 60.00	305	185	$ 11,100.00		$ -	50	$ 3,000.00		$ -		$ -
PAVEMENT													
Asphalt Concrete Pavement Patching	TN	$ 106.00	150		$ -	25	$ 2,650.00		$ -		$ -		$ -
DRAINAGE SYSTEMS													
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180		$ -	30	$ 36,000.00		$ -		$ -		$ -
EROSION CONTROL													
Hydro-Seeding	SF	$ 1.00	146900	6000	$ 6,000.00		$ -	7000	$ 7,000.00	9600	$ 9,600.00		$ -
Matting, Jute	SF	$ 1.50	1000	1000	$ 1,500.00		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000		$ -		$ -	1000	$ 1,000.00	1500	$ 1,500.00		$ -
Fence, Temporary Silt Containment	LF	$ 6.00	14275	600	$ 3,600.00		$ -	700	$ 4,200.00	1000	$ 6,000.00		$ -
High Visibility Fence	LF	$ 2.00	14275	600	$ 1,200.00		$ -	700	$ 1,400.00	1000	$ 2,000.00		$ -
LANDSCAPING													
Wet Pond Seeding	SF	$ 3.00	5100		$ -		$ -		$ -		$ -		$ -
MISC ITEMS													
Planting Preparation	AC	$ 5,000.00	17.28		$ -		$ -	0.4	$ 2,000.00	0.3	$ 1,500.00	1	$ 5,000.00
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73		$ -		$ -		$ -		$ -	1	$ 35,000.00
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05		$ -		$ -	0.4	$ 4,000.00	0.3	$ 3,000.00		$ -
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42		$ -		$ -		$ -		$ -	2	$ 7,000.00
Bioengineering Bank Stabilization	LF	$ 110.00	1894	1200	$ 132,000.00		$ -	483	$ 53,130.00		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -		$ -		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -		$ -		$ -
OTHER ITEMS													
Temporary Bypass	LS	$ 75,000.00	6		$ -	1	$ 75,000.00		$ -		$ -		$ -
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 8,730.00	1	$ 6,820.00	1	$ 6,690.00	1	$ 1,995.00	1	$ 3,170.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -	1	$ 9,548.00		$ -		$ -		$ -
Traffic Control on Major Roads (10%)	LS	10%	8		$ -		$ -		$ -		$ -		$ -
Land Acquisition	$	$ 1.00	415000		$ -		$ -	40000	$ 40,000.00		$ -		$ -
Large Woody Debris (Optional)	EA	$ 1,000.00	45		$ -		$ -		$ -		$ -		$ -
SUBTOTAL CONSTRUCTION COST					$ 174,600.00		$ 136,400.00		$ 133,800.00		$ 39,900.00		$ 63,400.00
Sales Tax (8.9%)					$ 15,500.00		$ 12,100.00		$ 11,900.00		$ 3,600.00		$ 5,600.00
TOTAL CONSTRUCTION COST					***$ 190,100.00***		***$ 148,500.00***		***$ 145,700.00***		***$ 43,500.00***		***$ 69,000.00***

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	PROJECT 6		PROJECT 7		PROJECT 8		PROJECT 9		PROJECT 10	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP													
Clearing and Grubbing	AC	$ 8,000.00	14.05	0.7	$ 5,600.00	1.2	$ 9,600.00	0.25	$ 2,000.00	0.6	$ 4,800.00	0.25	$ 2,000.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS													
Remove Pavement	SY	$ 22.00	420		$ -	70	$ 1,540.00		$ -		$ -		$ -
Sawcut Asphalt Concrete	LF	$ 3.50	300		$ -	50	$ 175.00		$ -		$ -		$ -
GRADING AND EXCAVATION													
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678		$ -	100	$ 3,000.00		$ -		$ -		$ -
Channel Excavation	CY	$ 18.00	28668	525	$ 9,450.00	1300	$ 23,400.00	120	$ 2,160.00		$ -	150	$ 2,700.00
Fine Grading	CY	$ 25.00	2940		$ -		$ -		$ -	560	$ 14,000.00		$ -
MINERAL AGGREGATES													
Crushed Surface Base Course	TN	$ 28.00	3980		$ -	30	$ 840.00		$ -		$ -		$ -
Boulders	TN	$ 60.00	305		$ -		$ -		$ -		$ -		$ -
PAVEMENT													
Asphalt Concrete Pavement Patching	TN	$ 106.00	150		$ -	25	$ 2,650.00		$ -		$ -		$ -
DRAINAGE SYSTEMS													
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180		$ -	30	$ 36,000.00		$ -		$ -		$ -
EROSION CONTROL													
Hydro-Seeding	SF	$ 1.00	146900		$ -	22000	$ 22,000.00		$ -	11000	$ 11,000.00		$ -
Matting, Jute	SF	$ 1.50	1000		$ -		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000		$ -	5000	$ 5,000.00		$ -	2000	$ 2,000.00		$ -
Fence, Temporary Silt Containment	LF	$ 6.00	14275		$ -	2200	$ 13,200.00		$ -	1000	$ 6,000.00		$ -
High Visibility Fence	LF	$ 2.00	14275		$ -	2200	$ 4,400.00		$ -	1000	$ 2,000.00		$ -
LANDSCAPING													
Wet Pond Seeding	SF	$ 3.00	5100		$ -		$ -		$ -	1400	$ 4,200.00		$ -
MISC ITEMS													
Planting Preparation	AC	$ 5,000.00	17.28	0.7	$ 3,500.00		$ -	1.5	$ 7,500.00	0.3	$ 1,500.00	0.2	$ 1,000.00
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73	0.7	$ 24,500.00		$ -	1.5	$ 52,500.00	0.1	$ 3,500.00	0.2	$ 7,000.00
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05		$ -		$ -		$ -	0.2	$ 2,000.00		$ -
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42	2.6	$ 9,100.00		$ -	1.5	$ 5,250.00		$ -	1	$ 3,500.00
Bioengineering Bank Stabilization	LF	$ 110.00	1894		$ -		$ -		$ -		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -		$ -		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -		$ -		$ -
OTHER ITEMS													
Temporary Bypass	LS	$ 75,000.00	6		$ -	1	$ 75,000.00		$ -		$ -		$ -
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 2,745.00	1	$ 11,180.00	1	$ 6,810.00	1	$ 3,210.00	1	$ 4,800.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -	1	$ 15,652.00		$ -		$ -		$ -
Traffic Control on Major Roads (10%)	LS	10%	8		$ -		$ -		$ -		$ -		$ -
Land Acquisition	$	$ 1.00	415000		$ -		$ -	60000	$ 60,000.00	10000	$ 10,000.00	75000	$ 75,000.00
Large Woody Debris (Optional)	EA	$ 1,000.00	45		$ -		$ -		$ -		$ -		$ -
SUBTOTAL CONSTRUCTION COST					$ 54,900.00		$ 223,600.00		$ 136,200.00		$ 64,200.00		$ 96,000.00
Sales Tax (8.9%)					$ 4,900.00		$ 19,900.00		$ 12,100.00		$ 5,700.00		$ 8,500.00
TOTAL CONSTRUCTION COST					***$ 59,800.00***		***$ 243,500.00***		***$ 148,300.00***		***$ 69,900.00***		***$ 104,500.00***

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	PROJECT 11		PROJECT 12		PROJECT 13		PROJECT 14		PROJECT 15	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP													
Clearing and Grubbing	AC	$ 8,000.00	14.05	0.1	$ 800.00	0.1	$ 800.00	0.1	$ 800.00	0.2	$ 1,600.00	1	$ 8,000.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS													
Remove Pavement	SY	$ 22.00	420		$ -		$ -		$ -		$ -		$ -
Sawcut Asphalt Concrete	LF	$ 3.50	300		$ -		$ -		$ -		$ -		$ -
GRADING AND EXCAVATION													
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678		$ -		$ -		$ -		$ -		$ -
Channel Excavation	CY	$ 18.00	28668		$ -		$ -	65	$ 1,170.00	800	$ 14,400.00	485	$ 8,730.00
Fine Grading	CY	$ 25.00	2940		$ -	225	$ 5,625.00		$ -		$ -		$ -
MINERAL AGGREGATES													
Crushed Surface Base Course	TN	$ 28.00	3980		$ -		$ -		$ -		$ -		$ -
Boulders	TN	$ 60.00	305		$ -		$ -		$ -		$ -		$ -
PAVEMENT													
Asphalt Concrete Pavement Patching	TN	$ 106.00	150		$ -		$ -		$ -		$ -		$ -
DRAINAGE SYSTEMS													
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180		$ -		$ -		$ -		$ -		$ -
EROSION CONTROL													
Hydro-Seeding	SF	$ 1.00	146900		$ -	1400	$ 1,400.00		$ -		$ -	13000	$ 13,000.00
Matting, Jute	SF	$ 1.50	1000		$ -		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000		$ -	200	$ 200.00		$ -		$ -	2000	$ 2,000.00
Fence, Temporary Silt Containment	LF	$ 6.00	14275		$ -	150	$ 900.00		$ -		$ -	1400	$ 8,400.00
High Visibility Fence	LF	$ 2.00	14275		$ -	150	$ 300.00		$ -		$ -	1400	$ 2,800.00
LANDSCAPING													
Wet Pond Seeding	SF	$ 3.00	5100		$ -	1600	$ 4,800.00		$ -		$ -		$ -
MISC ITEMS													
Planting Preparation	AC	$ 5,000.00	17.28	1.8	$ 9,000.00	0.2	$ 1,000.00	0.1	$ 500.00	0.6	$ 3,000.00	0.75	$ 3,750.00
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73	1.8	$ 63,000.00	0.1	$ 3,500.00	0.1	$ 3,500.00		$ -		$ -
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05		$ -	0.1	$ 1,000.00		$ -	0.6	$ 6,000.00	0.75	$ 7,500.00
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42		$ -		$ -	0.7	$ 2,450.00		$ -		$ -
Bioengineering Bank Stabilization	LF	$ 110.00	1894		$ -		$ -		$ -		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -		$ -		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -	11800	$ 118,000.00		$ -
OTHER ITEMS													
Temporary Bypass	LS	$ 75,000.00	6		$ -		$ -		$ -		$ -		$ -
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 4,095.00	1	$ 1,555.00	1	$ 705.00	1	$ 7,790.00	1	$ 3,905.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -		$ -		$ -		$ -		$ -
Traffic Control on Major Roads (10%)	LS	10%	8		$ -		$ -		$ -		$ -		$ -
Land Acquisition	$	$ 1.00	415000	5000	$ 5,000.00	10000	$ 10,000.00	5000	$ 5,000.00	5000	$ 5,000.00	20000	$ 20,000.00
Large Woody Debris (Optional)	EA	$ 1,000.00	45		$ -		$ -		$ -		$ -		$ -
SUBTOTAL CONSTRUCTION COST					$ 81,900.00		$ 31,100.00		$ 14,100.00		$ 155,800.00		$ 78,100.00
Sales Tax (8.9%)					$ 7,300.00		$ 2,800.00		$ 1,300.00		$ 13,900.00		$ 7,000.00
TOTAL CONSTRUCTION COST					***$ 89,200.00***		***$ 33,900.00***		***$ 15,400.00***		***$ 169,700.00***		***$ 85,100.00***

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	PROJECT 16		PROJECT 17		PROJECT 18		PROJECT 19		PROJECT 20	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP													
Clearing and Grubbing	AC	$ 8,000.00	14.05	0.25	$ 2,000.00	0.1	$ 800.00	0.1	$ 800.00	0.5	$ 4,000.00	0.5	$ 4,000.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS													
Remove Pavement	SY	$ 22.00	420		$ -		$ -	70	$ 1,540.00		$ -		$ -
Sawcut Asphalt Concrete	LF	$ 3.50	300		$ -		$ -	50	$ 175.00		$ -		$ -
GRADING AND EXCAVATION													
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678		$ -		$ -	100	$ 3,000.00		$ -		$ -
Channel Excavation	CY	$ 18.00	28668	160	$ 2,880.00		$ -	280	$ 5,040.00	300	$ 5,400.00	420	$ 7,560.00
Fine Grading	CY	$ 25.00	2940		$ -		$ -		$ -		$ -		$ -
MINERAL AGGREGATES													
Crushed Surface Base Course	TN	$ 28.00	3980		$ -		$ -	30	$ 840.00		$ -		$ -
Boulders	TN	$ 60.00	305		$ -		$ -		$ -		$ -		$ -
PAVEMENT													
Asphalt Concrete Pavement Patching	TN	$ 106.00	150		$ -		$ -	25	$ 2,650.00		$ -		$ -
DRAINAGE SYSTEMS													
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180		$ -		$ -	30	$ 36,000.00		$ -		$ -
EROSION CONTROL													
Hydro-Seeding	SF	$ 1.00	146900	4200	$ 4,200.00		$ -		$ -	6200	$ 6,200.00	7500	$ 7,500.00
Matting, Jute	SF	$ 1.50	1000		$ -		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000	800	$ 800.00		$ -		$ -	1000	$ 1,000.00	1500	$ 1,500.00
Fence, Temporary Silt Containment	LF	$ 6.00	14275	500	$ 3,000.00		$ -		$ -	600	$ 3,600.00	750	$ 4,500.00
High Visibility Fence	LF	$ 2.00	14275	500	$ 1,000.00		$ -		$ -	600	$ 1,200.00	750	$ 1,500.00
LANDSCAPING													
Wet Pond Seeding	SF	$ 3.00	5100		$ -		$ -		$ -		$ -		$ -
MISC ITEMS													
Planting Preparation	AC	$ 5,000.00	17.28	0.2	$ 1,000.00		$ -		$ -	0.25	$ 1,250.00	0.6	$ 3,000.00
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73		$ -		$ -		$ -	0.25	$ 8,750.00	0.6	$ 21,000.00
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05	0.2	$ 2,000.00		$ -		$ -		$ -		$ -
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42		$ -		$ -		$ -	0.5	$ 1,750.00	0.75	$ 2,625.00
Bioengineering Bank Stabilization	LF	$ 110.00	1894	211	$ 23,210.00		$ -		$ -		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -	1	$ 2,500.00		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -		$ -		$ -
OTHER ITEMS													
Temporary Bypass	LS	$ 75,000.00	6		$ -		$ -	1	$ 75,000.00		$ -		$ -
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 2,900.00	1	$ 700.00	1	$ 7,355.00	1	$ 2,830.00	1	$ 5,480.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -		$ -		$ -		$ -		$ -
Traffic Control on Major Roads (10%)	LS	10%	8		$ -		$ -	1	$ 14,710.00	1	$ 5,660.00	1	$ 10,960.00
Land Acquisition	$	$ 1.00	415000	15000	$ 15,000.00	10000	$ 10,000.00		$ -	15000	$ 15,000.00	40000	$ 40,000.00
Large Woody Debris (Optional)	EA	$ 1,000.00	45		$ -		$ -		$ -		$ -		$ -
SUBTOTAL CONSTRUCTION COST					$ 58,000.00		$ 14,000.00		$ 147,100.00		$ 56,600.00		$ 109,600.00
Sales Tax (8.9%)					$ 5,200.00		$ 1,200.00		$ 13,100.00		$ 5,000.00		$ 9,800.00
TOTAL CONSTRUCTION COST					***$ 63,200.00***		***$ 15,200.00***		***$ 160,200.00***		***$ 61,600.00***		***$ 119,400.00***

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	PROJECT 21		PROJECT 22		PROJECT 23		PROJECT 24		PROJECT 25	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP													
Clearing and Grubbing	AC	$ 8,000.00	14.05	1	$ 8,000.00	1.3	$ 10,400.00	0.1	$ 800.00	1	$ 8,000.00	0.1	$ 800.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS													
Remove Pavement	SY	$ 22.00	420		$ -		$ -		$ -		$ -	70	$ 1,540.00
Sawcut Asphalt Concrete	LF	$ 3.50	300		$ -		$ -		$ -		$ -	50	$ 175.00
GRADING AND EXCAVATION													
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678		$ -		$ -		$ -		$ -	100	$ 3,000.00
Channel Excavation	CY	$ 18.00	28668	3440	$ 61,920.00	1040	$ 18,720.00		$ -	560	$ 10,080.00		$ -
Fine Grading	CY	$ 25.00	2940		$ -		$ -	310	$ 7,750.00		$ -		$ -
MINERAL AGGREGATES													
Crushed Surface Base Course	TN	$ 28.00	3980		$ -		$ -		$ -		$ -	30	$ 840.00
Boulders	TN	$ 60.00	305		$ -		$ -		$ -		$ -		$ -
PAVEMENT													
Asphalt Concrete Pavement Patching	TN	$ 106.00	150		$ -		$ -		$ -		$ -	25	$ 2,650.00
DRAINAGE SYSTEMS													
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180		$ -		$ -		$ -		$ -	30	$ 36,000.00
EROSION CONTROL													
Hydro-Seeding	SF	$ 1.00	146900	18000	$ 18,000.00		$ -		$ -	15000	$ 15,000.00		$ -
Matting, Jute	SF	$ 1.50	1000		$ -		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000	3000	$ 3,000.00		$ -		$ -	2000	$ 2,000.00		$ -
Fence, Temporary Silt Containment	LF	$ 6.00	14275	1800	$ 10,800.00		$ -		$ -	1500	$ 9,000.00		$ -
High Visibility Fence	LF	$ 2.00	14275	1800	$ 3,600.00		$ -		$ -	1500	$ 3,000.00		$ -
LANDSCAPING													
Wet Pond Seeding	SF	$ 3.00	5100		$ -		$ -	2100	$ 6,300.00		$ -		$ -
MISC ITEMS													
Planting Preparation	AC	$ 5,000.00	17.28	4.2	$ 21,000.00	2	$ 10,000.00	0.1	$ 500.00	0.2	$ 1,000.00		$ -
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73	4.2	$ 147,000.00	2	$ 70,000.00	0.1	$ 3,500.00	0.2	$ 7,000.00		$ -
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05		$ -		$ -		$ -		$ -		$ -
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42	5	$ 17,500.00	4.75	$ 16,625.00		$ -		$ -		$ -
Bioengineering Bank Stabilization	LF	$ 110.00	1894		$ -		$ -		$ -		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -		$ -		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -		$ -		$ -
OTHER ITEMS													
Temporary Bypass	LS	$ 75,000.00	6		$ -		$ -		$ -		$ -	1	$ 75,000.00
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 16,620.00	1	$ 7,935.00	1	$ 1,255.00	1	$ 3,425.00	1	$ 7,355.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -		$ -		$ -		$ -		$ -
Traffic Control on Major Roads (10%)	LS	10%	8		$ -		$ -		$ -		$ -	1	$ 14,710.00
Land Acquisition	$	$ 1.00	415000	25000	$ 25,000.00	25000	$ 25,000.00	5000	$ 5,000.00	10000	$ 10,000.00	5000	$ 5,000.00
Large Woody Debris (Optional)	EA	$ 1,000.00	45		$ -		$ -		$ -		$ -		$ -
SUBTOTAL CONSTRUCTION COST					$ 332,400.00		$ 158,700.00		$ 25,100.00		$ 68,500.00		$ 147,100.00
Sales Tax (8.9%)					$ 29,600.00		$ 14,100.00		$ 2,200.00		$ 6,100.00		$ 13,100.00
TOTAL CONSTRUCTION COST					***$ 362,000.00***		***$ 172,800.00***		***$ 27,300.00***		***$ 74,600.00***		***$ 160,200.00***

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	PROJECT 26		PROJECT 27		PROJECT 28		PROJECT 29	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP											
Clearing and Grubbing	AC	$ 8,000.00	14.05	0.1	$ 800.00	0.1	$ 800.00	0.75	$ 6,000.00	0.25	$ 2,000.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS											
Remove Pavement	SY	$ 22.00	420	70	$ 1,540.00	70	$ 1,540.00		$ -		$ -
Sawcut Asphalt Concrete	LF	$ 3.50	300	50	$ 175.00	50	$ 175.00		$ -		$ -
GRADING AND EXCAVATION											
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678	100	$ 3,000.00	100	$ 3,000.00		$ -		$ -
Channel Excavation	CY	$ 18.00	28668		$ -		$ -	615	$ 11,070.00		$ -
Fine Grading	CY	$ 25.00	2940		$ -		$ -		$ -		$ -
MINERAL AGGREGATES											
Crushed Surface Base Course	TN	$ 28.00	3980	30	$ 840.00	30	$ 840.00		$ -		$ -
Boulders	TN	$ 60.00	305		$ -		$ -		$ -		$ -
PAVEMENT											
Asphalt Concrete Pavement Patching	TN	$ 106.00	150	25	$ 2,650.00	25	$ 2,650.00		$ -		$ -
DRAINAGE SYSTEMS											
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180	30	$ 36,000.00	30	$ 36,000.00		$ -		$ -
EROSION CONTROL											
Hydro-Seeding	SF	$ 1.00	146900		$ -		$ -		$ -		$ -
Matting, Jute	SF	$ 1.50	1000		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000		$ -		$ -		$ -		$ -
Fence, Temporary Silt Containment	LF	$ 6.00	14275		$ -		$ -		$ -		$ -
High Visibility Fence	LF	$ 2.00	14275		$ -		$ -		$ -		$ -
LANDSCAPING											
Wet Pond Seeding	SF	$ 3.00	5100		$ -		$ -		$ -		$ -
MISC ITEMS											
Planting Preparation	AC	$ 5,000.00	17.28		$ -		$ -	0.75	$ 3,750.00	1.13	$ 5,650.00
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73		$ -		$ -	0.75	$ 26,250.00	1.13	$ 39,550.00
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05		$ -		$ -		$ -		$ -
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42		$ -		$ -	2.2	$ 7,700.00		$ -
Bioengineering Bank Stabilization	LF	$ 110.00	1894		$ -		$ -		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -	22225	$ 222,250.00
OTHER ITEMS											
Temporary Bypass	LS	$ 75,000.00	6	1	$ 75,000.00	1	$ 75,000.00		$ -		$ -
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 7,355.00	1	$ 7,355.00	1	$ 3,965.00	1	$ 15,880.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -		$ -	1	$ 5,551.00	1	$ 22,232.00
Traffic Control on Major Roads (10%)	LS	10%	8	1	$ 14,710.00	1	$ 14,710.00		$ -		$ -
Land Acquisition	$	$ 1.00	415000	5000	$ 5,000.00	5000	$ 5,000.00	15000	$ 15,000.00	10000	$ 10,000.00
Large Woody Debris (Optional)	EA	$ 1,000.00	45		$ -		$ -		$ -		$ -
SUBTOTAL CONSTRUCTION COST					$ 147,100.00		$ 147,100.00		$ 79,300.00		$ 317,600.00
Sales Tax (8.9%)					$ 13,100.00		$ 13,100.00		$ 7,100.00		$ 28,300.00
TOTAL CONSTRUCTION COST					***$ 160,200.00***		***$ 160,200.00***		***$ 86,400.00***		***$ 345,900.00***

MAY CREEK

PLANNING LEVEL - COST ESTIMATE

LAST UPDATE: 06/04/2008

MATERIAL DESCRIPTION	UNIT	UNIT PRICE	TOTAL QUANTITY	INEFF. FLOW PROJECT 1		INEFF. FLOW PROJECT 2		INEFF. FLOW PROJECT 3		INEFF. FLOW PROJECT 4	
				QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
CLEARING+ GRUBBING+ AND ROADSIDE CLEANUP											
Clearing and Grubbing	AC	$ 8,000.00	14.05	0.3	$ 2,400.00	0.2	$ 1,600.00	0.5	$ 4,000.00	0.2	$ 1,600.00
REMOVAL OF STRUCTURES AND OBSTRUCTIONS											
Remove Pavement	SY	$ 22.00	420		$ -		$ -		$ -		$ -
Sawcut Asphalt Concrete	LF	$ 3.50	300		$ -		$ -		$ -		$ -
GRADING AND EXCAVATION											
Structure Excavation (Excavation Underneath Structures)	CY	$ 30.00	1678	237	$ 7,110.00	201	$ 6,030.00	140	$ 4,200.00	500	$ 15,000.00
Channel Excavation	CY	$ 18.00	28668	3334	$ 60,012.00	601	$ 10,818.00	8306	$ 149,508.00	4357	$ 78,426.00
Fine Grading	CY	$ 25.00	2940	371	$ 9,275.00	67	$ 1,675.00	923	$ 23,075.00	484	$ 12,100.00
MINERAL AGGREGATES											
Crushed Surface Base Course	TN	$ 28.00	3980	1000	$ 28,000.00	450	$ 12,600.00	1750	$ 49,000.00	600	$ 16,800.00
Boulders	TN	$ 60.00	305	20	$ 1,200.00	10	$ 600.00	30	$ 1,800.00	10	$ 600.00
PAVEMENT											
Asphalt Concrete Pavement Patching	TN	$ 106.00	150		$ -		$ -		$ -		$ -
DRAINAGE SYSTEMS											
Rein. Conc. Box Culvert 10' Span x 4' Rise	LF	$ 1,200.00	180		$ -		$ -		$ -		$ -
EROSION CONTROL											
Hydro-Seeding	SF	$ 1.00	146900	6000	$ 6,000.00	2500	$ 2,500.00	12500	$ 12,500.00	5000	$ 5,000.00
Matting, Jute	SF	$ 1.50	1000		$ -		$ -		$ -		$ -
Matting, Wood Excelsior	SF	$ 1.00	20000		$ -		$ -		$ -		$ -
Fence, Temporary Silt Containment	LF	$ 6.00	14275	550	$ 3,300.00	250	$ 1,500.00	950	$ 5,700.00	325	$ 1,950.00
High Visibility Fence	LF	$ 2.00	14275	550	$ 1,100.00	250	$ 500.00	950	$ 1,900.00	325	$ 650.00
LANDSCAPING											
Wet Pond Seeding	SF	$ 3.00	5100		$ -		$ -		$ -		$ -
MISC ITEMS											
Planting Preparation	AC	$ 5,000.00	17.28		$ -		$ -		$ -		$ -
Revegetation (Cadillac Scenario One)	AC	$ 35,000.00	14.73		$ -		$ -		$ -		$ -
Revegetation (Cheapest Scenario Three)	AC	$ 10,000.00	6.05	0.95	$ 9,500.00	0.4	$ 4,000.00	1.6	$ 16,000.00	0.55	$ 5,500.00
Revegetation (Tree and Shrub Supplementation in Riparian Corridor)	AC	$ 3,500.00	21.42	0.11	$ 385.00	0.05	$ 175.00	0.2	$ 700.00	0.06	$ 210.00
Bioengineering Bank Stabilization	LF	$ 110.00	1894		$ -		$ -		$ -		$ -
Beaver Deceiver	EA	$ 2,500.00	1		$ -		$ -		$ -		$ -
Bioswale Construction (Includes Excavation Grading and Seeding)	SF	$ 10.00	34025		$ -		$ -		$ -		$ -
OTHER ITEMS											
Temporary Bypass	LS	$ 75,000.00	6		$ -		$ -		$ -		$ -
Erosion and Sedimentation Control (5%)	LS	5%	33	1	$ 8,250.00	1	$ 2,670.00	1	$ 16,385.00	1	$ 8,580.00
Traffic Control on Minor Roads (7%)	LS	7%	6		$ -	1	$ 3,738.00	1	$ 22,939.00		$ -
Traffic Control on Major Roads (10%)	LS	10%	8	1	$ 16,500.00		$ -		$ -	1	$ 17,160.00
Land Acquisition	$	$ 1.00	415000		$ -		$ -		$ -		$ -
Large Woody Debris (Optional)	EA	$ 1,000.00	45	12	$ 12,000.00	5	$ 5,000.00	20	$ 20,000.00	8	$ 8,000.00
SUBTOTAL CONSTRUCTION COST					$ 165,000.00		$ 53,400.00		$ 327,700.00		$ 171,600.00
Sales Tax (8.9%)					$ 14,700.00		$ 4,800.00		$ 29,200.00		$ 15,300.00
TOTAL CONSTRUCTION COST					***$ 179,700.00***		***$ 58,200.00***		***$ 356,900.00***		***$ 186,900.00***

GeoEngineers

APPENDIX D
REPORT LIMITATIONS AND GUIDELINES FOR USE

APPENDIX D
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for exclusive use by King County, and their authorized agents. This report may be made available to members of the project team. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This Drainage and Restoration Plan for May Creek has been prepared for the King County. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study.

Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.