

**PIERCE COUNTY PUBLIC WORKS AND UTILITIES
Water Programs**

**SCOPE OF WORK
ARTONDALE CREEK / CULVERT REPLACEMENTS
Hunt Street Crossing (AD-01)
Artondale Drive Crossing (AD-02)**

6600 Block West Approx. at Hunt Street and at Artondale Drive

PROJECT D175-005

INTRODUCTION

The proposed project would improve storm drainage culverts for flood and erosion control, as well as fish passage at two sites in the Artondale Creek system on Gig Harbor Peninsula. The first culvert conveys the northeasterly branch from Maloney Lake and vicinity under Hunt Street NW, discharging into a steep severely eroding ravine, at least 40 feet in depth. Designated as AD-01 in the Gig Harbor Basin Plan by URS (Ref. 1, p. 4-17) it is undersized at 12 inches in diameter. The other culvert takes the main stem of Artondale Creek under Artondale Drive just east of 66th Ave. NW, where the existing 54-inch diameter culvert, designated in the Basin Plan as AD-02, reportedly impedes flood discharge and fish passage.

At Hunt Street, the project will entail special methods to remove old concrete pipe and insert a larger one without destabilizing a high road embankment. Outfall erosion control with energy dissipation is needed.

Washington Department of Fish and Wildlife (WDFW) in its fish passage design manual (Ref. 2) imposes additional criteria, complicating Artondale Drive culvert design. A proposed culvert should accommodate the normal open channel width and profile with a gravel bed and should facilitate rapid installation.

BACKGROUND INFORMATION

HISTORY

According to County Public Works, the Artondale Drive culvert was probably installed with a major road reconstruction in 1960. Gig Harbor Golf Course put a driveway across the creek on a small bridge with an opening 6-feet wide by 3.5-feet. Hunt Street, with its small culverts, was improved in 1949. Erosion below the Culvert AD-01 outfall was reported in the 1991 Comprehensive Plan, and checked in 1997.

TOPOGRAPHY

Artondale Creek has a roughly triangular watershed, southwest of the center of Gig Harbor Peninsula, and drains to the northwest tip of Wollochet Bay. The terrain is mostly rolling hills of 6% to 45% slope, with some flatter valleys and wetlands.

SOILS

Group C soils predominate most of the watershed, but well-drained Group A zones occur on hillsides, mostly south of Artondale Drive, in some sub-basins near the Golf Course, and from Artondale to 72nd Street west of 78th Avenue (Ref. 3). Wetlands are widely distributed about the watershed, associated with poorly drained soils in valleys, including the Culvert AD-02 project site and upstream ponding area.

DRAINAGE BASIN

The County standard 24-hour single event precipitation chart (Ref. 4, Pierce County Stormwater Manual, Appendix E, p. 3), shows Gig Harbor Peninsula receiving about 18 percent greater amounts in various design events than urban central Pierce County. In the MGS-Flood continuous simulation software, Artondale watershed is near the 48-inch annual precipitation isopluvial (see "Method of Analysis").

Of 3.22 square miles in Artondale basin, some 0.57 square miles (365 acres) drain to Culvert AD-01 at Hunt St. NW; it is included in the 1735-acre area tributary to Culvert AD-02 at Artondale Drive. The other

0.5 square-mile (320 acre) area enters into the impact analysis of culvert AD-04 at Wollochet Drive. The watershed was partly developed as residential land by 1996, when sub-basins ranged from 0.1 to 1 unit per acre. We anticipate imperviousness increasing from about 8 to 11 percent in the future, and forest cover being cut from 47 to 33 percent. This creates difficulty restoring natural conditions to the creek. It empties to the northwest corner of Wollochet Bay (Exhibit B). Reference 1 describes geologic history.

EXISTING FACILITIES AND DEFICIENCIES

In existing conditions, both culverts to be replaced would exceed the allowable headwater criterion of 1.5 times culvert diameter at a 100-year flow, per County Stormwater Manual (Ref. 4) Section 6.8.9.1.

Culvert AD-01: The Basin Plan by URS Consultants indicates that a 2-year peak flow would reach the threshold of road overtopping, even with a 7-foot inlet depth at the existing 12-inch culvert. This means that in a 100-year event with a peak of 50 Cfs+, about 35 Cfs would spill across Hunt Street, further damaging the high embankment and the severely eroded downstream ravine. Its slopes, near-vertical, will make construction access and equipment operations difficult or even hazardous.

Culvert AD-02: The old 54-inch diameter CMP, too small for flood flow and fish passage; was placed on about a 1.4% slope (Ref. 9, WDFW SSHEAR data) and sedimentation over time probably contributed to vertical misalignment, hence outlet-control limitations on capacity. Design analysis should be based on a slope of 0.3%+- to the inlet, but 1.0%+ from the outlet. Our site inspection found a hump, about 0.7 feet high in the downstream channel invert, within 3 to 4 feet of the outlet. The winding downstream channel was under a foot in depth for a few Cfs of flow. The bed is gravelly sand. The channel upstream is more uniform, with a sandy grass-lined bed for some 200 feet. WDFW SSHEAR data gives channel width as 1.5 meters (Ref. 9). Up to a third of the culvert is occupied by sandy sediment of flat profile and section, so the flow opening shrinks toward the outlet. Scour probably occurs in the culvert. The WDFW culvert design manual (Ref. 2, p.9) recommends inlet drop under 1.0 foot in the 10-year storm. But analyses (Exhibit J) show a drop of 1.40 feet. The existing culvert will be submerged at both ends with a 2-year flow. The fish passage criterion of 4 feet per second (Ref. 5, p. 3) would be reached at a 6-month event.

The creek has "Un-numbered A-Zones" designated above and below the Artondale Drive culvert, in the Flood Insurance Rate Maps (Ref. 6). Topographic maps show a sag-curve in the road a few hundred feet east of the culvert; apparently the overflow level is some 2 feet lower than assumed in the Basin Plan. This and the partial loss of culvert capacity from sedimentation would cause Artondale Drive to be overtopped in the 100-year flood, rather than having a few inches of freeboard as indicated in the URS study. Design discharge through a new structure should not exceed the combined through/over-flow of the existing culvert, to avoid liability for higher damage levels downstream, due to the project.

EXISTING STRUCTURES

Existing conditions are quite stable at culvert AD-02. At culvert AD-01, however, the Hunt Street road embankment, culvert, and adjacent property are at risk of being undermined by erosion in the deep ravine below the outfall, whose sides are nearly vertical.

PROPOSED DESIGN

ISSUES AND OBJECTIVES AT ARTONDALE DRIVE:

There is a need for balance between issues of protecting property from floods, and the ecosystem from impacts, and aesthetics and cost. The site is conducive to continuity of bed parameters - slope, width, gradation, and sediment equilibrium. The need to preserve detention storage effects, to prevent an increase in the flood flows downstream, implies that conditions which impede fish passage will still occur during the large storm events. A replacement culvert should satisfy fish passage criteria with respect to species and seasons, as circumstances permit, up to and beyond the high passage design flow.

An objective of the Basin Plan is habitat improvement upstream and downstream of Culvert AD-02. At Culvert AD-04; velocity is an issue at low tide, a more frequent event than fish passage design flow.

METHOD OF ANALYSIS

The WDFW manual "Fish Passage Design at Road Culverts" (Ref. 2, p. 64, 82-83) requires continuous or statistical flow estimates, instead of previously accepted Hydrograph or Rational methods. Design

flows at certain exceedence frequencies should be determined by one of the following methods:

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Gauging 2. Continuous simulation model 3. Local regression model 4. Regional regression model; | <p>Note: WDFW does not approve single event methods, such as:</p> <ol style="list-style-type: none"> 1. Rational 2. Hydrograph (SCS, SBUH) |
|--|--|

Continuous runoff modeling software is discussed in the Preliminary Technical Supplement (Ref. 11). The WDFW culvert manual (Ref. 2, p. 22) states that at fish passage design flows, replacement culverts usually have outlet control. For detailed design with a channel survey, a HEC-RAS model can be run to refine the culvert discharge rating, including the downstream effect of inflow from a 136-acre sub-area.

Fish Passage Design at Road Culverts: An "Interim Draft" January 2002 version of this manual, is being circulated and used by WDFW, awaiting formal approval. The main subjects in this publication are:

Design Options

- No-Slope is the simplest method, included in WAC 220-110-070 (Ref. 5, p. 2);
- Hydraulic Option *is set forth by same WAC section* in detail, yet subject to de-facto rejection by WDFW;
- Stream Simulation, *not provided by WAC*, is required by Oregon statute for culverts over 100 feet long.

Habitat Issues (Impacts)

Migration Barrier Culvert Conditions

Fish Passage Design Flows: To estimate these, the best techniques at our disposal appear to be:

- Low Flow Rate (by 95% exceedence definition, Ref. 5, p. 2) was assumed between the two lowest values in the "scatter diagram" of 20 monthly stage-discharge samples, from the Basin Plan Report, October 2002 version (Ref. 1, Figure 4-26); then re-computed from Feb to April 2003 gauge data.
- High Flow Rate "usually controls the culvert design" and "regardless of design option ... must be checked to ensure stability ..." (Ref. 2, p. 64). The Basin Plan charts stream readings, including Artondale Creek; but the sampling period, May 2000 to December 2001, experienced sub-normal rainfall and flows. Gauge readings by County staff, from November 2002 to April 2003, have been combined with those of the Basin Plan for high fish passage (10% exceedence) flow analysis.
- For resident salmon, Coho and Chum according to the area habitat biologist, the juvenile migration season is February to April, and the adult season is October to December.

Continuous Simulation Model: The MGS-Flood Program uses two sets of basin data, for "pre- and post-developed" land conditions (Exhibit H, p. 3-4). In this study, "pre-developed" means mid-1990's, prior to major flooding of 1996-1997; and "post-developed" means future "build-out" under growth management, reflected by higher percent impervious (per Basin Plan Table 3-3, Ref. 1) and conversion of woods to grass cover. Wetland areas are from the mid-1990's. This author found the MGS-Flood program with Longview rainfall provides the best flow-frequency figures (Preliminary Technical Supplement, Ref. 11).

Regional Regression Model: The WDFW culvert design manual (Ref. 2, Appendix C) has equations and regional factors for high fish passage design flow estimates. The result for the site is 27.75 Cfs. But WDFW accepts a derivation from gauging as more accurate (see the "Design Storm Event" section).

Comparison to Hydrograph Models: Three previous studies were based on the SCS unit hydrograph methodology, using HEC-1 or HEC-HMS; also, a crude whole-basin runoff computation was done with the Stormshed SBUH model (see Ref. 11). The latter computed a 100-year future peak flow of 300 Cfs. Of these, the MGS-Flood continuous model with Longview Station data will be used in design. Here is a summary of runoff to Culvert AD-02 by several models:

Runoff Event	URS		In-House	MGS		Stormshed
	Existing Table 4-27,	Future Table 5-2	HEC-1 Fut.	Longview Sta.		SBUH Future
				Existing	Future	
6-Mo Peak	39. Cfs*	N.A.	N.A.	39.1 Cfs	51.6 Cfs	23.3 Cfs
2-Yr Peak	72. Cfs [#]	50. Cfs	61. Cfs	68.2 Cfs	86.4 Cfs	69.7 Cfs
10-Yr Peak		N.A.	119. Cfs	133.7 Cfs	166.0 Cfs	168.2 Cfs
25-Yr Peak		162. Cfs	153. Cfs	174.5 Cfs	216.4 Cfs	225.9 Cfs
100-Yr Peak		238. Cfs	210. Cfs	246.5 Cfs	306.4 Cfs	300.0 Cfs

* Average of highest 3 of 20 monthly maximum flows. # Highest of the 20 monthly maximum flows.

DESIGN STORM EVENT

Culvert AD-01: At this site, Pierce County's Stormwater Manual requires culverts for natural channels to convey a 100-year, 24-hour storm after full development. The detention effect is negligible. Results of three runoff models are shown below. The J. Montgomery Study of 1991 had no corresponding point.

<u>Event</u>	<u>Basin Plan HEC-HMS</u>	<u>In-House HEC-1/SCS</u>	<u>MGS Rpt, Longview Sta.</u>
2-Year Peak	14. Cfs	16. Cfs	14.8 Cfs
25-Year Peak	43. Cfs	36. Cfs	35.2 Cfs
100-Year Peak	67. Cfs	50. Cfs	50.3 Cfs

The nearest resident has not noticed road overtopping in 30 years (it could have occurred overnight). Some sub-basin parameters were revised for outwash soil, and the hydrology re-run for detailed design.

Culvert AD-02: In addition to standard flood events, of which the 2, 25 and 100-year frequency flows can be compared to the Basin Plan under future conditions; the State Fish and Wildlife Department stipulates a number of crossing design criteria for salmon bearing streams. They are computed as:

<u>Event</u>	<u>Estimate</u>
• Low Flow Design Discharge	0.47 Cfs during juvenile salmon season.
• High Flow Design Discharge	4.0 Cfs for juvenile salmon season, 8.1 Cfs for adult season.
• 10-year Frequency Peak Flow	104 Cfs via existing pipe, 125 Cfs via concrete box, Alternative B
• 100-year Frequency Peak Flow	165 Cfs via either existing pipe or concrete box, Alternative B

DRAINAGE ELEMENTS

Culvert AD-01: The pipe diameter should be enlarged from 12 to at least 24 inches inside, assuming the existing headwater depth of 7 feet, to convey the 100-year flow. A reducer of 32-to-28 inch nominal size (outside diameter), Type SDR-26, is included to provide an intake opening of 29.07-inch diameter leading to a 25.85-inch inside diameter for the rest of the pipe. The estimate of \$90,880 for construction and \$12,000 for land is applied to all three alternatives. (See Exhibits D.1 and D.2).

Proposed HDPE Alternative, Curved Profile and Gabions: There would be a particular need for geotextile lining and a gravel layer, to resist erosion of underlying ground by flow through voids in the filler aggregate. This configuration should be in the form of a bowl with sills, to break the continuity of the high velocity discharge path, and conform to the ground to stabilize it.

Proposed HDPE Alternative, Curved Profile and Upwell Catch Basin: This device probably would best contain the high velocity impacts. It would need to be large, with a beehive grate on top, perhaps an interior baffle, and riprap -around it and on the downstream side as an apron

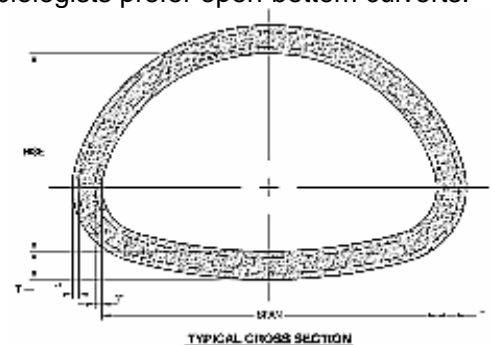
Proposed HDPE Alternative, Straight Profile and Drop Manhole: The terrain would require a very deep manhole. Large riprap would be placed in the sump to disperse the impact and abrasion of falling water (assuming some sediment load). It should have a riprap outfall apron and be at least partly surrounded by backfill; the latter would help stabilize the ravine walls.

Culvert AD-02:

At the peak of the February 1996 MGS-Flood simulation (used as a 100-year equivalent) estimated flow past this crossing was 165 Cfs, with 137 Cfs going through the pipe and 28 Cfs overflowing. But in the proposed culvert, the goal would be less rapid filling of storage in a given flood, neither overtopping the road nor exceeding existing-condition 100-year flow. Downstream flood profiles would rise somewhat in 25 to 50-year storms, but not the 100-year storm. Upstream water levels should decline in all events. Except for the full-bank width Option-D, flood control and fish passage criteria would be met; the latter apply to lower flows than FEMA 10-year to 500-year rates. Fish biologists prefer open-bottom culverts.

Culvert bed design: Stone or grain size distribution affects the bed n-value. The design can be refined so the combination of flow area above it and Manning's n-value give the best balance of flood relief and fish passage goals. Other gravel bed design and construction factors are in Reference 2, p. 42-50.

Proposed CMP or Concrete-Arch, Flared Ends, Alternative-A:



The section dimensions for this item are nominal 83 by 57 inch span and rise. Using aluminized steel would minimize water pollution from corrosion. The length would be within 100 feet, about 10 feet more than the existing culvert. Limiting length to 100 feet would enable the project to meet species-specific criteria (Ref. 2, 5 and 10) at a future 6-month flow. We anticipate using beveled head/wingwalls or end sections to reduce inlet head loss and turbulence (Exhibits E.1 and E.2).

- Installation: Reduction in skew angle to the road would help to hold culvert length under 100 feet. The grade would be about 0.1 percent, against 0.3 percent upstream and 1.3 percent downstream, to meet the slope ratio criterion (Ref. 2). A bed of gravel, or quarry spalls if needed, would fill the culvert to about 22 inches of depth at the center, to a 1.5 meter width (WDFW - Ref. 9). It would slope up at 3 H : 1 V on the sides. Bed depth would be 38% of rise in the center and 45% at the sides. Modeling of this option assumed the bed profile would keep the mound about 8.5 inches high past the outlet, to maintain interior water depth at 0.8 foot, with downstream channel depth at 1 inch.
- Advantages and Disadvantages: The CMP-arch would improve the stage-discharge curve, for migration above high fish passage design flow, and to prevent road overtopping in 75 to 100-year future floods. Velocities would decrease 30% or more at fish passage design flows, staying under the 4-foot-per-second and 0.8-foot drop capability of Cutthroat trout and Chum salmon up to over a year in the future condition. Inlet drop would decrease; from 1.40 feet to 1.04 feet in the 10-year future storm, and under 0.1 foot at high fish passage flow. Alternative-A would cut impoundment, by 0.09 foot in depth and 18 percent in volume at high fish passage flow for example. Construction cost, estimated at \$109,115, or \$199,995 with site AD-01, is lowest. Right-of-way and wetland mitigation at \$32,000 and \$10,500 would raise the total to \$242,495 for CMP.



Perspective End View

Proposed Concrete Box/ Architectural Endwall Alternative-B:

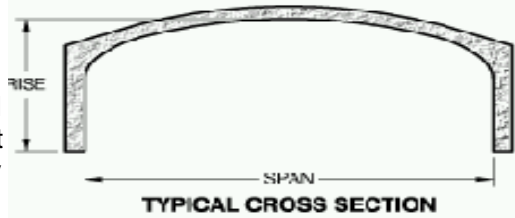
To address fishery/ environmental/ aesthetic preferences, we analyzed a bottomless culvert, with an opening wider than the 6.5-foot WDFW / Pierce Conservation District figure. It would have end / wingwalls, with compound-arch crowns, attached to square box-culvert sections, all made of concrete. Of the potential suppliers: Hydro-Arch Culverts, Con-Span Bridge Systems, and Surespan of West Vancouver, B.C., the latter has been most responsive. Culvert velocities could be moderated by a sand or water-blasted exposed-aggregate finish (n-value about 0.015) instead of a smooth interior finish. (See Exhibits E.1 and E.2)

- Installation: The bottomless box culvert segments are about 4 feet long, facilitating placement of a gravel or quarry spall bed. Installation of footings, which can be pre-cast, precedes the culvert. As in Alternative-A, the bed of 1.5-meter bottom width, (4 feet, 11 inches) would have upward slopes of 3 H : 1 V on both edges. Bed-depth-to-pipe-rise ratio does not apply. The bed profile would be restored as in Alternative-A, but with a coarser gradation to offset the lower roughness (n-value) of concrete top and sides. The concrete units would require somewhat heavier equipment than CMP. Integral head/wingwalls would contain the road embankment and improve end transitional flow.
- Advantages and Disadvantages: The box culvert option would have more pronounced effects on the existing rating curve than a CMP-Arch. Velocity, head loss and upstream pond stage would be further reduced throughout the flow range. Velocity would drop below 1.3 Fps at high fish passage design flow, for juvenile salmon migration; inlet drop would fall below 0.1 foot at high fish passage flow, and to 0.97 foot in a 10-year future storm, satisfying a recommendation to address upstream ponding (see Ref. 2, p. 9 and 24). Road overtopping would be avoided and freeboard increased, to over 1 foot in the 100-year storm, but potential impacts downstream would increase. Alternative-B has a \$186,620 construction estimate, \$95,000 over Alternative-A. Including both sites, with costs of right-of-way and wetland mitigation at \$32,000 and \$10,500; the total would amount to \$320,000.

Hybrid Culvert: Prefabricated Sections under Pavement / Cast-in-Place Skewed Ends, Alternative-C:

This variant, used in Montana, can be applied most readily to a three-sided box culvert - Alternative-B. It is a possibility for arch or bridge/culvert Alternatives A and D. Pre-fabricated end sections angled up to 45 degrees for concrete box types are available in some states. This configuration could reduce the earthwork volumes, wetland impacts, and right-of-way for rebuilding the road fill with flatter slopes and guardrails, to meet current traffic safety standards, although it does not have a separate cost estimate.

Stream Simulation / Full Bank-width Culvert and Slot Weir - Option-D: Box culverts can be built up with prefabricated corrugated metal plates to standard sizes but the 8-foot – 9-inch minimum span would not allow good proportions for the opening size needed, unless we abandoned detention. There is another option based on a full bank-width estimate of 17 feet, which could increase the span to over 20 feet. To replace storage / detention, we would be required to build a slot weir between the culvert and Golf Course. Though it would incur additional burdens for land and liability and double the construction cost this option is addresses the feasibility of placating the agency that controls Hydraulic Project Approvals.



- Installation: This option inherently has far greater impact areas, estimated at 5/6 more in wetlands, than other alternatives. Reducing the angle of skew to Artondale Drive could be an offsetting factor.
- Advantages and Disadvantages: The intended benefit of this option is to re-create unencumbered, contiguous, natural stream processes and habitat characteristics. We should ask, though, what a four-fold widening of the AD-02 culvert would accomplish, between culverts only 6 feet in width at Wollochet Drive and the Golf Course drive. Option-D construction cost is estimated at \$408,570, or 2 to 3½ times those for Alternative B or A. With the Hunt Street site, and right-of-way and wetland mitigation costs of \$44,000 and \$19,250, the total would be \$562,700.

Operational Hydraulic Parameter Comparison: On the next page is a table of existing and proposed culvert performance in a series of event peaks, with future conditions at Site AD-02. Proposed culvert outflows are from MGS-Flood. The synthetic-record 1996 storm, measured on hydrograph plots, is considered the nearest equivalent for a 100-year event. Other MGS flows are taken report pages 7-9. This table corroborates the MGS-Flood continuous model, especially for Culvert AD-02 with detention. MGS-Flood hydrographs for simulated major event peaks at Culvert AD-02 are in Reference _.

Storm Event	URS, Table 5-2, Fut.		In-House, HEC-1, Fut.		MGS, Longview Sta, Fut.			
	Runoff Qi	Ex.Culv.Qo	Runoff Qi	Ex.Culv.Qo	Runoff Qi	Ex.Culv.Qo	Alt.A Qo	Alt.B Qo
2-Yr	50. Cfs	49. Cfs	61. Cfs	58. Cfs	86.4 Cfs	68.9 Cfs	70.8 Cfs	76.1 Cfs
25-Yr	162.	145.	153.	120.	216.4	133.4	140.6	160.8
100-Yr	238.	184.	210.	162.	272.0*	165.0*	145.0*	165.0*

* Synthetic Feb. 7-10, 1996 event, from MGS-Flood graphic output.

Impacts to Wollochet Drive Culvert AD-04: Changes in flow-frequency regime due to Artondale Drive culvert enlargement could affect this stream crossing. Hydraulic calculations (Exhibit J) show that eliminating impoundment at the Artondale Drive culvert would only transfer the problems downstream, unless a more costly, inconvenient replacement of Culvert AD-04 were done. Downstream impacts of Alternative-A would be negligible; and would be greater by an order of magnitude with Alternative-B, but not acute; whereas Option-D would induce another ten-fold increase in impacts, doubling the 100-year peak flow and adding 3+ feet of ponding at Wollochet Drive. The culvert flares out a few feet in width near the outfall, which has a drop of over 1 foot at low to medium tide, hence a diurnal fish blockage. While only minor debris buildup is expected; the major damage risk appears to be from outfall velocities, exceeding 15 Fps, causing beach erosion and thus undermining the high embankment. Considering its outlet conditions, Culvert AD-04 could either be, or become, the worst fish barrier on Artondale Creek.

STRUCTURES

At Culvert AD-01: Construction should be scheduled for a dry period of minimal slope-failure risk.

- Possible methods would be boring through the road embankment from the uphill side after bursting the existing concrete pipe, then inserting HDPE pipe, shoring within the ravine in vertical stages, and lowering material into it by a winch or a crane.
- The concentrated design event discharge of 60 Cfs seems to warrant an inlet structure on the north side of Hunt Street, with riprap protection for the adjacent ground and approach channel. A pipe anchor collar could be installed at the proposed reducer, and tied back to the inlet structure. For a calculated velocity reaching 45-Fps down the pipe, an energy dissipator will be required at the outfall. Overtopping of Hunt Street should be avoided, since it could severely erode the high fill slope.

Culvert AD-02: Additional structure considerations are:

- The skewed angle of the flow path under Artondale Drive necessitates either wing-walls, retaining walls, angled end cuts, flared end sections, or a curved alignment to fit the culvert ends into the channel, embankment, and topography. This problem increases with the culvert width.
- To meet current highway safety standards, the road shoulders could be widened or equipped with guardrails, and / or the steep embankment sides (about 1:1) could be re-graded to 2:1 slopes, if they would fit within a 100-foot culvert length.

RIGHT-OF-WAY

Culvert AD-01: Permanent easements should be obtained, about 40 feet wide by 50 feet deep on the north side and 75 feet deep on the south side of Hunt Street; with temporary construction easements bringing the total areas to 60 feet wide by 90 and 75 feet deep. They should provide for the use of driveways on lots adjacent to the ravine; so material handler machines could reach into it from the lowest practicable level.

Culvert AD-02: Temporary easements should provide at least ¼ acre for construction staging and access. The permanent Artondale Drive NW right-of-way has extra width at Culvert AD-02; and we anticipate adding 0.1 acre or more on both sides, opposite and east of 66th Avenue.

Another complication with the full bank width option-D is the obvious implication of a weir as high as the roadway, just east of the Golf Course - an intent to use it along with other properties upstream for flood easements. No such easements exist to our knowledge. The County was not required by regulation in 1960, when the present culvert was designed and built, to consider a 100-year storm routing; a 10-year flow capacity was typical. So the detention effects, predicted by more recent studies, were inadvertent.

FIELD DATA NEEDED

Culvert AD-01: This culvert discharges into a ravine over 40 feet deep. A true ground survey is needed for a successful project, albeit hazardous.

Culvert AD-02: The WDFW fish passage design options all require certain field data - parameters of culvert and channel profiles upstream and downstream. Cross-sections should be taken, particularly at "control points", and intervals from both ends of the culvert for at least 200 feet; and bed material should be characterized. A profile should be taken of Artondale Drive, and the Golf Course driveway.

Upstream: Sedimentation shall be checked below Culvert AD-01; and where a sediment-laden ditch from a failing residential pond in Madrona Park enters Artondale creek.

Downstream: The County Planimetric Map (R01, T21, Sec.24) shows two small private ponds and two driveways within 800 feet east of Culvert AD-02 (in Basin Plan Reach AD04). They may be prone to impacts in flood events, or may affect fish migration. At a minimum, pipe sizes, materials, conditions, and heights of cover above the inverts, should be checked.

Culvert AD-04: There is reason to believe this culvert is a more significant fish barrier than the Basin Plan indicated, so it will receive additional site reconnaissance.

ENVIRONMENTAL CONSIDERATIONS AND PERMITS REQUIRED

An Environmental Checklist will be submitted for Planning and Land Services approval. Washington DFW advises that any project-related fill inside the "ordinary high water" line (such as improved road embankment replacement) may require a Corps of Engineers permit (404, Filling and Dredging). Only in that case, or with a dam safety issue, would the State Department of Ecology become involved; we would need their Temporary Modification of Water Quality Standards and Water Quality Certification, concomitant with the Corps permit. Wetland mitigation could be required, in regard to AD-02 culvert construction, and impacts on areas upstream should be assessed.

A Hydraulic Project Approval will be needed from the State Department of Fish and Wildlife. Title 220 of the State Code (Ref. 5, p.1) requires no-net-loss of habitat productive capacity. To the degree that

ponding would affect sedimentation in the stream habitat, it already occurs in the existing condition, but would be slightly reduced by either Alternative A or B. Thus the proposed culvert would favorably affect the issue, and meet WDFW's own recommendation not to exceed one foot of inlet drop in the 10-year event; the project would not be detrimental to habitat. An effort will be made to incorporate sediment control BMP's, to resist potential migration from two known upstream erosion sources (see "Proposed Design - Issues and Objectives").

MAINTENANCE CONSIDERATIONS

Maintenance costs have not been estimated in detail at this preliminary stage. Some observations are:

Culvert AD-01: A certain amount of sediment and debris will be carried by flood flows, especially since for an intermittent stream such as this, the channel is by no means adapted for a 100-year flow of about 60 Cfs. The provision of a sump upstream of the street crossing should have three benefits: less inlet erosion, less abrasion in the pipe and energy dissipator, and far easier access than the lower structure for sediment and debris removal.

Culvert AD-02: Maintenance of the gravel bed may be done on an as-needed basis, if there is clogging by fine sediment or debris from upstream, or degradation of the restored channel configuration due to future storm events.

SUMMARY AND RECOMMENDATIONS

Culvert AD-01: Conditions (high embankment, erosion, difficult access) call for an HDPE installation by directional drilling under the road, with up to three intermediate anchor collars, structures at both ends, a bank stabilization blanket on the steep slope, and additional downstream channel protection.

Culvert AD-02: Either alternative - A (CMP-Arch) or B (Concrete-Box) - could be optimized to meet the project objectives. The box-culvert might be preferred for its durability, appearance, open bottom, and slightly better low-end discharge rating for fish passage. An arch culvert of given capacity could provide a few more inches of head room, for maintenance and work on the gravel bed, probably at a lower cost.

Project scoping and pre-design will proceed according to all pertinent agencies' written criteria. Three preliminary cost estimates have been prepared (Exhibits F.1-3) with essentially similar assumptions for site AD-01, but showing differences between Alternatives A and B and Option D for site AD-02.

Cost Categories / Locations:	Construction	Right-of-way	Wetland Mitigation	Implementation Totals
Hunt St. Site AD-01				
Any Alternative	\$ 90,880	\$ 12,000	N.A.	\$102,880
Artondale Site AD-02				
Arch Pipe Alternative-A	\$109,115	\$ 20,000	\$ 10,500	\$139,615
Conc. Box Alternative-B	\$186,620	\$ 20,000	\$ 10,500	\$217,120
Full Bank-width Option-D	\$408,570	\$ 32,000	\$ 19,250	\$459,820

Permit applications will be prepared, on the basis of Alternative B with concrete end/wing/walls, useful for containing the fill over a 100-foot pipe length askew to the road. Any of the alternatives could be modified in its dimensions and its hydrology re-analyzed. We may decide to pursue a separate HPA for site AD-01 first. Since it is unsuited for fish passage, and detention is not a significant issue, approval is not expected to be problematic. Alternative-C, as a modification of Alternative A or B with cast-in-place angled end / wing / walls, could reduce the need for land and wetland mitigation. Further consultation with specialty contractors is advised on some design and construction details, at both culvert sites.

UTILITIES

The following utility companies are known to operate in the vicinity of this project:

Gas: Puget Sound Energy; Power: Peninsula Light Co; Water: Washington Water Service (Successor of Harbor Water Co.), and Rainier View Water Co; Phone: Centurytel (Telephone Utilities of Washington); Television: AT&T Broadband Cable, Electric Lightwave.

Other existing utility lines may be subject to relocation due to the proposed project. Mitigation or relocations of any other impacted utilities will be coordinated with the appropriate utility companies.

PROJECT SCHEDULE

The following schedule gives tentative completion dates for these project tasks:

Scope of Work:	Apr. / 2003	Final Plans and Specs.:	Feb. / 2004
Soils Report:	Jun. / 2003	Contract Advertisement:	May / 2004
Survey Work:	Jun. / 2003	Bid Opening:	Jun. / 2004
R/W Acquisition	Aug. / 2003	Contract Executed:	Jun. / 2004
P.E./Draft R/W Plans:	Oct. / 2003	Const. - Notice to Proceed:	Jun. / 2004
Environmental Work:	Dec. / 2003		

A detailed project schedule is attached as Exhibit G.

AUTHORIZATION


Harold Smelt, P.E., Capital Improvement Program Manager

Date

Tim Ramsaur, P.E., Water Programs Manager

Date

REFERENCES

1. Gig Harbor Basin Plan, by URS Consultants, draft dated March 2002, revised October 2002.
2. Fish Passage Design at Road Culverts, by Washington Department of Fish and Wildlife (WDFW) "interim working document" dated January 2002, to replace 1999 version, pending formal approval.
3. Pierce County Soil Survey by U.S. Soil Conservation Service (SCS, now NRCS) dated 1979.
4. Pierce County Stormwater Management and Site Development Manual, November 1, 1999.
5. WAC 220-110-070, Water Crossing Structures, effective 1994.
6. Flood Insurance Rate Maps, Pierce County (Unincorporated Areas), published by NFIP/FEMA, (Panels 530138-125 and 150), August 1987.
7. Pierce County SWM Master Plan, James Montgomery Consultants, March 1991.
8. SCS-TR55, Urban Hydrology for Small Watersheds, U.S.D.A., 1986.
9.  **SSHEAR Fish Passage Barrier Inventory** Current, April 2003.
Contact: Brian Benson
(360) 902-2570
10. Oregon Department of Fish & Wildlife, Guidelines and Criteria For Stream-Road Crossings, from state Web site, April 2003, (see Oregon Revised Statutes 509.580-645).
11. Artondale Creek/Culvert Replacements - Preliminary Technical Supplement, Water Programs, 2003.