

# APPENDIX A: STORMWATER CAPITAL IMPROVEMENT PROGRAM

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# **GORST CREEK WATERSHED STORMWATER CAPITAL IMPROVEMENT PLAN**

## **Technical Memorandum**



For: City of Bremerton, WA



September 2013

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## INTRODUCTION

This memorandum is prepared as part of the Stormwater Management Plan used to comply with National Pollutant Discharge Elimination System Phase II (NPDES II) permit requirements. It follows up on the findings described in the Stormwater Facility Deficiencies Technical Memorandum for the Stormwater Plan of the Gorst Creek Watershed. The watershed encompasses the Bremerton city limits, portions of unincorporated Kitsap County, and a small portion of the Port Orchard city limits. No improvements were identified within Port Orchard. The City of Bremerton is planning for the Gorst Creek Watershed, and particularly for the unincorporated Gorst Urban Growth Area (UGA) in partnership with Kitsap County. Possible approaches for correcting drainage deficiency problems are discussed for locations in the watershed, focusing on lands in and adjacent to the Gorst UGA where drainage deficiencies were concentrated.

## OBJECTIVE

The objective of this technical memorandum is to prioritize stormwater corrective actions based on stormwater infrastructure deficiencies identified in the *Existing Conditions and Deficiencies Technical Memorandum* (AECOM, January 2013).

## METHODOLOGY

A strategy for the City and County will be suggested from a priority ranking of identified drainage infrastructure deficiencies. This will be accomplished by developing a schematic level solution to estimate programmatic costs and then provide a ranking based on Kitsap County Surface and Stormwater Management ranking criteria. Potential funding sources will be identified.

## SITE-SPECIFIC IDENTIFIED DRAINAGE INFRASTRUCTURE DEFICIENCIES

Drainage infrastructure deficiencies are identified by site and are located on Figure 1. General potential or observed deficiency concerns are provided in notes for each of the 16 sites shown on the figure. The legend identifies flooding, chemical, and biological deficiency concerns for each site. Unresolved or potential problems from drainage complaints and records are also noted for the site locations shown on Figure 1. The storm sewer systems and creeks within the Gorst UGA boundary are shown on the map in Appendix A.

### Identified Fish Passage Barriers

In addition to the site-specific infrastructure deficiencies, fish passage barriers have been identified in the Gorst Creek Watershed. A final summary basin-wide barrier inventory and assessment is addressed in the *Fish Passage Barrier Capital Improvement Plan Technical Memorandum*, included as Appendix D.

### Creek UGA Flooding

The floodplain for the 100-year event in the Gorst Creek Watershed extends well beyond the creek banks and encompasses significant developed areas within the UGA. Two creeks, Gorst Creek and Parish Creek, are responsible for flooding in the UGA. Flooding also occurs off of an unnamed creek at the very northeast corner of the drainage basin, flowing from north to south. Runoff from approximately eight acres of the Gorst Creek Watershed extends flooding within the UGA. The flooding closes state highways and local roads and homes and businesses are inundated by flood waters. Several drainage deficiency flood sites are related to the inability of these creeks to discharge peak flows to Sinclair Inlet, especially during high tides.

### ***Discussion and Recommendations:***

Recent increases in flooding on Parish Creek may indicate that flooding on Gorst Creek may be increasing due to development. Upstream unincorporated Kitsap County area development that discharges into Gorst Creek is regulated by Kitsap County Stormwater Management Standards. To comply with the NPDES Phase II stormwater permit, in 2008, Kitsap County adopted the current Washington State Department of Ecology

(Ecology) stormwater standards in the *Kitsap County Stormwater Management Ordinance and Design Manual*. These standards generally provide for flow and water quality controls for new development. However, these standards do not necessarily reduce current existing discharge volumes or provide days long lag time strategies to control peak discharge flows into these creeks. Applying low impact development strategies is an approach being considered to reduce peak flow runoff and was discussed in a separate *Programmatic Stormwater Management Alternatives Technical Memorandum* (AECOM, March 2013).

Recent hydrology studies were completed for Gorst Creek when the City of Bremerton added fish habitat features to the creek. In the 1930s, Gorst Creek was diverted into a straight, 700-foot-long channel to control Bremerton's drinking water supply at Gorst and salmon passage was deliberately restricted. Improvements have since removed the concrete channel features and altered the stream section. The creek must provide fish habitat as well as function for flow conveyance purposes. These dual needs will require careful stream analysis prior to any future alterations. Flows for Parish Creek and the unnamed creek northeast of the Gorst Creek outlet should also be accurately modeled with broad based watershed solutions in mind.

### **Chemical and Biological Deficiencies**

In 2010, two pump stations and a sanitary sewer collection system were built in the Gorst UGA as part of the Sinclair Inlet Restoration Project. The project tied in residential properties with failing or non-conforming septic systems into the sewer system in the UGA. All residential properties and most of the businesses on septic systems in the UGA in the Gorst area were connected to the collection system. The Kitsap County Public Health District is currently administrating and monitoring the connection of five remaining businesses to this sanitary collection system.

The Kitsap County Public Health District has noted chemical issues in runoff coming off parking lots that water quality treatment facilities would help mitigate. No specific parking lots are currently noted as a specific drainage infrastructure deficiency but this general issue should be considered.

In the case of two residential sites noted as stormwater facility deficiencies outside of the UGA, the septic systems were designed before the established standards were developed and before the 1960s when reporting requirements associated with permitting began. While no observed problem is evident, hillside seepage and flooding can potentially pose a condition where septic systems could conceivably be compromised. It is recommended that homes using septic systems in the older neighborhoods either be required to perpetually maintain a well-functioning septic system or be eventually tied into the county sanitary sewer collection system.

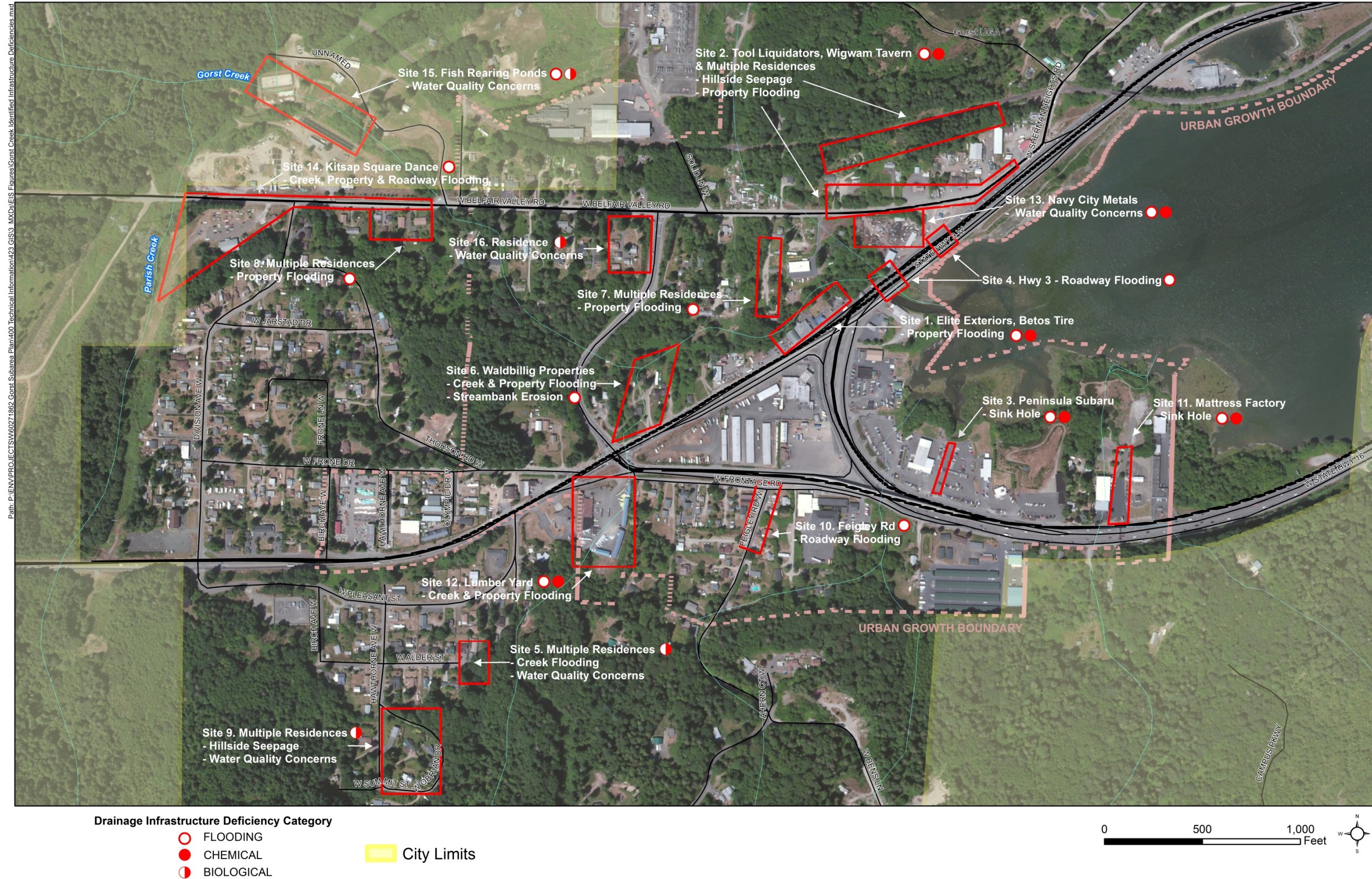
Additional sites with potential biologic issues include cases of observed cloudy creek water at fish rearing ponds where Parish Creek joins into Gorst Creek and an older report observing several waterfowl residing within a backyard residential pond. These deficiencies are addressed in the comments that follow.

### **Description of Deficiencies by Site**

#### **Site 0 Basin UGA Flood Assessment**

Due to uncertainty associated with the root causes of flooding within the UGA, it is recommended that a comprehensive flood and flow study be performed to assess the volume and source of stormwater inputs into the area by mapping the streams, flow patterns and storm systems (including illicit connections) upgradient of the UGA area. This would involve field survey and mapping of source areas, channel scour and in-ground piping, as well as stream flow gauging, storm observation, and other tasks. The goal of this study is to evaluate where excess flow is coming from and to determine possible mitigation for this increased flow in the uplands. The estimated cost for this study is \$600,000.





**Figure 1 - Gorst Creek Identified Infrastructure Deficiencies**  
(Fish passage deficiencies for sites 17 through 25 are not shown)



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**Site 1 – Elite Exteriors and Betos Tire, 3987 State Highway 3 W, Bremerton, WA 98312-4940**

*Identified Deficiency* – State Highway (Hwy) 3 runoff is channeled along the road shoulder to a sag point in the road profile near the properties of Elite Exteriors and Betos Tires. The two properties are flooded as the runoff drains northwest to Gorst Creek. The frequency of the flooding problem is not known. The roadway lacks any ditch or tight-line drainage system at this low point.

*Discussion and Recommendations:* Road runoff at this low spot should be picked up, treated, and conveyed to the north approximately 75 feet to Gorst Creek. A backflow preventer may be needed to restrict reverse drainage from high tailwater levels in Gorst Creek. The hydraulic grade lines for the creek and the sewer would need to be checked. Gorst Creek is overwhelmed during high tides and heavy rainfall, and under these conditions, the creek is known to cause highway flooding (See Appendix B for the storm sewer system layout). The flood runoff is adjacent to Hwy 3 and any drainage modifications needed within the Washington State Department of Transportation (WSDOT) right-of-way is the responsibility of WSDOT. Public flooding of properties may require a City and WSDOT solution to resolve.

*Estimate:* Study scope includes researching the boundaries of WSDOT right-of-way, commercial property boundaries, and drainage easements; developing the hydrologic and hydraulic analysis; designing the catch basin and water quality treatment for roadway runoff, storm sewer, and possible backflow preventer. Construction costs include installing a catch basin in pavement with 75 linear feet (LF) of storm sewer with a backflow preventer. See Appendix C for site cost estimate summaries.

**Site 2 – Multiple business and residential sites, along W. Belfair Valley Road, north of Navy City Metals property**

*Site 2, Problem 1, Hillside Seepage Deficiency* - Seepage from the upland hillside flows behind the building of Tool Liquidators (3476 W. Belfair Valley Road) and Winners Circle Bar and Grill (3548 W. Belfair Valley Road, or old Wigwam Tavern) after day long rains.

*Hillside Seepage Discussion and Recommendations:* The owner of Tool Liquidators installed sump pumps at the rear of the property to counter seepage flow as high as 2 inches through the building. The Winner's Circle Bar and Grill property also corrected rear property hillside drainage problems while under previous ownership. The source of the seepage was reported to appear from along an extended width of the hillside somewhere at the base. This drainage seepage upstream, with high volumes and broad width area within the UGA properties, is worth reviewing.

To investigate the problem, additional discussions are suggested with the rest of the property owners in the general area known to flood. A limited geotechnical investigation would be required to review the seepage flow source (see Appendix A). Existing geotechnical mapped and soil drilling data for the area should be reviewed.

*Site 2, Problem 2, Unnamed Tributary Flooding Deficiency* - The unnamed tributary begins at the northeast corner of the basin and flows south and then east along the north side of W. Belfair Valley Road in 7-foot-wide by 8-foot-deep ditches. The tributary crosses the road in a 36-inch-diameter concrete culvert into one of the ditches and then outlets through a 36-inch culvert to the southeast into Sinclair Inlet across Hwy 3. The ditch gets overwhelmed with the combination of rising tides and heavy rain at this Hwy 3 sag location. Flooding in this area is frequent and severe in impact. Business for Winners Circle Bar and Grill shuts down when the lot floods and the road is closed by the high water. Tool Liquidators, the Winner's Circle Bar and Grill, and adjacent residential properties to the west reported ditch overflow flooding up to the foundation footing of their buildings during high tides and high



**Photo 1** Belfair Valley Road 36 IN Culvert crosses the roadway at the Winner's Circle Bar and Grill

intensity storms. Tool Liquidators has had up to 18 inches of flood waters within their building. The Navy City Metals yard has occasionally flooded next to these ditches. Finally, a discharging street drainage line/inlet to the northeast silts up from reverse pipe flow sediment in the front of Tool Liquidators.

*Unnamed Tributary Discussion and Recommendations:* Flooding of the multiple businesses and residences is closely related to the Hwy 3 flooding road closures discussed for Site 4. Flooding of business and residences is common and severe enough that drainage subreach creek source controls and outlet culvert design of the ditch flow should be carefully reviewed.

If adequate studies have not been completed by the county, the size and elevation of the ditches and culverts should be reviewed and compared to tidal information and flood elevations. Any solution requiring modifications to the state culvert or highway will involve cooperation with WSDOT to resolve.

*Estimate:* Preliminary study scope includes providing time for discussions with property owners, the county, and WSDOT; limited geotechnical investigation and reporting; hydrologic investigation of the tributary; and preparation of an alternatives memorandum.

### **Site 3 - Peninsula Subaru, 3888 State Highway 16 W, Bremerton, WA, 98312**

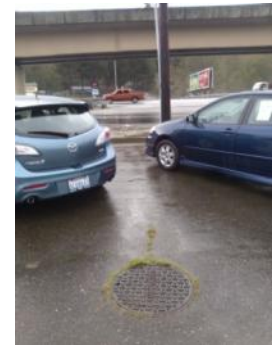
A 270 LF by 18-inch CMP culvert runs from south to north under the Subaru car lot and into Sinclair Inlet (see Appendix B for the County's storm sewer system). A sink hole developed on the northeast side of the Peninsula Subaru property in their paved parking area over the top of this culvert. It appears that the CMP culvert has corroded and has created the sink hole as a result of culvert piping or exterior flows undermining and eroding out the bedding around the pipe. The outlet for this pipe is set roughly 10 feet below the parking area and includes a tee diffuser at or below the water level depending on the tides. A culvert and a storm sewer trunk line drains into this culvert on the south end. The storm sewer is adjacent to Hwy 16. The culvert crosses Hwy 16 and picks up the flow from an unnamed tributary. Proper drainage for these connecting pipes is dependent on the repair of the Subaru culvert.

In addition, this culvert is the downstream component of Culvert 18, Map ID - NL 6, which is considered a fish barrier culvert with 500 LF of habitat gain and a high obstacle rating.

*Discussion and Recommendations:* Repair of the culvert is complicated by a claim by the owner that the culvert is set within an easement and they are not responsible for its repair. The City of Bremerton does not claim ownership nor honor the maintenance responsibility for a storm drainage line within the easement. The issue of maintenance will need to be resolved before the repair can be completed.

Capacity of this undermined culvert may be reduced and might be affecting the ability to drain runoff away from Hwy 16. However, flow upstream in the unnamed tributary appeared to be unencumbered at the culvert entrance in observations during recent near record rains. Public comments report that stormwater is undermining many of the roads in the vicinity of Feigley Road and the frontage road on the south side of Hwy 16 as discussed with flood deficiencies for Site 10. Common sediment accumulations are noted to clog road drainage catch basins in this area. WSDOT, Subaru, and the City of Bremerton need to coordinate to address the underground erosion and capacity issues associated with this culvert.

*Estimate:* Preliminary design and coordination scope includes multi-jurisdictional and private owner coordination; survey services to include resolving land dispute; and design of culvert replacement. Construction scope assumes replacing the existing culvert with 270 LF of 48-inch-wide arch culvert.

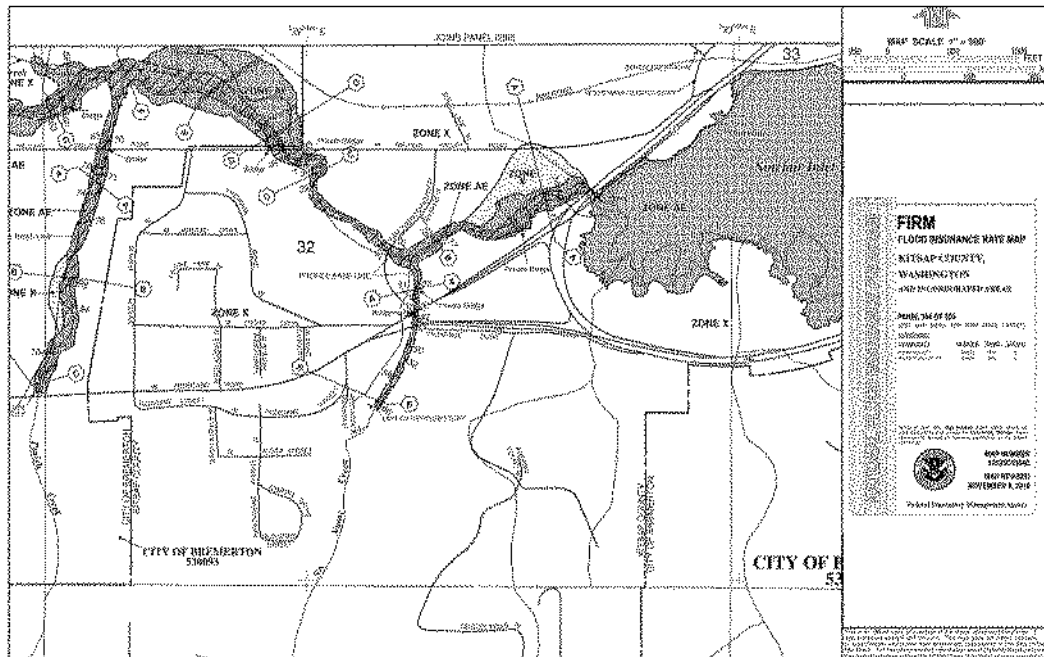


**Photo 2** At south culvert end, looking south across SR 16 toward unnamed tributary

**Site 4 – Hwy 3 /Hwy 16** (at two culvert road crossing locations near the Navy City Metals property at 3805 Hwy 3 W. Bremerton).

On several occasions within the last seven years, Hwy 3 W and Hwy 16 have closed down to traffic at these two culvert crossing locations due to a simultaneous high tide and high rainfall intensity. These road crossing locations cross Hwy 3 and Hwy 16 to Sinclair Inlet and are the outlets of Gorst Creek and the unnamed creek tributary northeast of the Gorst Creek outlet. The runoff from the unnamed tributary outlets into Sinclair Inlet through a 36-inch concrete culvert as discussed in Site 2. Gorst Creek outlets through twin 7-foot-wide concrete bottomless box culverts into Sinclair Inlet. Vehicle access between Bremerton and large outlying areas within the Kitsap Peninsula is dependent on Hwy 16 and Hwy 3 at this critical location.

Roadway runoff and property flooding as discussed in Sites 2, 7, and 13 are impacted by the flooding in floodplain areas. Gorst Creek is unable to discharge to Sinclair Inlet through the culvert during high tides and heavy rainfall events without backwater flooding in the floodplain areas. According to FEMA insurance studies, Gorst Creek has a peak 100-year NGVD elevation of 14.3 feet and record tide levels have been recorded as high as 12.9 feet. The 100-year and 500-year flood levels for the Gorst Creek Watershed are illustrated in the FEMA Flood Insurance Map shown in Figure 2.



**Figure 2 - FEMA Flood Map**

**Discussion and Recommendations:** It is evident from Figure 2 that Gorst Creek has a huge floodplain area. Generally, as development adds impervious surface within the subbasins, creek volumes increase. Times of concentration are reduced for the peak creek flows. When Sinclair Inlet tides are high at the same time as peak stream flows are occurring, the creeks cannot drain the backwater through the outlet culverts. The inability of the backwater to drain through the culverts causes overflows onto the roadway. Three intuitive options to reduce roadway flooding include:

1. Review if creek flow concentrations to the outlet culverts can be reduced, minimized, or mitigated.
2. Look at improving the hydraulic capacity of the outlet culverts and creek channel.
3. Look at raising the roadway grade above the floodway elevation.



Any solution requiring modifications to the culverts or roadway will require a multi-jurisdictional solution with WSDOT to resolve. Culvert flow line and soffit elevations and highway profile elevations should be reviewed against record or prevailing high tide information. From site observations, it appears to be possible to raise the roadway profile several feet in the vicinity of the culvert at the unnamed creek to keep traffic from being blocked during flooding. Bridge clearance could be a problem for raising Hwy 3 at Gorst Creek because the Hwy 16 bridge crosses at this point and it already has a substandard 15.1-foot vertical clearance.

*Estimate:* Preliminary study scope includes a hydrology study for Gorst Creek, including defining floodplain impacts addressed in Site 7; reviewing alternatives for culvert modifications; analyzing and reviewing alternative channel modifications, including environmental and fish passage implications; and reviewing the feasibility of raising the highway profile at both culvert locations. Fish habitat and environmental permitting will be needed and impacts will need to be assessed. Construction scope assumes contingencies for raising Hwy 3 at the unnamed creek; modifying the Gorst Creek culvert; and providing possible undefined channel widening improvements/riparian enhancement features to Gorst Creek.

#### **Site 5 – Multiple residences, east end of W. Alder Street (Outside of the Gorst UGA)**

Residences may flood from creek overflows. Septic systems in this old part of town could be under stress during peak flow periods creating a concern for water quality by the Kitsap County Public Health District. Many of the septic systems were designed before established standards were developed and before the 1960s when reporting requirements associated with permitting began.

*Discussion and Recommendations:* Grandfathered septic systems may eventually fail. For replacement or restoration of services, regulations should require upgrading to current standards of care to ensure water quality concerns are addressed for the community.

*Estimate:* No costs are anticipated for resolving this deficiency.

#### **Site 6 – Waldbillig Properties.**

These properties include the residences of 4159 and 4177 Hwy 3 and a commercial property at 4163 Hwy 3 that are all located on the north side of the highway and east of Sam Christopherson Avenue W.

Unnamed Creek (1227026475270) Flooding - A ditch carries flow along the west side of the property to the north into Gorst Creek. This perched elevated ditch overtops its banks and floods the yards of two homes. At the north end of the property, the ditch flow cascades down into Gorst Creek.

Sam Christopherson Road Culvert - A drainage complaint was received by Kitsap County Public Works that the two residences flood due to installation of a 24-inch private driveway culvert upstream along Sam Christopherson Road. The County inspected the site and noted that the culvert and driveway were on private property.

Gorst Creek Erosion - The Kitsap County Public Health District thought that the owner claimed that the residence at 4159 Hwy 3 was almost lost to stream bank erosion in Gorst Creek three to four years ago.

*Discussion and Recommendations:* The ditch flow is mostly restricted by the upstream 36-inch-diameter culvert(s) that constrain the maximum flow volumes coming from Hwy 3 and the unnamed creek. Since the ditch flow overtops the banks, the capacity of the ditch will need to be increased and sized based on the outlet flows picked up by the ditch to prevent flooding of the properties. Fish habitat and environmental impacts will need to be assessed.



**Photo 3** Looking south

The Sam Christopherson Road culvert is located west of the Waldbillig properties. No action was taken by the County after determining that the culvert was on private property. It is not apparent how a driveway culvert would cause flooding on any property other than the adjacent property on Sam Christopherson Road. More investigation is needed to determine if culvert clogging was the issue or not.

The slopes along the sides of the Gorst Creek channel are erodible and show recent sloughing on the southern slopes. Gorst Creek has flows up to 1,145 cfs at a peak velocity of 8 fps based on FEMA insurance studies for a 100-year storm event during the last ¼ mile where profile slopes are near flat. The shear stresses are likely high enough to continue to cause erosion. The basis of erosion potential in Gorst Creek should be quantified. The threat to property structures can be evaluated in this location compared to erosion potential within the creek. Stream bank protection measures will be reviewed and considered if needed.

*Estimate:* Preliminary study scope includes modeling receiving waters into the ditch; designing and analyzing the ditch channel; holding discussions with the culvert property owners along Sam Christopherson Road; computing shear stresses in Gorst Creek near the Waldbillig properties; determining fish habitat and environmental requirements; and developing design of stream bank protective measures. The construction estimate scope assumes 380 LF of ditch modifications and 250 LF of Gorst Creek stream bank protective measures adjacent to the properties.

#### **Site 7 – Old Belfair Valley Road properties**

These properties are southeast of Old Belfair Valley Road and Sam Christopherson Avenue W. and west of Navy City Metals. Flooding was reported to have occurred in this area in the past. Neighbors reported that homes in the area are now abandoned. This area is within the Gorst Creek 100-year floodplain according to the FEMA floodplain Flood Insurance Rate Mapping shown in Figure 2. Access into the site was restricted, probably because of abandonment of homes due to previous flooding.

*Discussion and Recommendations:* The area closer to Gorst Creek would likely be more susceptible to flooding damages. The *Water Resource Inventory Area #15 2000 Salmon Habitat Limiting Functions Report* from the Washington State Conservation Commission made recommendations in this area to:

- Restore natural channel configuration and floodplain function in the lower 0.8 mile of Gorst Creek.
- Seek removal or relocation of approximately six businesses and 10 to 12 residences that encroach into the natural floodplain.
- Restore functional riparian zones from the mouth of Gorst Creek to the old diversion site at river mile 0.8.

Modeling of the creek flow and floodplain as discussed for Site 4 would be helpful to determine a more accurate floodplain boundary and property impacts.

*Estimate:* Study scope includes effort to determine floodplain impacts and the reach of general flooding in this residential and commercial zoned area documented in a technical memorandum. This effort assumes use of the hydrologic modeling completed for Site 4.

#### **Site 8 – Multiple residential homes, W. Belfair Valley Road at Gorst Creek (Outside of the UGA)**

It was reported by Kitsap County Public Health District that Gorst Creek has flooded near the fish hatchery where the creek crosses Belfair Valley Road. Several homes at 4277, 4259 and 4273 W Belfair Valley Road on the south side of the road and west of the Gorst Creek crossing have experienced minor flood runoff impacts caused by overflow from the Kitsap Square Dance property where Parish Creek overtops its banks. The overflow travels downstream along the shoulder edges of W. Belfair Valley Road and into the low lying driveways and grades of these homes.

*Discussion and Recommendations:* Although these homes are located adjacent to Gorst Creek, the flooding threat is the upstream creek bank overtopping at Parish Creek, located a quarter of a mile away. Parish Creek

flooding is discussed under Site 14. Currently, the problem has been mitigated by the County sandbagging the driveways to 1 foot high or so to prevent flooding of the property and downstream neighboring properties.

*Estimate:* The scope is directly tied to solving flooding discussed under Site 14. No costs have been estimated for this site.

**Site 9 – Multiple residences** between W. Summit Street and O'Brian Drive, Gorst, WA (Outside of Gorst UGA)

Stress on septic systems is a water quality concern for the Kitsap County Public Health District in this neighborhood due to hillside seepage and raised water tables during peak rain events. The septic systems were designed earlier than the current established standards were developed and before the 1960s when reporting requirements associated with permitting began. Monitoring of septic systems is not normally completed during peak flow events so the performance of these systems is uncertain under these circumstances.

*Discussion and Recommendations:* As these unincorporated county septic systems fail, new permits will bring the older systems up to current code compliance required in the implementation of the NPDES II stormwater permits as specified through the *Kitsap County Stormwater Management Ordinance and Design Manual* and county and state water quality laws.

*Estimate:* No task work is required other than coordination of these water quality concerns with Kitsap County.

**Site 10 – Multiple residences along Feigley Road switchback** (Outside of Gorst UGA)

Drainage records reported that flooding occurred when a frontage road crossing culvert was plugged on Feigley Road, a moderately sloped and switchbacked street. The location was not specified and the problem was reportedly resolved by removing the debris blockage and may not be an ongoing problem. Additionally, public comments reported that stormwater is undermining the roads in the vicinity of Feigley Road and the frontage road on the south side of Hwy 16.

*Discussion and Recommendations:* Hwy 16 is curbed and ditched along the stretch adjacent to W. Frontage Road. Inlets located within the shoulder area are sparsely spaced. Feigley Road is mildly sloped with no curbing or ditching near the intersection with W. Frontage Road. From initial observations, it is not apparent what could create an erosive condition that could undermine any of the local or state roadways in the area.

More investigation and discussions with neighboring businesses are needed to identify the threats, damages, and jurisdiction of responsibility of the deficiencies identified by drainage records and public comments, if any. Coordination may eventually be needed between the City of Bremerton, Kitsap County, and WSDOT. A site visit is needed to review culverts along Feigley Road that might be more susceptible to clogging and therefore cause flooding of property downstream.

*Estimate:* Study scope includes coordination with Kitsap County and WSDOT, a site visit, and development of a memorandum detailing problems and proposed actions.

**Site 11 - The Mattress Ranch, 3650 Hwy 16 W., Port Orchard**

The owner currently has a sink hole developing approximately 25 feet from the back of the parking lot in line with drainage structures at the Mattress Factory. Kitsap County Public Works storm sewer mapping shows a storm sewer under the Mattress Ranch parking lot that is connected to a WSDOT storm sewer and two upstream Hwy 3 catch basins. A Kitsap County Public Works drainage complaint shows that the storm sewer under the Mattress Ranch is a 30-inch CMP private line that is the responsibility of the owner. The complaint notes a sink hole problem in 2003. The storm sewer section that is maintained by the Mattress Ranch likely has a problem with piping or the undermining of culvert bedding that causes the sink holes. Kitsap County maintains the outfall swale at the end of the Mattress Ranch drain pipe and is averse to taking responsibility for cleaning this private drainage line.



WSDOT maintains 120 LF of 30-inch culvert upstream of this culvert and is identified as a fish passage barrier (Site 34, Culvert 20, Map ID 108494).

*Discussion and Recommendations:* Kitsap County Public Works reports that sediment filled up the WSDOT catch basins and connecting storm sewer quickly after a recent maintenance cleaning in this area. The upstream runoff from the south side hills can carry sand and gravel unto the highway. The County suspects that the private storm sewer line may have significant silt deposits as a result. Overflow from inlets on Hwy 16 may be contributing to the downstream issues reported with Site 10 near Feigley Road.

*Estimate:* The design scope includes City coordination with WSDOT, Kitsap County, and the property owner to fix the culvert and discuss state highway maintenance to find solutions for maintaining the roadway drainage system. Construction scope assumes replacement of the existing culvert with 310 LF of 58-inch-wide by 36-inch arch culvert to connect up to the WSDOT culvert.

**Site 12 – Washington Cedar Lumber Yard, 4041 Hwy 3 W, Bremerton (junction of Hwy 16 and Hwy 3)**

Kitsap County Public Works and the Kitsap County Public Health District noted previous flooding from an upstream unnamed tributary that caused property damage in the lumber yard from an overwhelmed 36-inch diameter steel CMP culvert entrance upstream of the paved lot. Flows enter the site from an upstream unnamed stream 12270264775270 from the south (see photo 4). The headwater of the unnamed stream is just downstream of the Port Orchard UGA near the McCormick Woods development.

To avoid flooding, the manager has to maintain a screen at the culvert entrance that prevents debris from entering the 350 LF by 36-inch-diameter culvert pipe. Silt has not been an issue with the culvert. In the *Existing Fish Passage Barriers Technical Memorandum*, the culvert is classified as a fish barrier due to 1-foot-high peak flows and a length longer than 100 feet. The obstacle rating was evaluated as low to medium. The culvert is downstream of 5,000 LF of potential habitat.

*Discussion and Recommendations:* Past and potential flooding from this private culvert predominantly is a threat mostly to damage of material stored on this private site. However, flows draining across the paved lot could end up quickly flowing north across Hwy 16. The business has taken preventative measures by removing the culvert screen guard during heavy rains that collect debris and dams up the stream but also prevents debris from entering the culvert. Flooding caused by debris clogging can be mitigated by using a pool near the culvert entrance to slow velocities and snag debris before lodging in the inlet.



**Photo 4** Looking south at 36-inch culvert (in shadow)

Fish passage improvements are discussed for Site 26 (Culvert 12 - Map ID 111010) in the *Fish Passage Barrier Capital Improvement Plan Technical Memorandum* (Appendix D).

Site 12 emphasizes reducing clogging, while Site 26 emphasizes abandoning the culvert with a rerouted culvert to reduce culvert lengths to improve fish passage.

*Estimate:* The design scope includes a site visit, review of property ownership, and development of an inlet pond with debris catchment features. Construction scope assumes an inlet pond.

**Site 13 – Navy City Metals, 3805 Hwy 3 W. Bremerton**

This site is monitored by Ecology through an industrial permit. The ditch on the north side of W. Belfair Valley Road (see photo 5) is connected to a second continuing downstream ditch by a 36-inch culvert crossing under the road. This ditch is drained by a 36-inch culvert crossing Hwy 3 to Sinclair Inlet. The second ditch (see photo 4) is adjacent to this active metal recycling facility. Backwater from high tides and heavy rainfall floods the properties noted in Site 2 and the yard at Navy City Metals. Employees report that flooding as deep as 3 feet has been seen in the yard. All yard drainage leaves through an oil/water separator and is released into the ditch by a 6-inch pipe. Metal laden runoff released into Sinclair Inlet is a concern because copper and zinc levels are already high.



**Photo 5** Looking southeast at ditch and 36-inch culvert crossing west of Hwy 3

*Discussion and Recommendations:* The water quality for this site is the responsibility of Ecology. The flooding of this site is related to solving the flooding problems described for Gorst Creek at the outlet with Sinclair Inlet as discussed for Site 4. Investigation should include discussions with the property owner. A backflow preventer with the 4-inch outlet pipe with their oil/water separator may help relieve flooding. The grades surrounding the site should be reviewed to see if the site is lower than the creek channel flood levels and straight-forward flood mitigation solutions should be reviewed.

Estimate: This is the responsibility of Ecology. No costs are estimated.

**Site 14 –Kitsap Square Dance Association, 6800 W. Belfair Valley Road, Gorst, WA (Outside UGA)**

Fish passage problems are encountered in Parish Creek downstream of the W. Belfair Valley Road crossing and bank overtopping problems occur from Parish Creek upstream of the road crossing within the Kitsap Square Dance Association property. During high flows, Parish Creek jumps the narrow and shallow creek bed channel into surrounding floodplain areas to the east, approximately 400 feet upstream of the W. Belfair Valley Road culvert. Over the years, high flow events have brought sediment into this area causing loss of the main channel due to infilling, and creating braiding and broad floodplain overflows into the adjacent areas (see photos 17 and 18). From this location, floodplain drainage tends to flow through the Kitsap Square Dance Association gravel parking lot to the northeast corner where it crosses W. Belfair Valley Road. The sheet flow flows down both road shoulders toward the road's sag point at the Gorst Creek crossing, 800 feet to the east.

For flows that remain in Parish Creek west of the dance hall facility, the main channel flows through a 5-foot-diameter steel CMP culvert under the W. Belfair Valley Road. This culvert outlet is directed into a concrete channel constructed with 12-inch weir drops.



**Photo 6** Creek bank overflow from behind first row of trees upstream of the Association's property



**Photo 7** Kitsap Square Dance Association parking that overtops W. Belfair Valley Road

*Discussion and Recommendations:* The culvert fish passage problem and creek flooding problems and solution alternatives are discussed in a technical memorandum called *Parish Creek Fish Habitat Improvement* (AECOM 2012). The obstacle rating for this culvert was evaluated as medium. Barrier elements include 1-foot weir drops without notches, slope culvert, and high velocities at peak flows. This culvert is downstream of 7,400 LF of potential habitat.

The reason sediment is infilling Parish Creek needs to be identified. Soils are known to be susceptible to erosion and the site should be observed for evidence of slides or other tell tale signs of where the sediment is originating. Property development at the headwaters should be reviewed and analyzed for the possibility it is increasing Parish Creek flow rates. The Sunny Slope development, adjacent to Parish Creek, was constructed without any stormwater controls.

*Estimate:* Study scope includes hydrologic modeling of Parish Creek and design plans and specifications for a bridge providing fish passage and rechanneling of overtopping flows from Parish Creek. A conservative construction estimate is provided in the *Parish Creek Fish Habitat Improvement Technical Memorandum* for constructing a 34 LF by 40-foot flat slab fish passage bridge over W. Belfair Valley Road and a 256 LF 6-foot by 4-foot box culvert to redirect overtopped flows back to Parish Creek.

#### **Site 15 – Fish Rearing Ponds (Outside UGA)**

A Sun Times article reported that 1.6 million baby Chinook salmon died from oxygen deprivation in May 2006 as sediment debris washed into the creek from rains and clogged an intake pipe. Coincidentally, a County drainage complaint cited a concern for silt clouding up the creek water twice in one week about that time. The County noted that the engineer suspected that a large slide occurred up Parish Creek Canyon due to heavy rain.

*Discussion and Recommendations:* Additional investigation will be needed to fully understand siltation of Parish Creek upstream as discussed for Site 14. Silt accumulation of Parish Creek is seen as the cause of flooding for Sites 8 and 14. A site visit should be included to discuss the drainage incident with the owner of the parcel belonging to the property owners called Bremerton Watershed.

*Estimate:* Study scope includes a site visit to walk the Parish Creek valley and watershed ridge, discussions and meeting notes with the engineer at the town of Sunny Slope about recent property development, and drainage code requirements; and provision for limited geotechnical research and preparation of a memorandum.

#### **Site 16 – Residence, 4052 Old Belfair Valley Highway, Gorst, WA**

A formal drainage complaint received from the Kitsap County Public Works addressed possible water quality pollution by animals and vehicles on this private property. The concern was that pollution could end up in Gorst Creek (KCPW Ref#100876). The property has a pond with resident waterfowl. The property was inspected but no corrective action was requested by Kitsap County Public Works at that time.

*Discussion and Recommendations:* This drainage complaint may no longer be valid if the conditions have changed or if pollution is not likely to escape from the property. The property should be visited by the City to note current condition. Following the site visit, the property should be removed as a concern if there is not a noticeable problem. No costs are estimated for this private site.



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# **Appendix A: Gorst Creek Watershed Plan**

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FIGURE 3.1-1 GORST CREEK WATERSHED: SOILS

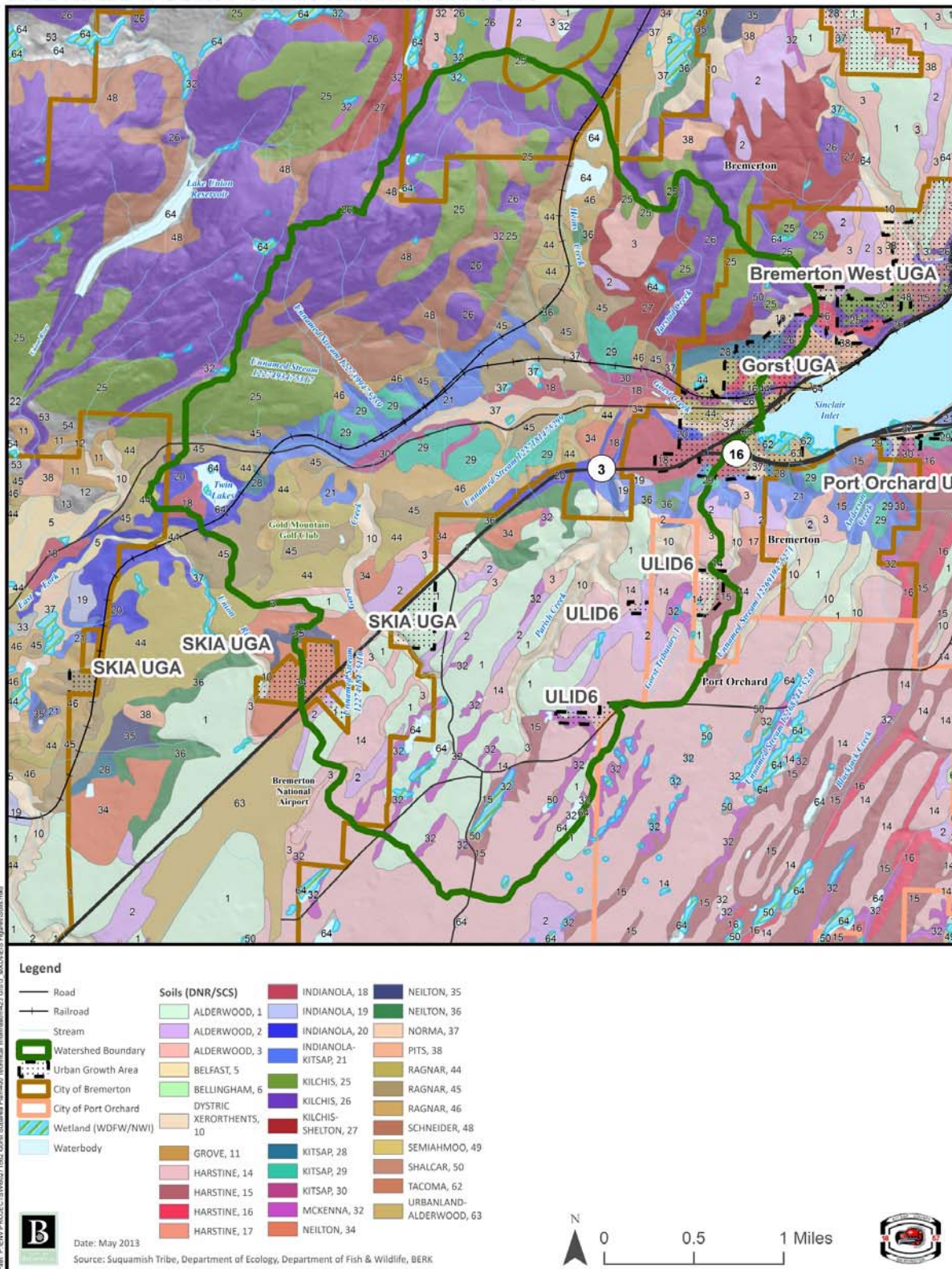
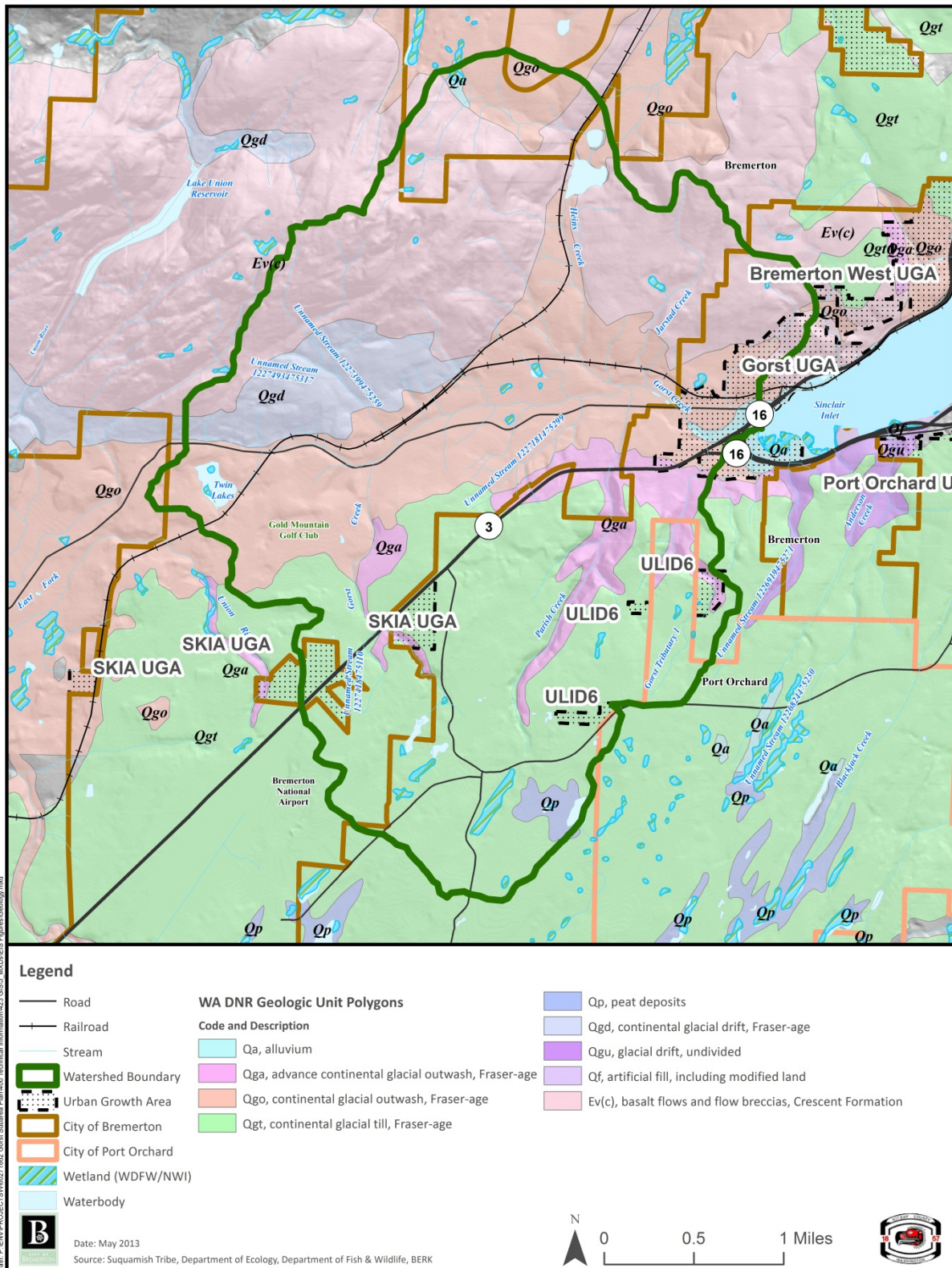




FIGURE 3.1-1 GORST CREEK WATERSHED: GEOLOGY



# **Appendix B: Kitsap County Public Works Surface and Stormwater Management**

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- |                                                                                                                                                                              |                                                                                                                                                                                                   |                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>CB1</li> <li>CB1-SL</li> <li>CB1-BL</li> <li>CB2</li> <li>CMH</li> <li>OWS1</li> <li>OWS2</li> <li>Other</li> <li>TideGate</li> </ul> | <ul style="list-style-type: none"> <li>Collector/Kitsap County</li> <li>Collector/Private</li> <li>Collector/Commercial</li> <li>Ditch</li> <li>Trench</li> <li>Culvert</li> <li>Swale</li> </ul> | <ul style="list-style-type: none"> <li>DischargeStructure</li> <li>DiversionPoint</li> <li>JunctionChamber</li> <li>StorageBasin</li> <li>Other</li> <li>Vault</li> <li>Storm Grid</li> <li>Tax Parcels</li> </ul> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### KITSAP COUNTY PUBLIC WORKS Surface and Stormwater Management

Note: The information presented in the map comes from several sources and varies in data quality. This map provides information on the type and relative location of components which comprise the surface water drainage system of Kitsap County. It should not be used as a basis for developing engineering designs. For more information, contact Kitsap County Surface and Storm Water Management Program at 360-337-5777.





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## Appendix C: Site Costs

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**Gorst Watershed**  
**Summary of Programmatic Costs**

Site	Location	Description	Engineering Costs	Construction Costs	Rounded Total	Revenue Source
0	Flood Cause Study	Evaluate source areas and flooding within UGA	\$600,000	\$0	\$600,000	S, G
1	Elite Exteriors/Betos Tire	WSDOT Hwy 3 flooding	\$ 24,491.39	\$ 149,735.67	\$ 174,000.00	S, G
2	Business and homes north of Navy City Metals	Hillside seepage & stream overbank flooding	\$ 99,180.00	\$ -	\$ 99,000.00	S, G
3	Peninsula Subaru	Storm drain piping & sink hole	\$ 36,753.26	\$ 179,682.58	\$ 216,000.00	S, G
4	State Hwy 3/16	Highway flooding from two creeks	\$ 172,560.00	\$ 3,051,000.00	\$ 3,224,000.00	S, G
5	Residences east end of W. Alder Street	Water quality from septic systems	\$0.00	\$0.00	\$0.00	
6	Waldbillig Property	Stream overtopping	\$ 175,485.19	\$ 873,526.27	\$ 1,049,000.00	S, G
7	Old Belfair Residences at Sam Christopherson	Gorst Creek floodplain flooding	\$ 14,640.00	\$ -	\$ 15,000.00	S, G
8	W. Belfair Valley Rd. Residences w. of Gorst Cr.	Parish Creek street flooding	\$0.00	\$0.00	\$0.00	
9	Multiple residences between W. Summit Street and O'Brian Drive	Water quality concern to septic systems from high water tables	\$0.00	\$0.00	\$0.00	
10	Feigley Road switchback	Roadway undermining and culvert clogging Private storm sewer piping creating sink hole & fish passage barrier	\$ 13,260.00	\$ -	\$ 13,000.00	S, G
11	The Mattress Ranch	Upstream Culvert 12 inlet flooding and fish passage, Map ID #111010	\$ 77,394.23	\$ 378,371.80	\$ 456,000.00	S, G*
12	Washington Cedar lumber yard	Water quality concerns with yard flooding	\$ 20,480.00	\$ 271,288.65	\$ 292,000.00	S, G
13	Navy City Metals	Parish Creek bank overtopping w/ Culvert 8, Map ID #105106	\$0.00	\$0.00	\$0.00	
14	Kitsap Square Dance Association	Gorst Creek bank overtopping	\$ 32,580.00	\$1,013,000	\$ 1,046,000.00	S, G*
15	Fish Rearing Ponds	Water quality with private pond	\$ 17,560.00	\$ -	\$ 18,000.00	S, G
16	Residence, 4052 Old Belfair Valley Highway	W. Belfair Valley Rd near Gold Mountain Golf Course	\$0.00	\$0.00	\$0.00	
17	Culvert 1, Map ID 105103	Road vicinity	\$ 45,919.35	\$ 114,494.62	\$ 160,000.00	S, G
18	Culvert 2, NL #1	Gold Mountain Golf Course Road	\$ 51,905.76	\$ 143,761.49	\$ 196,000.00	S, G
19	Culvert 3, Map ID NL #2	W. Belfair Hwy @ Gold Mountain Golf Course Rd	\$ 16,185.28	\$ 79,128.02	\$ 95,000.00	S, G
20	Culvert 4, Map ID NL #3	Heins Creek Culvert Crossing	\$ 55,232.78	\$ 80,013.47	\$ 135,000.00	S, G
21	Culvert 6, Map ID 105105	Jarstad Creek Railroad Crossing			\$0.00	
22	Culvert 7, Map ID 105107	Heins Creek COB access road crossing	\$ 45,786.38	\$ 113,844.53	\$ 160,000.00	S, G
23	Culvert 8, Map ID 105106	Parish Creek Culvert W. Belfair Highway	\$0.00	\$0.00	\$0.00	
24	Culvert 10, Map ID 111009	North side Hwy 3 @ junction of Hwy 16 Unnamed Creek 1227026475270 at South Side of Hwy 16	\$ 52,589.48	\$ 147,104.13	\$ 200,000.00	S, G
25	Culvert 11, Map ID 108414	Unnamed Creek 1227026475270 at South Side of Hwy 16	\$ 67,612.05	\$ 220,547.80	\$ 288,000.00	S, G
26	Culvert 12, Map ID 111010	Hwy 16	\$ 61,899.42	\$ 192,619.40	\$ 255,000.00	S, G
27	Culvert 13, Map ID 107158	Gorst Creek at Hwy 3 MP 28	\$ 154,201.80	\$ 742,933.24	\$ 897,000.00	S, G, WSDOT



28	Culvert 14, Map ID 105104	Gorst Creek South of Hwy 3 MP 28	\$0.00	\$0.00	\$0.00	
29	Culvert 15, Map ID NL #5	Unnamed Stream 1227418475110 South of Hwy 3 MP 28	\$ 27,357.08	\$ 133,745.72	\$ 161,000.00	S, G, WSDOT
30	Culvert 16, Map ID 115006	Gorst Creek at West Belfair Highway	\$ 233,522.57	\$ 1,141,665.89	\$ 1,375,000.00	S, G
31	Culvert 17, Map ID 110964	Gorst Creek at Hwy 3 at Outfall Unnamed Creek at Hwy 16 and connects to Subaru culvert			\$0.00	
32	Culvert 18, Map ID NL #6	Unnamed Creek at Hwy 16	\$ 72,665.13	\$ 306,564.66	\$ 379,000.00	S, G, WSDOT*
33	Culvert 19, Map ID NL #7	Unnamed Stream 1226919475271 at Hwy 16 and connects to Mattress Ranch Culvert	\$ 36,660.00	\$ -	\$ 37,000.00	S, G, WSDOT
34	Culvert 20, Map ID 108494	Unnamed Stream 1226919475271 at Hwy 16	\$ 54,964.17	\$ 198,392.12	\$ 253,000.00	S, G, WSDOT
35	Stream Barrier 1, Map ID 110970		\$ 41,950.94	\$ 95,093.50	\$ 137,000.00	S, G, WSDOT

Notes: Sites with \$0.00 are: the responsibility of an entity other than the City of Bremerton, are included under another site, or were not costed. See notes below.

Site 5: No costs are anticipated.

Site 8: Costs are tied to Site 14, no direct costs for Site 8.

Site 9: No costs were estimated.

Site 13: Responsibility of Washington State Department of Ecology.

Site 16: No costs, private site.

Site 21: No costs, owned by the U.S. Navy

Site 23: Costs are included in Site 14 work.

Site 28: No costs or scope estimated.

Site 31: Responsibility of the Washington State Department of Transportation.

S = Stormwater fund (rates)

G = Grants

WSDOT = WSDOT may be required to assist with funds

\* = cause may be private individuals, potential for private contribution or costs incurred by owner

**Site 1**

Description	PM	SR Eng	Eng
<b>Elite Exteriors/Betos Tire Flooding</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>
Hydraulics & Hydrology, Calcs 5%			5,442.53
Plans, Specs & Est. for culvert 10%			10,885.06
Subtotal Hours*			16,327.59
OH & Contingencies 50%			8,163.80
<b>Design Totals</b>			<b>24,491.39</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit Cost</b>	<b>Unit</b>	<b>Total</b>
Excavation	75	4	4	1200	35.00	CY	42,000.00
Pav't Repair	20	10	0.5	100	129.00	SY	12,900.00
18" Stormsewer				75	50.00	LF	3,750.00
Shoring	75	4	1	300	5.00	SF	1,500.00
Culvert Testing				75	2.56	LF	192.00
Type 1L CB				1	1,300.00	EA	1,300.00
CB filter insert				1	200.00	EA	200.00
18" Flap gate				1	2,000.00	EA	2,000.00
Subtotal							63,842.00
Misc Construction 25%							15,960.50
Construction Subtotal							79,802.50
Traffic Control 10%							7,980.25
Survey Services 2%							1,596.05
Erosion Control & Env Permits 12%							9,576.30
Construction Subtotal							98,955.10
Mobilization 10%							9,895.51
Construction Subtotal							108,850.61
Construction Engineering 10%							10,885.06
<b>Construction Total</b>							<b>\$ 119,735.67</b>

<b>Property Acquisition</b>	75	20		1500	20	SF	\$ 30,000.00
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<b>Site Total</b>							<b>\$ 174,227.06</b>
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\* = calculated as a percentage of construction costs

## Site 2

Description	PM	SR Eng	Eng	
<b>Business and homes north of Navy City Metals</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>	
Discussions & minutes property owners	8	8		
Discussions & minutes w/ Kitsap County	8	8		
Discussions & minutes w/ WSDOT	8	8		
Hydrologic & hydraulic study	16	60	120	
Alternatives memo	16	80	80	
Subtotal Hours	56	164	120	46,120.00
OH & Contingencies 50%				23,060.00
Geotechnical investigation & rpt				30,000.00
<b>Engineering Total</b>				<b>\$ 99,180.00</b>

**Site 3**

Description	PM	SR Eng	Eng
<b>Peninsula Subaru</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

Stream and culvert analysis 5% of construction				8,167.39
Design (10% of construction)				16,334.78
Subtotal hours*	0	0	0	24,502.17
OH & Contingencies 50%				12,251.09
<b>Engineering total</b>				<b>\$ 36,753.26</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit Cost</b>	<b>Unit</b>	<b>Total</b>
Excavation	270	6	8	480	35.00	CY	16,800.00
Embankment	270	6	8	480	35.00	CY	16,800.00
Pav't Repair	270	6	1	180	129.00	SY	23,220.00
48" wide arch CMP culvert	270			270	85.00	LF	22,950.00
Shoring	270	1	8	2,160	5.00	SF	10,800.00
Type II 60" dia. CB	1			1	5,000.00	EA	5,000.00
Stream diversion	1			1	10,000.00	LS	10,000.00
Diffusion tail piece	1			1	500.00	EA	500.00
Subtotal							106,070.00
Misc Construction 25%							26,517.50
Construction Subtotal							132,587.50
Erosion Control & Env. Permits @12%							15,910.50
Survey @1.5%							1,988.81
Construction Subtotal							148,498.00
Mobilization 10%							14,849.80
Construction Subtotal							163,347.80
Construction Engineering 10%							16,334.78
<b>Construction Total</b>							<b>\$ 179,682.58</b>

<b>Site Total</b>	<b>\$ 216,435.84</b>
-------------------	----------------------

\* calculated as percentage of construction costs



**Site 4**

Description State Hwy 3/16	PM \$170	SR Eng \$150	Eng \$100	
Gorst Creek hydrology stream study	40	80	120	
Culvert/bridge modification alternatives	24	80	120	
Creek modification alternatives memorandum	24	80	120	
Feasibility study to raise Hwy 3	24	80	120	
Total Hours	112	320	480	
	19,040.00	48,000.00	48,000.00	
Subtotal				115,040.00
OH & Contingencies 50%				\$ 57,520.00
<b>Total Study</b>				<b>\$ 172,560.00</b>

I. RIGHT OF WAY	Cost	
29000 SF	\$20	\$580,000

II. CONSTRUCTION	Unit	Quantity	Cost	Total	\$355,180
1 Grading / Drainage					
1.1 Earthwork (100' x39'x10' Cut culvert)	CY	1,445	\$35.00	\$50,575.00	
1.2 Earthwork Fill 500LFx90'x2' (raise road)	CY	3,333	\$35.00	\$116,655.00	
1.3 Drainage Cut (2,900LFx5'x10' channel)	CY	\$ 5,370	\$35.00	\$187,950.00	
2 Structures					\$39,500
2.1 Bridge Structure 34' x 40'	SF		\$180.00	\$0.00	
2.2 Culvert Structure	LF	100	\$395.00	\$39,500.00	
2.3 Retaining Walls (Cut)	SF		\$100.00	\$0.00	
2.4 Retaining Walls (Fill)	SF		\$60.00	\$0.00	
2.5 Bridge Removal	SF		\$20.00	\$0.00	
3 Surfacing / Paving					\$ 708,050
3.1 HMA Paving (culv & raise road) (600LFx90'Wx8")/27*2.05T/CY	TN	2,747	\$150.00	\$412,050.00	
3.2 CSBC (culv & raise road) (600LFx90'Wx12")/27*1.85T/CY	TN	3,700	\$80.00	\$296,000.00	
4 Roadside Development					\$132,300
	12%	Of sections 1, 2 & 3		\$132,300.00	
(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)					
5 Traffic Services & Safety					\$ 132,300
	12%	Of sections 1, 2 & 3		\$132,300.00	
(Price includes Guard Rail, Striping, Utilities, Traffic Control)					

Construction Subtotal Items 1,2,3,4 and 5 (Round to nearest 1000) \$1,367,000

6 Contingencies	25% of Subtotal	\$ 342,000	
7 Construction Subtotal (Lines 1 through 6)		\$ 1,709,000	
8 Mobilization -	8% of Line 7	\$ 137,000	
9 Subtotal (Lines 7 & 8)		\$ 1,846,000	
10 Sales Tax -	8.60% of Line 9	\$ 159,000	
11 Subtotal		\$ 2,005,000	
12 Construction Engineering	10% of Line 11	\$ 201,000	
13 Construction Total (Lines 11 and 12)		\$ 2,206,000	

III. DESIGN ENGINEERING & ADMINISTRATION	12% of Line 13	\$ 265,000	
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IV. TOTAL ESTIMATED COST	Lines I, 13 and III	<b>\$3,051,000</b>	
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**Site Total \$ 3,223,560.00**

**Site 5**

Description	PM	SR Eng	Eng
	\$170	\$150	\$100

**Residences east end of W. Alder Street****Total** **0**

No costs are anticipated for this site.

**Site 6**

Description	PM	SR Eng	Eng
<b>Waldbillig Property</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report 5%*							38,996.71
Design of stream bank protection & report @5% construction*							38,996.71
Ditch design & concept design @ 10%						\$	77,993.42
Subtotal Hours	0	0	0				-
Subtotal						\$	155,986.83
OH & Contingencies 25%							19,498.35
<b>Total Study</b>						<b>\$</b>	<b>175,485.19</b>

<b>Ditch &amp; stream bank Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	380	5	3	211	CY	35.00	7,388.89
Embankment	380	5	3	211	CY	35.00	7,388.89
Seeding	380	5	1	1900	SF	10.00	19,000.00
Cut Retaining wall	100	1	8	800	SF	60.00	48,000.00
Temporary stream diversion ( Gorst Cr. & Unnamed Cr)	680			1	LS	30,000.00	30,000.00
stream bank Protection	250	1	10	2500	SF	60.00	150,000.00
Subtotal							261,777.78
Misc Construction 25%							65,444.44
Construction Subtotal							327,222.22
Survey 1.5%							4,908.33
Temp Erosion Control, Env permits 12%							39,266.67
Construction Subtotal							371,397.22
Mobilization 10%							37,139.72
Construction Subtotal							779,934.17
Const Engineering 10%							93,592.10
<b>Construction Total</b>						<b>\$</b>	<b>873,526.27</b>
<b>Site Total</b>							<b>\$ 1,049,011.45</b>

\* calculated as percentage of construction costs

Site 7

Description	PM	SR Eng	Eng	
Old Belfair Residences at Sam Christopherson	\$170	\$150	\$100	
Technical memorandum on floodplain impacts	12	48	36	
Subtotal	8	40	24	9,760.00
OH & Contigencies 50%				4,880.00
Study Total				\$ 14,640.00

**Site 8**

	PM	SR Eng	Eng	
Description	\$170	\$150	\$100	
<b>W. Belfair Valley Rd. Residences w. of Gorst Cr.</b>				
<b>Total</b>				<b>0</b>

Costs are tied to Site 14 , no direct costs for Site 8.



**Site 9**

Description	PM	SR Eng	Eng	
<b>Multiple residences between W. Summit Street and O'Brian Drive</b>	\$170	\$150	\$100	
<b>Total</b>				<b>0</b>

No costs were estimated.

**Site 10**

Description	PM	SR Eng	Eng	
<b>Feigley Road switchback</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>	
Site visit		8		
Meeting, minutes coordinating w/ WSDOT	8	8		
Technical Memorandum	4	24	8	
Total Hours	12	40	8	8,840.00
OH & Contingencies 50%				4,420.00
<b>Study Total</b>				<b>\$ 13,260.00</b>

**Site 11**

Description	PM \$170	SR Eng \$150	Eng \$100				
<b>The Mattress Ranch</b>							
<b>Study</b>							
Hydrologic and hydraulic analysis (5% of construction)							17,198.72
Design (10% of construction)							34,397.44
Subtotal*	0	0	0				51,596.15
OH & Contingencies 50%							25,798.08
<b>Total Study</b>						\$	<b>77,394.23</b>
<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	310	7	7	563	CY	35.00	19,690.74
Embankment	310	5	3	172	CY	35.00	6,027.78
58" width x 36" arch culvert	310	1	1	310	LF	95.00	29,450.00
Shoring	310	1	7	2,170	SF	5.00	10,850.00
Pavement Repair	310	10	1	344.4	SY	129.00	44,433.33
Temporary stream diversion (tie into nearby storm sewer)	1	1	1	1	EA	5,000.00	5,000.00
Subtotal							115,451.85
Misc Construction 25%							28,862.96
Construction Subtotal							144,314.81
Survey 1.5%							2,164.72
Temp Erosion Control, Env permits 12%							17,317.78
Construction Subtotal							163,797.31
Mobilization 10%							16,379.73
Construction Subtotal							343,974.36
Const Engineering 10%							34,397.44
<b>Construction Total</b>						\$	<b>378,371.80</b>
<b>Site Total</b>						\$	<b>455,766.03</b>

\* calculated as percentage of construction costs

**Site 12**

Description	PM	SR Eng	Eng	
<b>Washington Cedar lumber yard</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>	
Site visit		8	8	
Hydrologic and hydraulic analysis	8	24	24	
Research and report	16	40	24	
<b>Totals</b>	<b>24</b>	<b>72</b>	<b>56</b>	<b>\$ 20,480.00</b>

<b>Basin Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	100	75	8	2,222	CY	35.00	77,777.78
(Culvert 12 Construction covered under Site 26)				0	LF		-
Temporary stream diversion (tie into nearby storm sewer)	1	1	1	1	EA	5,000.00	5,000.00
Subtotal							82,777.78
Misc Construction 25%							20,694.44
Construction Subtotal							103,472.22
Survey 1.5%							1,552.08
Temp Erosion Control, Env permits 12%							12,416.67
Construction Subtotal							117,440.97
Mobilization 10%							11,744.10
Construction Subtotal							246,626.04
Const Engineering 10%							24,662.60
<b>Construction Total</b>							<b>\$ 271,288.65</b>

<b>Site Total</b>	<b>\$ 291,768.65</b>
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**Site 13**

	PM	SR Eng	Eng
Description	\$170	\$150	\$100
Navy City Metals			

**Total****0**

Site is responsibility of the Washington State Department of Ecology



**Site 14**

Description		PM	SR Eng	Eng	
Kitsap Square Dance Association		\$170	\$150	\$100	
Hydrologic analysis Parish Creek		16	100	40	21,720.00
OH & Contingencies 50%					10,860.00
Total Design					
(Engineering design included on line III below)					\$ 32,580.00
I.	RIGHT OF WAY		Cost		
	1100 SF		\$5		\$5,500
II.	CONSTRUCTION	Unit	Quantity	Cost	Total
1	Grading / Drainage				\$97,200
1.1	Earthwork (256' Culvert Cut/Fill)	CY	1,897	\$35.00	\$66,395.00
1.2	Earthwork (425' Ditch Cut/Fill)	CY	880	\$35.00	\$30,800.00
1.3	Drainage	10%	Of Sections 2.3-4, & 3		N/A
2	Structures				\$345,920
2.1	Bridge Structure 34' x 40'	SF	1,360	\$180.00	\$244,800.00
2.2	Culvert Structure	LF	256	\$395.00	\$101,120.00
2.3	Retaining Walls (Cut)	SF		\$100.00	\$0.00
2.4	Retaining Walls (Fill)	SF		\$40.00	\$0.00
2.5	Bridge Removal	SF		\$20.00	\$0.00
3	Surfacing / Paving				\$24,370
3.1	HMA Paving	TN	99	\$150.00	\$14,850.00
	(Assumes 100LF, 8" CSBC and 6" HMA)				
3.2	CSBC	TN	119	\$80.00	\$9,520.00
4	Roadside Development				\$56,100
		12%	Of sections 1, 2 & 3		\$56,100.00
	(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)				
5	Traffic Services & Safety				\$56,100
		12%	Of sections 1, 2 & 3		\$56,100.00
	(Price includes Guard Rail, Striping, Utilities, Traffic Control)				
	Construction Subtotal	Items 1,2,3,4 and 5 (Round to nearest 1000)			\$580,000
6	Contingencies		20% of Subtotal		\$116,000
7	Construction Subtotal (Lines 1 through 6)				\$696,000
8	Mobilization -		8% of Line 7		\$56,000
9	Subtotal (Lines 7 & 8)				\$752,000
10	Sales Tax -		8.60% of Line 9		\$65,000
11	Subtotal				\$817,000
12	Construction Engineering		10% of Line 11		\$82,000
13	Construction Total (Lines 11 and 12)				\$899,000
III.	DESIGN ENGINEERING & ADMINISTRATION		12% of Line 13		\$108,000
IV.	TOTAL ESTIMATED COST	Lines I, 13 and III			\$1,013,000
Site Total					\$ 1,045,580.00

Site 15

Description	PM	SR Eng	Eng	
<b>Fish Rearing Ponds</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>	
Site visit & notes		12		
Sunnyside Engineers Meeting w/ Notes	12	8		
Total Hours	12	20	0	5,040.00
OH & Contingencies 50%				2,520.00
Geotechnical provision				10,000.00
<b>Study Total</b>				<b>\$ 17,560.00</b>

**Site 16**

	PM	SR Eng	Eng
Description	\$170	\$150	\$100

**Residence, 4052 Old Belfair  
Valley Highway**

**Total** **0**

No costs were estimated, private site.

**Site 17**

Description	PM	SR Eng	Eng
<b>Culvert 1, Map ID 105103</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report 5%*	5,204.30
Ditch design & concept design 10%*	10,408.60
Biological Assessment	15,000.00
<b>Subtotal</b>	<b>30,612.90</b>
OH & Contingencies 50%	15,306.45
<b>Total Study</b>	<b>\$ 45,919.35</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	40	27	12	480	CY	35.00	16,800.00
Embankment	40	27	12	480	CY	35.00	16,800.00
Shoring	40	1	12	480	SF	5.00	2,400.00
58" wide arch culvert	40			40	LF	95.00	3,800.00
Base Course (1.85 TN/CY)	60	24	1	99	TN	80.00	7,893.33
HMA Pavement (2.05 TN/CY)	60	24	0.67	73	TN	150.00	10,988.00
Temporary stream diversion	1	1	1	1	LS	10,000.00	10,000.00
<b>Subtotal</b>							<b>58,681.33</b>
Misc Construction 25%							14,670.33
<b>Construction Subtotal</b>							<b>73,351.67</b>
Erosion Control & Env Permits 12%							8,802.20
Traffic Control 15%							11,002.75
Survey 2%							1,467.03
<b>Construction Subtotal</b>							<b>94,623.65</b>
Mobilization 10%							9,462.37
<b>Construction Subtotal</b>							<b>104,086.02</b>
Construction Engineering 10%							10,408.60
<b>Construction Total</b>							<b>\$ 114,494.62</b>
<b>Site Total</b>							<b>\$ 160,413.97</b>

\* calculated as percentage of construction costs

**Site 18**

Description	PM	SR Eng	Eng
<b>Culvert 2, NL #1</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch  
flow report 5%

6,534.61

Ditch design & concept design 10%

13,069.23

Biological Assessment

15,000.00

Eng Labor Subtotal\*

0	0	0
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Subtotal

34,603.84

OH & Contingencies 50%

17,301.92

**Total Study**

**\$ 51,905.76**

**Culvert Construction**

	L	W	D	Qty	Unit	Unit Cost	Total
Excavation	40	27	12	480	CY	35.00	16,800.00
Embankment	40	27	12	480	CY	35.00	16,800.00
58" wide arch culvert	40			40	LF	95.00	3,800.00
Shoring	40	1	12	480	SF	5.00	2,400.00
Base Course (1.85 TN/CY)	60	24	1	99	TN	80.00	7,893.33
HMA Pavement (2.05 TN/CY)	60	24	0.67	73	TN	150.00	10,988.00
Temporary stream diversion	1	1	1	1	LS	15,000.00	15,000.00
Subtotal							73,681.33
Misc Construction 25%							18,420.33
Construction Subtotal							92,101.67
Erosion Control & Env Permits 12%							11,052.20
Traffic Control 15%							13,815.25
Survey 2%							1,842.03
Construction Subtotal							118,811.15
Mobilization 10%							11,881.12
Construction Subtotal							130,692.27
Construction Engineering 10%							13,069.23
<b>Total Construction</b>							<b>\$ 143,761.49</b>

**Site Total**

**\$ 195,667.25**

\* calculated as percentage of construction costs



**Site 19**

Description	PM	SR Eng	Eng
<b>Culvert 3, Map ID NL #2</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch  
flow report 5%  
Ditch design & concept design 10%

3,596.73  
7,193.46

Eng Labor Subtotal\*

0 0 0

-

Subtotal

10,790.18

OH & Contingencies 50%

5,395.09

**Total Study**

**\$ 16,185.28**

**Culvert Construction**

	L	W	D	Qty	Unit	Unit Cost	Total
Excavation	20	24	8	142	CY	35.00	4,977.78
Embankment	20	24	8	142	CY	35.00	4,977.78
58" wide x 31" arch culvert	20			20	LF	95.00	1,900.00
Shoring	20	1	8	160	SF	5.00	800.00
Base Course (1.85 TN/CY)	40	24	1	66	TN	80.00	5,262.22
HMA Pavement (2.05 TN/CY)	40	24	0.67	49	TN	150.00	7,325.33
Temporary stream diversion	1	1	1	1	LS	15,000.00	15,000.00
Subtotal							40,243.11
Misc Construction 25%							10,060.78
Construction Subtotal							50,303.89
Erosion Control & Env Permits 12%							6,036.47
Traffic Control 15%							7,545.58
Survey 3%							1,509.12
Construction Subtotal							65,395.06
Mobilization 10%							6,539.51
Construction Subtotal							71,934.56
Construction Engineering 10%							7,193.46
<b>Total Construction</b>							<b>\$ 79,128.02</b>

**Site Total**

**\$ 95,313.29**

\* calculated as percentage of construction costs

**Site 20**

Description	PM	SR Eng	Eng
<b>Culvert 4, Map ID NL #3</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>
<b>Study</b>			
Hydrologic and hydraulic analysis & ditch flow report 5%			3,636.98
Ditch design & concept design 10%			7,273.95
Design of stream bank protection & report 15%			\$ 10,910.93
Biological Assessment			\$ 15,000.00
Eng Labor Subtotal*	0	0	0
Subtotal			36,821.86
OH & Contingencies 50%			18,410.93
<b>Total Study</b>			<b>\$ 55,232.78</b>

<b>Bridge Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	12	24	8	85	CY	35.00	2,986.67
Embankment	12	24	8	85	CY	35.00	2,986.67
12' flat slab bridge or 3 sided culvert	12	12	1	144	SF	130.00	18,720.00
Base Course (1.85 TN/CY)	40	12	0.5	16	TN	80.00	1,315.56
HMA Pavement (2.05 TN/CY)					TN	150.00	-
Temporary stream diversion	1	1	1	1	LS	15,000.00	15,000.00
Subtotal							41,008.89
Misc Construction 25%							10,252.22
Construction Subtotal							51,261.11
Erosion Control & Env Permits 12%							6,151.33
Traffic Control 15%							7,689.17
Survey 2%							1,025.22
Construction Subtotal							66,126.83
Mobilization 10%							6,612.68
Subtotal							72,739.52
Construction Engineering 10%							7,273.95
<b>Construction Total</b>							<b>\$ 80,013.47</b>
<b>Site Total</b>							<b>\$ 135,246.25</b>

\* calculated as percentage of construction costs

**Site 21**

	PM	SR Eng	Eng
Description	\$170	\$150	\$100

**Culvert 6, Map ID 105105**

Owned by Navy

**Total** **0**

No costs, site is owned by the U.S. Navy

**Site 22**

Description	PM	SR Eng	Eng
<b>Culvert 7, Map ID 105107</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report 5%		5,174.75
Ditch design & concept design 10%		10,349.50
Biological Assessment		15,000.00
Eng Labor Subtotal*	0      0      0	-
Subtotal		30,524.25
OH & Contingencies 50%		15,262.13
<b>Total Study</b>		<b>\$ 45,786.38</b>

<b>Bridge Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	20	24	8	142	CY	35.00	4,977.78
Embankment	20	24	8	142	CY	35.00	4,977.78
12' flat slab bridge or 3 sided culvert	12	20	1	240	SF	130.00	31,200.00
Base Course (1.85 TN/CY)	40	20	0.5	27	TN	80.00	2,192.59
HMA Pavement (2.05 TN/CY)					TN	150.00	-
Temporary stream diversion	1	1	1	1	LS	15,000.00	15,000.00
Subtotal							58,348.15
Misc Construction 25%							14,587.04
Construction Subtotal							72,935.19
Erosion Control & Env Permits 12%							8,752.22
Traffic Control 15%							10,940.28
Survey 2%							1,458.70
Construction Subtotal							94,086.39
Mobilization 10%							9,408.64
Subtotal							103,495.03
Construction Engineering 10%							10,349.50
<b>Construction Total</b>							<b>\$ 113,844.53</b>
<b>Site Total</b>							<b>\$ 159,630.91</b>

\* calculated as percentage of construction costs

**Site 23**

	PM	SR Eng	Eng
Description	\$170	\$150	\$100
<b>Culvert 8, Map ID 105106</b>			

**Total** **0**

Costs for this site are included under Site 14.



**Site 24**

Description	PM	SR Eng	Eng
<b>Culvert 10, Map ID 111009</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report 5%				6,686.55
Ditch design & concept design 10%				13,373.10
Biological Assessment				15,000.00
Eng Labor Subtotal*	0	0	0	-
Subtotal				35,059.65
OH & Contingencies 50%				17,529.83
<b>Total Study</b>				<b>\$ 52,589.48</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	100	20	6	444	CY	35.00	15,555.56
Embankment	100	20	6	444	CY	35.00	15,555.56
Shoring	100	1	6	600	SF	5.00	3,000.00
58" wide x 36" arch culvert	100			100	LF	95.00	9,500.00
Base Course (1.85 TN/CY)	80	16	1	88	TN	80.00	7,016.30
HMA Pavement (2.05 TN/CY)	80	16	0.67	65	TN	150.00	9,767.11
Temporary stream diversion	1	1	1	1	LS	15,000.00	15,000.00
Subtotal							75,394.52
Misc Construction 25%							18,848.63
Construction Subtotal							94,243.15
Erosion Control & Env Permits 12%							11,309.18
Traffic Control 15%							14,136.47
Survey 2%							1,884.86
Construction Subtotal							121,573.66
Mobilization 10%							12,157.37
Subtotal							133,731.03
Construction Engineering 10%							13,373.10
<b>Construction Total</b>							<b>\$ 147,104.13</b>
<b>Site Total</b>							<b>\$ 199,693.61</b>

\* calculated as percentage of construction costs

**Site 25**

Description	PM	SR Eng	Eng
<b>Culvert 11, Map ID 108414</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report 5%				10,024.90
Ditch design & concept design 10%				20,049.80
Biological Assessment				15,000.00
Eng Labor Subtotal*	0	0	0	-
Subtotal				45,074.70
OH & Contingencies 50%				22,537.35
<b>Total Study</b>				<b>\$ 67,612.05</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	190	20	6	844	CY	35.00	29,555.56
Embankment	190	20	6	844	CY	35.00	29,555.56
58" wide x 36" arch culvert	190			190	LF	95.00	18,050.00
Shoring	190	1	6	1140	SF	5.00	5,700.00
Base Course (1.85 TN/CY)	120	16	1	132	TN	80.00	10,524.44
HMA Pavement (2.05 TN/CY)	120	16	0.67	98	TN	150.00	14,650.67
Temporary stream diversion	1	1	1	1	LS	5000.00	5,000.00
Subtotal							113,036.22
Misc Construction 25%							28,259.06
Construction Subtotal							141,295.28
Erosion Control & Env Permits 12%							16,955.43
Traffic Control 15%							21,194.29
Survey 2%							2,825.91
Construction Subtotal							182,270.91
Mobilization 10%							18,227.09
Subtotal							200,498.00
Construction Engineering 10%							20,049.80
<b>Construction Total</b>							<b>\$ 220,547.80</b>
<b>Site Total</b>							<b>\$ 288,159.85</b>

\* calculated as percentage of construction costs

**Site 26**

Description	PM	SR Eng	Eng				
Culvert 12, Map ID 111010	\$170	\$150	\$100				
<b>Study</b>							
Hydrologic and hydraulic analysis & ditch flow report 5%							8,755.43
Ditch design & concept design 10%							17,510.85
Biological Assessment							15,000.00
Eng Labor Subtotal*	0	0	0				-
Subtotal							41,266.28
OH & Contingencies 50%							20,633.14
<b>Total Study</b>							<b>\$ 61,899.42</b>
<b>Culvert Construction</b>							
	L	W	D	Qty	Unit	Unit Cost	Total
Excavation	440	20	6	1,956	CY	35.00	68,444.44
Embankment	50	20	6	222	CY	35.00	7,777.78
58" wide x 36" arch culvert (@fire station corner)	140			140	LF	95.00	13,300.00
Shoring	140	1	6	840	SF	5.00	4,200.00
Base Course (1.85 TN/CY)				0	TN	80.00	-
HMA Pavement (2.05 TN/CY)				0	TN	150.00	-
Temporary stream diversion	1	1	1	1	LS	5,000.00	5,000.00
Subtotal							98,722.22
Misc Construction 25%							24,680.56
Construction Subtotal							123,402.78
Erosion Control & Env Permits 12%							14,808.33
Traffic Control 15%							18,510.42
Survey 2%							2,468.06
Construction Subtotal							159,189.58
Mobilization 10%							15,918.96
Subtotal							175,108.54
Construction Engineering 10%							17,510.85
<b>Construction Total</b>							<b>\$ 192,619.40</b>
<b>Site Total</b>							<b>\$ 254,518.82</b>

\* calculated as percentage of construction costs

**Site 27**

Description	PM	SR Eng	Eng
<b>Culvert 13, Map ID 107158</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow  
report 3%

20,261.82

Ditch design & concept design 10%

67,539.39

Biological Assessment

15,000.00

Eng Labor Subtotal\*

0	0	0
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Subtotal

102,801.20

OH & Contingencies 50%

51,400.60

**Total Study****\$ 154,201.80****Bridge Construction**

	L	W	D	Qty	Unit	Unit Cost	Total
Excavation	174	16	6	619	CY	35.00	21,653.33
Embankment				0	CY	35.00	-
Bridge or 3 legged culvert	40	48		1,920	SF	180.00	345,600.00
Base Course (1.85 TN/CY)			1	0	TN	80.00	-
HMA Pavement (2.05 TN/CY)			0.67	0	TN	150.00	-
Temporary stream diversion	1	1	1	1	LS	15,000.00	15,000.00
Subtotal							382,253.33
Misc Construction 25%							95,563.33
Construction Subtotal							477,816.67
Erosion Control & Env Permits 12%							57,338.00
Traffic Control 15%							71,672.50
Survey 1.5%							7,167.25
Construction Subtotal							613,994.42
Mobilization 10%							61,399.44
Subtotal							675,393.86
Construction Engineering 10%							67,539.39
<b>Construction Total</b>							<b>\$ 742,933.24</b>

**Site Total****\$ 897,135.05**

\* calculated as percentage of construction costs

**Site 28**

	PM	SR Eng	Eng
Description	\$170	\$150	\$100

**Culvert 14, Map ID 105104**

<b>Total</b>	<b>0</b>
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No costs or scope were estimated for this site.

Description	PM	SR Eng	Eng
<b>Culvert 15, Map ID NL #5</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**\$ 27,357.08**

**\$ 133,745.72**

**\$ 161,102.79**

\* calculated as percentage of construction costs

**Site 30**

Description	PM	SR Eng	Eng
<b>Culvert 16, Map ID 115006</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow  
report 5%

Ditch design & concept design 10%

Eng Labor Subtotal

Subtotal\*

OH & Contingencies 50%

**Total Study****Bridge Construction**

Excavation

Downstream channel edge enhancement

Bridge (24' channel)

Base Course (1.85 TN/CY)

HMA Pavement (2.05 TN/CY)

Temporary stream diversion

Streambed Control Weirs

Subtotal

Misc Construction 25%

Construction Subtotal

Erosion Control & Env Permits 12%

Traffic Control 15%

Survey 1.5%

Construction Subtotal

Mobilization 10%

Subtotal

Construction Engineering 10%

**Construction Total****Site Total**

\* calculated as percentage of construction costs

51,893.90

103,787.81

0 0 0

-

155,681.71

77,840.86

**\$ 233,522.57**

L	W	D	Qty	Unit	Unit Cost	Total
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72	48	12	1,536	CY	35.00	53,760.00
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700	4	12	1,244	CY	35.00	43,555.56
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72	36		2,592	SF	180.00	466,560.00
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	36	1	0	TN	80.00	-
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	36	0.67	0	TN	150.00	-
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1			1	LS	15,000.00	15,000.00
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288	1	4	43	CY	200.00	8,533.33
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587,408.89

146,852.22

734,261.11

88,111.33

110,139.17

11,013.92

943,525.53

94,352.55

1,037,878.08

103,787.81

**\$ 1,141,665.89**

**\$ 1,375,188.46**



**Site 31**

	PM	SR Eng	Eng
Description	\$170	\$150	\$100

**Culvert 17, Map ID 110964**

<b>Total</b>	<b>0</b>
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No cost, site is the responsibility of the Washington State Department of Transportation

**Site 32**

Description	PM	SR Eng	Eng
<b>Culvert 18, Map ID NL #6</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report 2%				5,573.90
Ditch design & concept design 10%				27,869.51
Biological Assessment				15,000.00
Eng Labor Subtotal	0	0	0	-
Subtotal*				48,443.42
OH & Contingencies 50%				24,221.71
<b>Total Study</b>				<b>\$ 72,665.13</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	210	8	10	622	CY	35.00	21,777.78
50" wide x 31" arch culvert	210		10	210	LF	85.00	17,850.00
Shoring	210	1	10	2,100	SF	5.00	10,500.00
Base Course (1.85 TN/CY)	170	48	1	559	TN	80.00	44,728.89
HMA Pavement (2.05 TN/CY)	170	48	0.67	415	TN	150.00	62,265.33
Temporary stream diversion				0	LS	15,000.00	-
Subtotal							157,122.00
Misc Construction 25%							39,280.50
Construction Subtotal							196,402.50
Erosion Control & Env Permits 12%							23,568.30
Traffic Control 15%							29,460.38
Survey 2%							3,928.05
Construction Subtotal							253,359.23
Mobilization 10%							25,335.92
Subtotal							278,695.15
Construction Engineering 10%							27,869.51
<b>Construction Total</b>							<b>\$ 306,564.66</b>

<b>Site Total</b>	<b>\$ 379,229.79</b>
-------------------	----------------------

\* calculated as percentage of construction costs

**Site 33**

Description	PM	SR Eng	Eng	
Culvert 19, Map ID NL #7	\$170	\$150	\$100	
Hydrologic & hydraulic study	16	40	40	
Memorandum	16	60	40	
Subtotal Hours	32	100	40	24,440.00
OH & Contingencies 50%				12,220.00
Engineering Total				\$ 36,660.00

**Site 34**

Description	PM	SR Eng	Eng
<b>Culvert 20, Map ID 108494</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow report @ 2% (Mostly completed w/Site 11)				3,607.13
Ditch design & concept design 10%				18,035.65
Biological Assessment				15,000.00
Eng Labor Subtotal*	0	0	0	-
Subtotal				36,642.78
OH & Contingencies 50%				18,321.39
<b>Total Study</b>				<b>\$ 54,964.17</b>

<b>Culvert Construction</b>	<b>L</b>	<b>W</b>	<b>D</b>	<b>Qty</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total</b>
Excavation	120	8	8	284	CY	35.00	9,955.56
58" wide x 36" arch culvert	120		1	120	LF	95.00	11,400.00
Shoring	120	1	8	960	SF	5.00	4,800.00
Base Course (1.85 TN/CY)	120	48	1	395	TN	80.00	31,573.33
HMA Pavement (2.05 TN/CY)	120	48	0.67	293	TN	150.00	43,952.00
Temporary stream diversion				0	LS	15,000.00	-
Subtotal							101,680.89
Misc Construction 25%							25,420.22
Construction Subtotal							127,101.11
Erosion Control & Env Permits 12%							15,252.13
Traffic Control 15%							19,065.17
Survey 2%							2,542.02
Construction Subtotal							163,960.43
Mobilization 10%							16,396.04
Subtotal							180,356.48
Construction Engineering 10%							18,035.65
<b>Construction Total</b>							<b>\$ 198,392.12</b>

<b>Site Total</b>	<b>\$ 253,356.29</b>
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\* calculated as percentage of construction costs

**Site 35**

Description	PM	SR Eng	Eng
<b>Stream Barrier 1, Map ID 110970</b>	<b>\$170</b>	<b>\$150</b>	<b>\$100</b>

**Study**

Hydrologic and hydraulic analysis & ditch flow  
report 5%

4,322.43

Ditch design & concept design 10%

8,644.86

Biological Assessment

15,000.00

Eng Labor Subtotal\*

0	0	0
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-

Subtotal

27,967.30

OH & Contingencies 50%

13,983.65

**Total Study**

**\$ 41,950.94****Bridge Construction**

Excavation

L	W	D	Qty	Unit	Unit Cost	Total
20	12	4	36	CY	35.00	1,244.44

Embankment

40	12	8	142	CY	35.00	4,977.78
----	----	---	-----	----	-------	----------

Wooden Bridge

20	12		240	SF	130.00	31,200.00
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Base Course (1.85 TN/CY)

40	12	0.5	16	TN	80.00	1,315.56
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Temporary stream diversion

1	1	1	1	LS	10,000.00	10,000.00
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Subtotal

48,737.78

Misc Construction 25%

12,184.44

Construction Subtotal

60,922.22

Erosion Control & Env Permits 12%

7,310.67

Traffic Control 15%

9,138.33

Survey 2%

1,218.44

Construction Subtotal

78,589.67

Mobilization 10%

7,858.97

Subtotal

86,448.63

Construction Engineering 10%

8,644.86

**Construction Total**

**\$ 95,093.50**

**Site Total**

**\$ 137,044.44**

\* calculated as percentage of construction costs

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# **Appendix D: Gorst Creek Watershed Fish Passage Barrier Capital Improvement Plan Technical Memorandum**



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# **GORST CREEK WATERSHED FISH PASSAGE BARRIER CAPITAL IMPROVEMENT PLAN Technical Memorandum**



For: City of Bremerton, WA



September 2013

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## Attachments

### Attachment A: Fish Passage Barrier Inventory

## INTRODUCTION

This memorandum has been prepared as part of the Stormwater Capital Improvement Plan. It follows up on the findings of the existing fish passage barriers identified in the *Fish Passage Barrier Preliminary Engineering Technical Memorandum* prepared by Parametrix, December 30, 2011. The City of Bremerton is planning for the Gorst Creek Watershed, and particularly for the unincorporated Gorst Urban Growth Area (UGA) in partnership with Kitsap County. The City and County are considering best management practices for development, restoration, and protection, including how to manage stormwater and restore fish habitat. In this memorandum, programmatic solutions with cost estimates for fish passage drainage barrier problems are discussed.

## OBJECTIVES

The objectives of this technical memorandum are:

1. Review the basin-wide barrier inventory in the *Fish Passage Barrier Preliminary Engineering Technical Memorandum*.
2. Provide a corrective action programmatic assessment for each barrier.
3. Prepare a programmatic cost for each fish barrier.

## METHODOLOGY

The *Fish Passage Barrier Preliminary Engineering Technical Memorandum* (Parametrix 2011) includes the evaluation of fish passage barrier areas from inventoried Washington State Department of Fish and Wildlife (WDFW) and Washington State Department of Transportation (WSDOT) fish barriers, Water Resource Inventory Area (WRIA) 15, and seven additional sites. In this memorandum, programmatic strategies are developed for the City for the fish passage barriers previously identified. The fish passage deficiency locations were then ranked in order of priority based on effectiveness, implementation factors, and cost. The ranking is found in Appendix E of the *Stormwater Capital Improvement Plan Technical Memorandum*. Programmatic solutions were derived from WDFW guidelines for the sites listed in the *Fish Passage Barrier Preliminary Engineering Technical Memorandum*. Site visits to provide more accurate conditions were not included in this scope and more detailed costs and scope development should be expected to occur during design.

## RELATED CITY OF BREMERTON AND GORST CREEK WATERSHED APPLICABLE FISH PASSAGE REGULATORY POLICIES

### Fish Passage and Listed, Threatened or Endangered Species

The *Existing Drainage Infrastructure Deficiencies Technical Memorandum* (AECOM, January 2013) identified several culverts with limited or blocked fish passage. WAC 220-110-070 defines the WDFW fish-passage criteria for new design and retrofit of culverts.

Recent significant judicial rulings (U.S. v. Washington, No. CV 70-9213, ruling issued March 29, 2013) require fish passage barrier removal on fish bearing streams to be completed by the fall of 2016 on state recreational lands, and by 2030 on highways administered by WSDOT.

### Bremerton Municipal Code 15.40 Stormwater

Bremerton's Stormwater Management Plan Update was adopted January 2009. The plan identifies actions needed to coordinate the existing Stormwater Program with the National Pollutant Discharge Elimination System Phase II (NPDES II) Stormwater Permit and Puget Sound Partnership's Action Agenda.

## CORRECTIVE ACTIONS FOR SITE-SPECIFIC FISH PASSAGE DEFICIENCIES

Existing fish passage barriers in the Gorst Creek Watershed were identified in the *Fish Passage Barrier Preliminary Engineering Technical Memorandum* (Parametrix 2011). The memorandum discussed remaining existing fish barriers inventoried by WSDOT (Attachment A) and WDFW (Attachment B). The fish passage barriers are based on Level A passability criteria of water surface drops, culvert length, and culvert velocity. Currently, WDFW has no listed fish species upstream of five of these identified barriers. However, these are included as fish barriers due to the potential habitat upstream of these impassable barriers. Of the existing inventoried fish barriers, two were improved and should no longer be considered barriers and should be reclassified. The two improvements were culvert 9 (Parish Creek at State Highway [Hwy] 3) where fish ladder type baffles were added to the existing culvert, and Heins Creek at the Navy Railroad Crossing, Fishway 1, Map ID 105108, which received a new baffled chute fish ladder.

### Sites 17 through 35 General

Culverts typically are fish passage obstacles to both juvenile and adult species of fish under varying conditions. These culverts can pose a complete barrier, partial barrier, or a temporal barrier to both adult and juvenile fish depending on flow conditions. The culverts have been identified as barriers based on Level A passability criteria: water surface drops, culvert length, slope and flow velocity, and culvert width compared to stream channel width.

Stream flow capacity can often be achieved along with fish passage capacity. To achieve long-term effectiveness, Baker and Volcher, 1990 came up with a priority of stream crossing measures based on experience and research. In addition, WDFW provides design criteria for culvert and fishway design. Depending on stream width, profile, and other design requirements, the suggested preference for stream crossing design is:

1. Bridge over the floodway or main body of creek flow and 100-year floodplain
2. Bridge over the floodway
3. Culvert with natural streambed bottom wide enough to include the floodway
4. Culvert with slope less than 0.5%
5. Baffled culvert or fish ladder included with the culvert to allow fish to rest especially throughout a longer culvert.

Figure 1 shows the watershed with the UGA boundaries. The inventoried fish passage barriers are shown on map FP-1 in the *Fish Passage Barrier Preliminary Engineering Technical Memorandum* (Parametrix 2011).



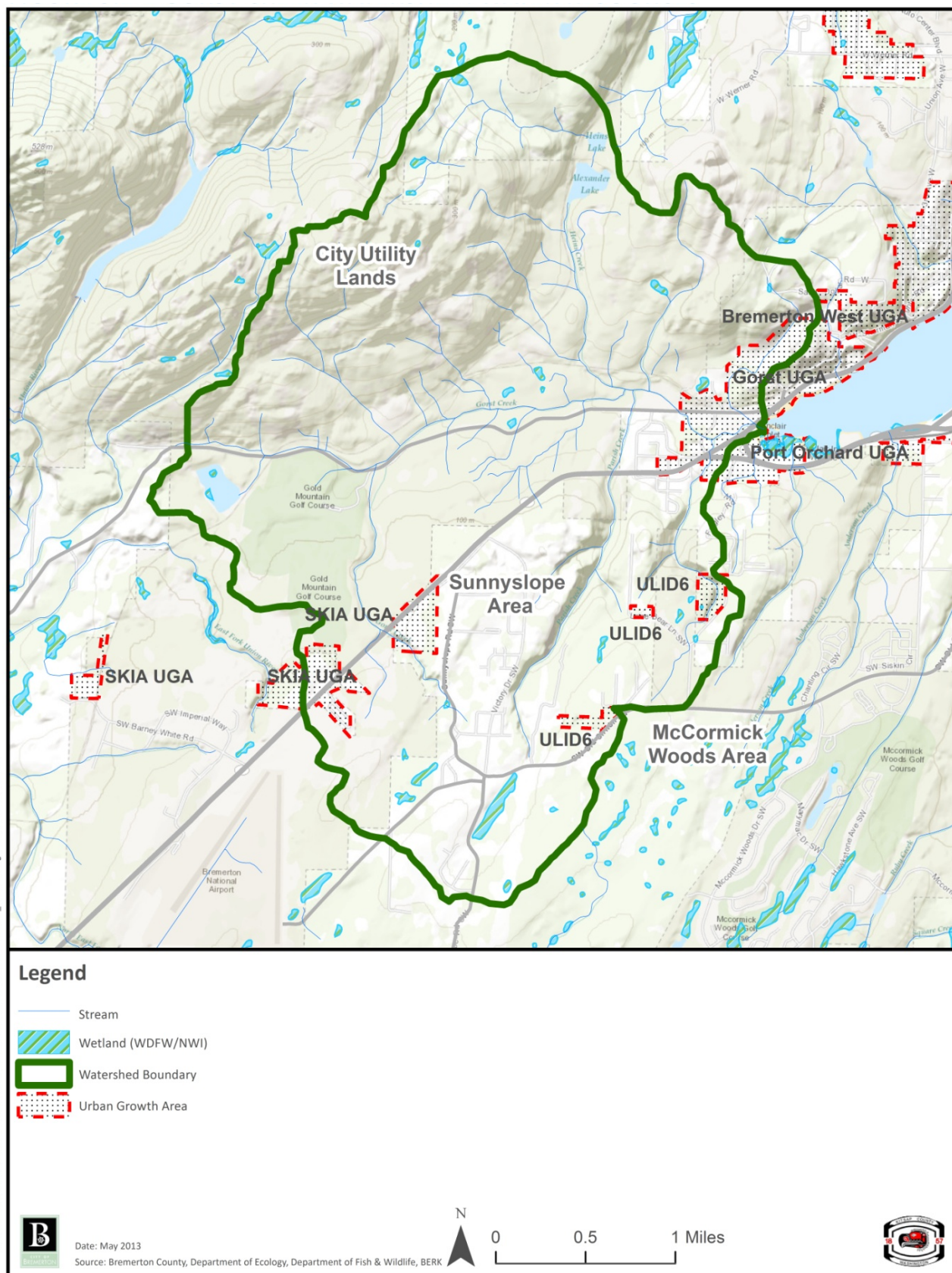


Figure 1: Watershed Plan Showing UGA Boundaries

The following narrative addresses relevant priority ranking and comes from the WDFW Fish Passage Barrier Assessment Manual:

Percent passability is estimated for all fish passage features, and uses a combination of professional judgment and species ability to negotiate water surface drop, velocity, and depth. A feature may be evaluated as a total barrier (0% passable), a partial barrier (33% passable; some passage), a less severe partial barrier (67% passable), or a non-barrier (100% passable; passable during all times when flow is present, up to the high fish passage flow). The guidance provided in subsequent chapters is based upon the abilities of a 15.24 centimeter (6 inch) trout, so it should not be construed as an absolute value for all salmonid species and life stages.

Each of the following identified fish passage barrier sites are discussed in this memorandum and recommendations are noted. The following sites continue in number following from the 16 stormwater deficiencies identified in the existing stormwater deficiencies memorandum (AECOM 2013). Most of the photos in the following descriptions are borrowed from the Parametrix 2011 memorandum.

### Sites 17 through 35 Specific Discussion

**Site 17 – Culvert 1** (City of Bremerton, Outside UGA) – Map ID 105103 – Gorst Creek at Gold Mountain Golf Course Road

The obstacle rating was evaluated as medium for this culvert. This 40 linear foot (LF), 36-inch-diameter concrete culvert has vertical drop and velocity barrier elements downstream of 5,500 LF of potential habitat.

*Discussion and Recommendations:*

Improving this culvert will open up over a mile of fish habitat upstream of this culvert. From WRIA data, the stream is expected to have a 2% to 4% gradient in this tributary. Upstream flows will need to be modeled to determine flow and high velocity rates. Channel depths are estimated to be 10 to 12 feet below road height based on limited site visits in the area. In general, high velocity can be addressed with the use of a broader culvert with a flatter slope and can be accompanied with less desirable engineered streambed control measures or culvert baffles for the steeper slopes.



**Photo 1** Culvert 1 outlet at south end



**Photo 2** Culvert 1 inlet

*Estimate:* For estimating purposes, the study scope includes designing the drainage culvert and performing an upstream modeling study. Per WAC 220-710-070 for all fish bearing streams, a biological assessment will be required as part of a required Hydraulic Project Approval (HPA) permit. The construction scope is based on replacing the existing culvert with a 58-inch-wide arch culvert suitable for fish passage.

**Site 18 – Culvert 2** (Kitsap County, Outside UGA) – Map ID NL 1 – Gorst Creek West Belfair Highway at Gold Mountain Golf Course

The obstacle rating was evaluated as very low. Barrier elements for this 100 LF 36-inch aluminum arch bottomless culvert include sediment and high velocity at peak flow. From WRIA data, the stream is expected to have a 2% to 4% gradient in this tributary. The culvert is downstream of 5,400 LF of potential habitat. The culvert crosses under the 24-foot-wide paved asphalt road for Gold Mountain Golf Course.

*Discussion and Recommendations:* This culvert is the responsibility of Kitsap County and currently has a 100% rating for fish passage. Channel depths are assumed to be 10 to 12 feet deep compared to the road height based on limited site visits in the area.

*Estimate:* For estimating purposes, the study scope includes designing the drainage culvert and performing an upstream modeling study to determine if sedimentation has affected the capacity of the culvert to handle



100-year storm event flows. A biological assessment will be required as part of a required HPA permit. While it may be possible to remove sediment within the culvert, the construction scope is based on replacing the existing culvert with a 58-inch-wide arch culvert suitable for fish passage.

**Site 19 – Culvert 3** (City of Bremerton, Outside UGA) – Map ID NL 2 – Unnamed Tributary to Gorst Creek; West Belfair Highway at Gold Mountain Golf Course Road, North End

The obstacle rating was evaluated as impassable. Barrier elements for the 20 LF dual 16-inch-diameter aluminum CMP culvert pair include a large vertical drop and high velocity at peak flows. From WRIA data, the stream is expected to have a 2% to 4% gradient in this tributary. The channel to road depth is approximately 8 feet with a 4.5-foot-wide creek floodway. The culverts are downstream of 300 LF of potential habitat.

*Discussion and Recommendations:* Due to the short potential habitat gain, replacing these culverts to remove the vertical drop and reduce the velocity is a low priority because of the limited benefit. An arch culvert replacement large enough to span the floodway would be the recommended improvement.

*Estimate:* For estimating purposes, the study scope includes drainage culvert and upstream modeling study. The construction scope includes a 20 LF by 58-inch-wide arch culvert across an estimated nominal 12-foot-wide gravel road.



**Photo 10** Culvert 3 outlets

**Site 20 – Culvert 4** (City of Bremerton, Outside UGA) – Map ID NL 3 – Heins Creek Culvert Crossing

The obstacle rating was evaluated as low to medium. Barrier elements for this 20 LF 60-inch-diameter aluminum CMP culvert include a vertical drop of less than a foot and high velocities at peak flows. The culvert is downstream of 1,000 LF of potential habitat.

*Discussion and Recommendations:* The floodway channel for this culvert is approximately 10 feet wide and approximately 8 feet below the grade of the 12-foot-wide gravel roadway. Ideally, the culvert would be designed to span the floodway to avoid the larger velocities.

*Estimate:* For estimating purposes, the study scope includes an upstream modeling study. A biological assessment will be required as part of the HPA permit. The construction scope includes a 12 LF by 12-foot-wide slab bridge or three-sided concrete culvert.



**Photo 11** Culvert 4 outlet

**Culvert 5** is a box culvert that has been modified for fish passage. The fish passage barrier status should be updated to indicate it is fish passable.

**Site 21 – Culvert 6** (US Navy, Outside UGA) – Map ID 105105 Jarstad Creek Railroad Crossing

The obstacle rating was evaluated as high to impassable. This is a 267 LF 30-inch-diameter steel and concrete joined culvert approximately 29 feet below the railroad grade. Barrier elements include a 12-inch outlet drop, high velocities during peak flows, and leaks from a piping condition where soil support has eroded.

*Discussion and Recommendations:* The Navy owns and is responsible for the culvert. The Navy has evaluated and prioritized this culvert for replacement as a fish passage barrier as recorded *An Analysis of Stream Culvert Fish Passage on the Navy Rail Line Between Bremerton and Shelton, Washington*, (Battelle Marine Sciences Laboratory, Sequim, WA, December 2004).

*Estimate:* An estimate is not prepared because this is a federal site.

**Site 22 – Culvert 7** (City of Bremerton, Outside UGA) – Map ID 105107 Heins Creek City of Bremerton Access Road Crossing

The obstacle rating was evaluated as low to medium. Barrier elements for this 30 LF dual 48-inch-diameter steel galvanized CMP culvert pair include a 1-foot outlet drop and has high velocities at peak flow rates. From WRIA data, the stream is expected to have less than a 2% gradient in this creek. The stream width is approximately 10 feet wide. The stream is 6 feet lower than the 20-foot-wide gravel road grade. The culvert is downstream of 5,000 potential habitat.

**Photo 12** Culvert 7 outlets

*Discussion and Recommendations:* Increasing the slope would adversely affect fish passage by increasing velocities. The culverts could either be replaced or perhaps enhanced with less desirable step wall(s) to raise the water level at the outlet end to match the invert elevation of the culvert. The flows upstream of the crossing should be modeled.

**Photos 13 & 14** Culvert 7 outlets

*Estimate:* The study scope includes design of a drainage culvert and upstream modeling study. A biological assessment will be required as part of a required HPA permit. The construction scope includes a 12 LF by 20-foot-wide flat slab bridge or comparable three-sided culvert.

**Site 23 - Culvert 8** (City of Bremerton, Outside UGA) – Map ID 105106 Parish Creek Culvert West Belfair Highway

This culvert has a high priority for replacement. Please refer to the culvert discussion described for Site 14 in the *Stormwater Capital Improvement Plan Technical Memorandum* and the Parish Creek addendum to the *Existing Drainage Infrastructure Deficiencies Technical Memorandum* (AECOM, January 2013).

*Estimate:* The scope for this culvert is included with the *Stormwater Capital Improvement Plan Technical Memorandum* for Site 14.

**Culvert 9** is a WSDOT culvert that has since been modified for fish passage modifications to include baffles. The fish passage barrier status should be updated to indicate it is fish passable.

**Site 24 – Culvert 10** (Privately owned culvert) – Map ID 111009 – Unnamed Creek at North Side of Hwy 3 at Hwy 3 and Hwy 16 junction

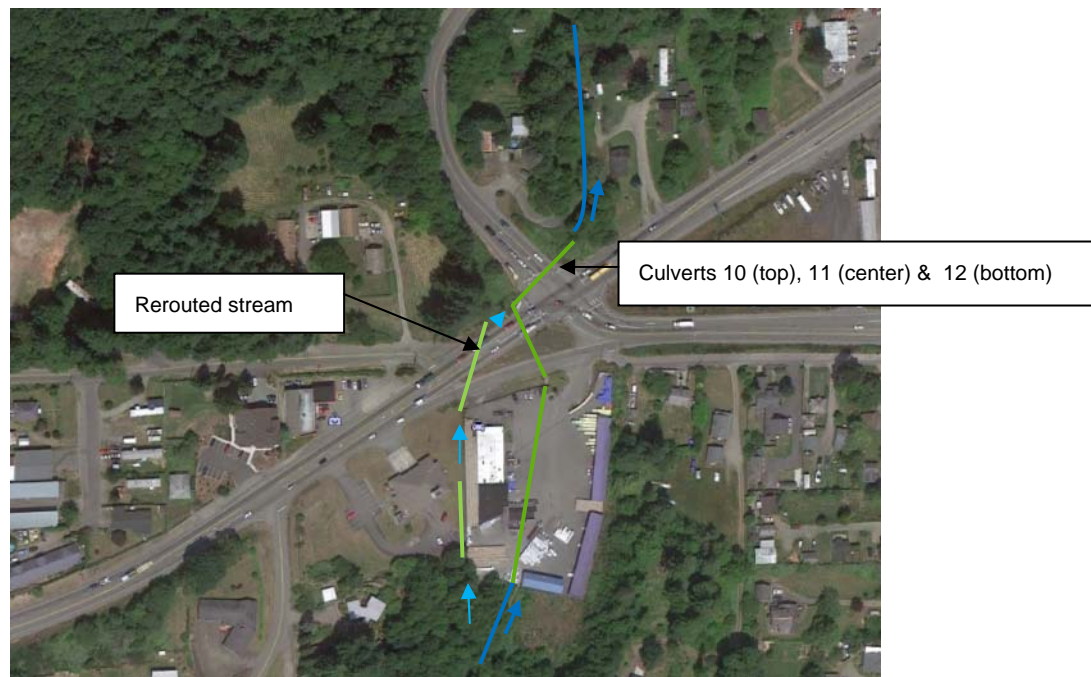
The obstacle rating was evaluated as low to medium. Barrier elements for this 100 LF plus 36-inch-diameter steel CMP culvert include 1-foot high velocities at peak flows and a length greater than 100 feet. From WRIA data, the stream is expected to have a 2% to 4% gradient in this tributary. The culvert is downstream of 5,700 LF of potential habitat.

*Discussion and Recommendations:* Sedimentation of this culvert has reduced the minimum 1-foot clearance for a culvert having a bank flow width less than 8 feet. In the Water Crossings WAC 220-110-070 “Culverts shall be installed according to an approved design to maintain structural integrity to the 100-year peak flow with consideration of the debris loading likely to be encountered.” The bank flow width is not directly applicable in this case since there is a 36-inch-diameter storm sewer and culvert directly upstream.



**Photo 15** Culvert 10 outlet

Length of the culvert reach cannot be addressed without redirecting the flow from this unnamed stream (1227026475270). The upstream flow traverses a total of 640 LF into three culverts that outlet into the small channel outlet shown. The 100 LF plus length of culvert crosses Sam Christopherson Road where it picks up the culvert crossing Hwy 3 from the lumber yard (addressed under Site 25) and then crosses Washington Cedar Lumber yard culvert (addressed under Sites 12 and 26). This culvert may be completed incrementally (see Figure 2).



**Figure 2 - Existing Culverts of Unnamed Stream**

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling. A biological assessment will be required as part of the HPA permit. While may be possible to clean out the sediment from the culvert, the construction scope assumes the culvert will be replaced with a rerouted 58-inch-wide arch culvert to the south side of Hwy 16 and Hwy 3. Unnamed Creek 1227026475270 will be rerouted around the west side of the Washington Cedar Lumber Yard within the fire station property.



**Site 25 - Culvert 11** (WSDOT) – Map ID 108414 – Unnamed Creek 1227026475270 at South Side of Hwy 16

The obstacle rating was evaluated as low to medium. Barrier elements for this 120 LF 36-inch-diameter concrete culvert include 1-foot-high velocities at peak flows and length greater than 100 feet. From WRIA data, the stream is expected to have a 2% to 4% gradient in this tributary. The culvert is downstream of 5,600 LF of potential habitat.

*Discussion and Recommendations:* This culvert crosses Hwy 3 and is directly upstream and connects with Culvert 10 at Site 24. Similar to Site 24, length of the culvert reach cannot be addressed without redirecting the flow from unnamed stream (1227026475270). The upstream flow traverses a total of 640 LF into three culverts that outlet into the small channel outlet shown. The 100 LF plus length of culvert crosses Sam Christopherson Road where it picks up the culvert that crosses Hwy 3 from the lumber yard (Site 25) and which crosses the culvert length under the Washington Cedar Lumber yard addressed in the discussion of Sites 12 and 26 (See Figure 2). Addressing this culvert may be done incrementally. Replacement of this culvert is the responsibility of WSDOT.

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling. A biological assessment will be required as part of the HPA permit. The construction scope includes replacing the culvert with a rerouted 190 LF by 58-inch-wide arch culvert between the north and south sides of Hwy 16 and Hwy 3. Unnamed Creek 1227026475270 will be rerouted around the Washington Cedar Lumber Yard.

**Site 26 - Culvert 12** (Privately owned) – Map ID 111010 – Unnamed Creek 1227026475270 at South Side of Hwy 16

The obstacle rating was evaluated as low to medium. Barrier elements for this 120 LF 36-inch-diameter concrete culvert include 1-foot high velocities at peak flows and length greater than 100 feet. From WRIA data, the stream is expected to have a 2% to 4% gradient in this tributary. The culvert is downstream of 5,600 LF of potential habitat.

*Discussion and Recommendations:* This 36-inch-diameter CMP culvert is the same culvert discussed under Site 12 and is associated with the Washington Cedar Lumber Yard. As discussed with Sites 24 and 25, the inlet shown in photo 16 is the beginning of roughly 640 LF of culvert and storm sewer pipe that outlets near the Waldbillig properties. The outlet drainage flow of this culvert enters directly into the inlet of the culvert mentioned in Site 25. The only option for improving fish passage is to reroute the stream around the current property and avoid the culvert running through the business property. The private owner will be responsible for adhering to WDFW fish passage compliance.



**Photo 16** Culvert 12 inlet

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling. A biological assessment will be required as part of the HPA permit. The construction scope includes replacing the culvert with a rerouted 300 LF of 5-foot-wide creek bed and 140 LF by 58-inch-wide arch culvert adjacent to the fire station and parking lot. Unnamed Creek 1227026475270 will be rerouted around the Washington Cedar Lumber Yard.

**Site 27 - Culvert 13** (WSDOT, Outside UGA) – Map ID 107158 – Gorst Creek at Hwy 3 MP 28

The obstacle rating was evaluated as low to medium. Barrier elements for this 2% sloped 174 LF 48-inch-wide by 42-inch-high three-sided box culvert include 1-foot high peak flows and a length greater than 100 feet.

*Discussion and Recommendations:* Replacement of this culvert crossing Hwy 3 is the responsibility of WSDOT.

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling. A biological assessment will be required as part of the HPA permit. Due to the length, the construction scope includes replacing the culvert with a bridge. The bridge length is estimated at 40 LF to extend out wide enough to include the unknown floodplain width of the stream.

**Site 28 – Culvert 14** (Privately Owned, Landfill) – Map ID 105104 – Gorst Creek South of Hwy 3 MP 28

The obstacle rating was evaluated as impassible due to sediment infill. This is a 500 LF 24-inch metal CMP culvert.

*Discussion and Recommendations:* The drainage in the landfill is currently being redesigned with the State.

*Estimate:* No scope or estimate is provided.



**Photo 17** Culvert 14 inlet

**Site 29 - Culvert 15** (WSDOT, Outside UGA) – Map ID NL 5 – Unnamed Stream 1227418475110 South of Hwy 3 MP 28

The obstacle rating was evaluated as impassible due to an inlet structure on the entrance of the culvert. This is an 80 LF 18-inch-diameter concrete culvert crosses the 48-foot-wide Hwy 3 paved roadway downstream of 1,000 LF of potential habitat. The flow path follows a ditch along Hwy 3 for several hundred feet.

*Discussion and Recommendations:* The culvert is not identified in WRIA data as a culvert of concern. Replacement of this culvert is the responsibility of WSDOT.

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling and a conceptual design study. Construction scope includes 300 LF of 5-foot-wide ditch channel with fish estuarine features and an 80 LF by 58-inch-wide by 36-inch arch culvert.

**Site 30 – Culvert 16** (Kitsap County, Outside UGA) – Map ID 115006 – Gorst Creek at West Belfair Highway

The obstacle rating was evaluated as low to medium. Barrier elements for these 60 LF 72-inch Steel CMP and 96-inch steel arch bottomless culverts include a 6-inch plus drop, sloped passage, and high velocities. The creek slope is roughly 1.6%. These culverts are downstream of 13,200 LF of potential habitat.

*Discussion and Recommendations:* WRIA 15 recommendations include replacing the culverts with a bridge and restoring estuarine features in the creek below the culverts. Based on the flood profile below, the twin culverts appear to dissipate the hydraulic head upstream for the 10-year to 500-year stream flows. The typical velocity of flow through the culverts would logically be expected to remain high since they are under inlet control with approximately 12 feet of backwater. Removing or modifying these culverts would possibly produce adverse upstream and downstream impacts to the creek. Replacement of this culvert is the responsibility of Kitsap County.



**Photo 18** Culvert 16 outlet

*Estimate:* For estimating purposes, the design scope includes stream hydrologic modeling and a conceptual design study. Construction scope includes a 72 LF span bridge, upstream streambed control weirs, downstream control for 700 LF upstream and 700 LF downstream, and stream bank enhancements for 700 LF downstream.

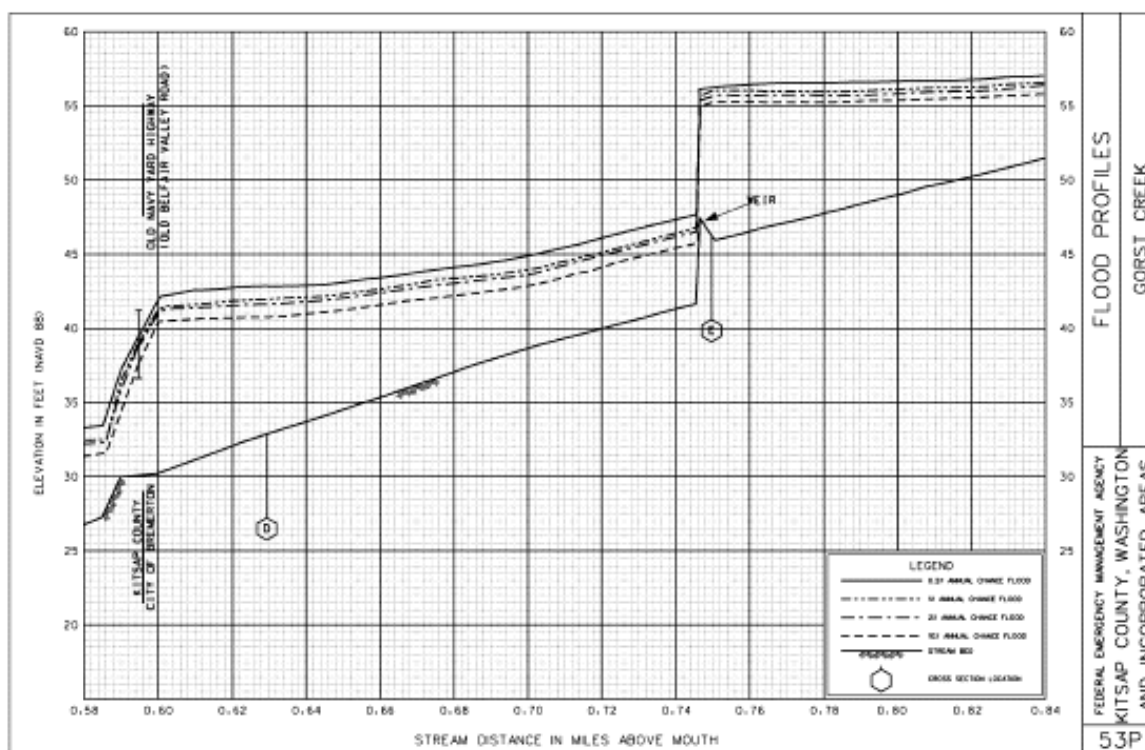


Figure 3 - Gorst Creek Profile Upstream from W. Belfair Valley Road

**Site 31 – Culvert 17 (WSDOT) – Map ID 110964 – Gorst Creek at Hwy 3 at Outfall**

The obstacle rating was evaluated as low. There are no fish barrier elements to the 120 LF 84-inch by 84-inch twin box culverts.

*Discussion and Recommendations:* This culvert is discussed with Site 4 and is the responsibility of WSDOT.



Photo 19 Culvert 17

**Site 32 – Culvert 18 (WSDOT) – Map ID NL 6 – Unnamed Creek at Hwy 16**

This 210 LF by 24-inch-diameter culvert crosses Hwy 16 north to a manhole at the south end of the Subaru dealership parking lot. The receiving culvert then runs north through the Subaru dealership parking lot for a total of approximately 480 LF. The obstacle rating is evaluated as high. Barrier elements for this 24-inch-diameter concrete culvert include a high velocity and length greater than 100 LF. The culvert provides approximately 500 LF of potential habitat.

*Discussion and Recommendations:* As discussed for Site 3, the repair of the Subaru portion of the receiving culvert is complicated by the owner's claim that the culvert is set within an easement and it is not responsible for the culvert's repair. WSDOT is responsible for this culvert.



Photo 20 Culvert 18 inlet

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling and a conceptual design study. A biological assessment will be required as part of the HPA permit. Construction estimate scope includes 210 LF of 50-inch-wide by 31-inch arch culvert.



**Site 33 – Culvert 19** (WSDOT) – Map ID NL 7 – Unnamed Creek at Hwy 16  
The obstacle rating for this 24-inch-diameter concrete culvert was evaluated as impassable. Barrier elements include a 2-foot drop and high velocities.

*Discussion and Recommendations:* Culvert length and the length of reach is not known. Replacement of this culvert is the responsibility of WSDOT.

*Estimate:* For estimating purposes, the design scope includes investigating this stream for fish habitat quality and the feasibility of improving the site to remove this fish barrier.



**Photo 21** Culvert #19 outlets

**Site 34 – Culvert 20** (WSDOT) – Map ID 108494 – Unnamed Stream 1226919475271 at Hwy 16

The obstacle rating for this 532 LF 30-inch-diameter concrete culvert was evaluated as high. Barrier elements include an 18-inch drop at the inlet and high velocity. The continuation of this culvert appears to be the 30-inch-diameter CMP culvert crossing the Mattress Ranch noted in Site 11 of the *Stormwater Capital Improvement Plan Technical Memorandum*.

*Discussion and Recommendations:* The slope of this culvert is 1%. WSDOT is responsible for the portion of the culvert that crosses Hwy 16.

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling and a conceptual design study. A biological assessment will be required as part of the HPA permit. Construction scope includes 120 LF of 58-inch-wide by 36-inch arch culvert.



**Photo 22** Culvert #20

**Site 35 – Stream Barrier 1** (Privately owned) – Map ID 110970 – Unnamed Stream 1226919475271 at Hwy 16

The wood bridge structure is clogged on the inlet side with debris. The obstacle rating was evaluated as very high. Barrier elements include a 2-foot drop and high velocities.

*Discussion and Recommendations:* The private owner will be responsible for adhering to WDFW fish passage compliance.

*Estimate:* For estimating purposes, the design scope includes upstream hydrologic modeling and a conceptual design study. A biological assessment will be required as part of the HPA permit. Construction scope includes a 20 LF raised wood bridge, 12 feet wide.



**Photo 23** Private Wooden Bridge

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# **Attachment A: Fish Passage Barrier Inventory**

GORST WATERSHED FISH PASSAGE BARRIER INVENTORY

Culvert		Barrier				% Fish	Potential Habitat	Rear Area	Spawn Area	Culvert	Diameter (			
Photo ID #	Notes	Map ID	WDFW FPID #	WRIA Number	WSDOT ID #	Passage	Lineal Gain (ft)	(square miles)	(square miles)	Shape	in)	Material	% slope	Length (ft)
culvert 1	Gold Mtn G.C.	105103	5899 SiteRecID 6589	15.0216		66	5,500			RND	36	CONC		40 est.
culvert 2	Wst Bel HW @ G.C.	NL #1				100	5,400			ARCH	36	CAL		100 est.
culvert 3	Minor Contrib	NL #2				0	300			RND	16	CAL Twin		20 est.
culvert 4	Upper Heins Creek	NL #3				66	1,000			RND	60	CAL		20 est.
culvert 5	Jarstad Box @ park	NL #4				100	2,200			BOX		CONC		
culvert 6	Jarstad RR crossing	105105	5901 SiteRecID 6591	15.0218		0	1,500			RND	30	CONC & SPS		300 est.
culvert 7	Heins Creek	105107	5903 SiteRecID 6593	15.0221		66	5,000			RND				30 est.
culvert 8	Parish Creek WBHW	105106	5902 SiteRecID 6592	15.0220		33	7,400			RND	60	CST		<100 est
culvert 9	Parish Creek @ SR 3	118126	9818 SiteRecID 11598	15.0220	990323	66	5,200			RND <sup>1</sup>	108	SPS		
culvert 10	SR 3 SR 16 junction	111009	15383 SiteRecID 17490		996828	66	5,700			ARCH	36	CMP		100 est.
culvert 11	SR 3 SR 16 junction	108414	10985 SiteRecID 12803	15.0217	991585	66	5,600			RND	36	CONC		120 est.
culvert 12	Cedar Lumberyard	111010	17492 SiteNum 996830		996830	33	5,000			RND	36	CMP		370 est.
culvert 13	WSDOT SR 3 BOX	107158	9681 SiteRecID 11454	15.0216	990168	33	4,186	0.00035	0.00058	BOX		PCC	1.96	174
culvert 14	Landfill Culvert	105104	5900 SiteRecID 6590	15.0216		0	2,400			RND	24	CAL		500 est
culvert 15	SR 3 Culvert	NL #5				0	1,000			RND	18	CONC		80 est
culvert 16	Gorst Cr. WstBelHW	115006	20961 SiteRecID 6587	15.0216		66	13,200			RND, ARCH	72 & 120	CMP Twin		60
culvert 17	Gorst outfall	110964	15308 SiteRecID 17403	15.0216	996740	67	16,900			BOX	84	CONC Box Twin	0.20	120
culvert 18	Unnamed at SR 16	NL #6				0	500 est.			RND	24	CONC		470 est
culvert 19	Unnamed at SR 16	NL #7				0				RND				
culvert 20	Unnamed at SR 16	108494	11063 SiteRecID 12860	15.0216	991670	33				RND	30	OTH	0.99	532
Barrier 21	Wooden Structure	110970?	15325 SiteRecID 17424		996761	0								
Fishway 1	Heins Creek	105108	5904 SiteRecID 6594	15.0221		100				Fishway <sup>2</sup>		CONC WP		150 est
	TESC nonexistant	118570	36020 SiteRecID 13213		991993	100								

<sup>1</sup> Culvert with baffles or otherwise designed for improved fish passage, Culvert with roughened channel inside, etc.

<sup>2</sup> Combination of weir and pool, vertical slot or roughened channel fishways, etc.

Fishway Definitions: **BC** = baffled culvert, **BF** = baffled flume, **PC** = pool chute, **WP** = weir pool, **SP** = Steep Pass, **VS** = vertical slot, **SBC** = streambed control, **RCC** = roughened channel culvert, **BL** = blasted falls, **TH** = trap and haul, **Unk** = unknown

Codes Used for Culvert Shape

ARCH - bottomless arch  
SQSH - squash  
RND - round

BOX - rectangular  
ELL - ellipse  
OTH - other

Codes Used for Culvert Materials

PCC - precast concrete  
CST - corrugated steel  
SST - smooth steel  
CAL - Corrugated aluminium  
SPS - structural plate steel

SPA - structural plate aluminium  
TMB - timber  
MRY - masonry  
OTH - other  
PVC - plastic

Washington State Department of Fish and Wildlife Progress Performance Report For WSDOT Fish Passage Inventory, June 2011 Appendix IIIA. WSDOT Fish Barriers Inventoried as of Feb 2011

Based on Field Inspection by Engineer 12-2011, barrier rating by velocity estimated and not calculated, barrier drops estimated and not measured

Table 3.3. Criteria for assigning passability to culverts that are assessed as barriers. When more than one parameter applies, use the more restrictive passability value.

Parameter	Value	Range	Passability
Water Surface Drop	≥0.24 meters	≥0.24 m & <0.5 m	0.67
		≥0.5 m & <1.0 m	0.33
		≥1.0 m	0
Slope (Culverts ≤18.3 meters length)	≥1.0%	≥1.0% & <2.0%	0.67
		≥2.0% & <4.0%	0.33
		≥4.0%	0
Slope (Culvert >18.3 meters length)	≥1.0%	≥1.0% & <2.0%	0.33
		≥2.0%	0

GORST WATERSHED FISH PASSAGE BARRIER INVENTORY

LocationID	Name	Tributary to	Latitude	Longitude	USource	BarrierOwn	AgencyType	AgencyTy_1	FishWayType	FishWay Notes	FishWaySta	FishWayS_1	RefID	Year_Comp	Year_Remov	GenPassSta	Height	Updated	InternalAg
1226963475279	Gorst Creek	Gorst Creek, flows into Puget Sound	47.52431700000	-122.74288300000	DIG		22	City of Bremerton Kitsap County? City of Bremerton City of Bremerton City of Bremerton	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	1	0		6589
1227104475308	Unnamed Stream [1227104475308]	Unnamed Stream [1227104475308], trib to Gorst Creek	47.53114000000	-122.71202600000	DIG		4	US Navy	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	2	0		6591
1227133475309	Heins Creek	Heins Creek, trib to Gorst Creek	47.53098400000	-122.71624600000	GPS		22	City of Bremerton	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	2	1		6593
1227123475308	Parish Creek	Parish Creek, trib to Gorst Creek	47.52924100000	-122.71385700000	GPS		22	City of Bremerton	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	2	0		6592
1227123475308	Parish Creek	Parish Creek, trib to Gorst Creek	47.52373700000	-122.71592700000	GPS		2	WSDOT	213	Hybrid or multiple types <sup>2</sup>	2	Fishway present and functioning	17000	1992	0	3	0		11598
BW17490	PointID for WDFW FPDsl.mdb SiteRec_ID 17490	PointID for WDFW FPDsl.mdb SiteRec_ID 17490	47.52633500000	-122.70427600000	GPS		21	Private	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	3	0		17490
1227026475270	Unnamed Stream [1227026475270]	Unnamed Stream [1227026475270], trib to Gorst Creek	47.52554100000	-122.70425700000	GPS		2	WSDOT	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	2	0		12803
BW17492	PointID for WDFW FPDsl.mdb SiteRec_ID 17492	PointID for WDFW FPDsl.mdb SiteRec_ID 17492	47.52519700000	-122.70467800000	GPS		21	Private	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	1	0		17492
1226963475279	Gorst Creek	Gorst Creek, flows into Puget Sound	47.51060000000	-122.74199800000	GPS		2	WSDOT	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	2	0		11454
1226963475279	Gorst Creek	Gorst Creek, flows into Puget Sound	47.51032100000	-122.74137300000	GPS		21	Private	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	1	1		6590
1226963475279	Gorst Creek	Gorst Creek, flows into Puget Sound	47.52925800000	-122.70850200000	GPS		23	Kitsap County	BC	Culvert is designed for fish passage <sup>3</sup>	2	Fishway present and functioning	17000	1987	0	3	0		6587
1226963475279	Gorst Creek	Gorst Creek, flows into Puget Sound	47.52800800000	-122.69885700000	GPS		2	WSDOT WSDOT WSDOT	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	3	0		17403
1226919475271	Unnamed Stream [1226919475271]	Unnamed Stream [1226919475271], flows into Puget Sound	47.52457500000	-122.69457500000	GPS		2	WSDOT	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	1	0		12860
BW17424	PointID for WDFW FPDsl.mdb SiteRec_ID 17424	PointID for WDFW FPDsl.mdb SiteRec_ID 17424	47.52325100000	-122.69406100000	GPS		21	Private	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	2	0		17424
1227133475309	Heins Creek	Heins Creek, trib to Gorst Creek	47.53234900000	-122.71983300000	GPS		4	US Navy	101	WP Fish Ladder constructed 2011	1	Barrier has no known fishway	17000	0	0	1	4		6594
1226963475279	Gorst Creek	Gorst Creek, flows into Puget Sound	47.51048800000	-122.74173300000	GPS		2	WSDOT	101	None (Fishway known to be absent)	1	Barrier has no known fishway	17000	0	0	1	0	10/23/2008	13213

## **Appendix E: Ranking of Improvements**

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Sites	Priority Table	Solution Complexity Table	Costs	Responsibility	Action	Standing
0	1	3	5	1	1	1
1	3	4	4	1	12	2
2	3	3	3	1	10	2
3	6	4	4	1	15	3
4	1	3	6	3	13	2
5	N/A	N/A	N/A	N/A	0	N/A
6	3	5	6	1	15	3
7	3	6	2	1	12	2
8	N/A	N/A	N/A	N/A	0	N/A
9	N/A	N/A	N/A	N/A	0	N/A
10	6	1	2	1	10	2
11	6	4	5	20	35	4
12	3	3	4	1	11	2
13	N/A	N/A	N/A	N/A	0	N/A
14	1	5	6	1	13	2
15	2	3	2	3	10	2
16	N/A	N/A	N/A	N/A	0	N/A
17		4	4	1	8	1
18		4	4	2	10	2
19		4	3	1	8	1
20		4	3	1	8	1
21	N/A	N/A	N/A	N/A	0	N/A
22		4	4	1	8	1
23	N/A	N/A	N/A	N/A	0	N/A
24		5	4	20	29	4
25		5	4	3	12	2
26		5	4	20	29	4
27		4	5	3	12	2
28	N/A	N/A	N/A	N/A	0	N/A
29		4	4	3	11	2
30		4	6	2	12	2
31	N/A	N/A	N/A	N/A	0	N/A
32		5	5	3	13	2
33		3	2	3	8	1
34		5	4	3	12	2
35		4	3	20	27	4

**Legend**

1= Public Safety Risk  
2= Fish ESA > 70%  
3= Property Risk (Major)  
4= Fish ESA > 50%  
5= Fish ESA > 20%  
6= Property Risk (Minor)

1= Trivial < \$10,000  
2= Low \$10,000 to \$50,000  
3= medium \$50,000 to \$150,000  
4= Moderately high \$150,000 to \$300,000  
5= High \$300,000 to \$1,000,000  
6= Extremely high > \$1,000,000

Priority 1 <10  
Priority 2 10 to 15  
Priority 3 16 to 25  
Priority 4 > 25

1= Minor construction / watch  
2= Maintenance (Annual)  
3= Feasibility study  
4= Construction requiring permit  
5= Construction requires calculation (complex, multiple jurisdictions)  
6= Major (NEPA, Extensive)

1= City of Bremerton  
2= Kitsap County  
3= WSDOT  
20= Non city, county, state