CHAPTER 6: ANALYSIS OF CONVEYANCE ALTERNATIVES

A hydrologic model (HSPF) created in Phase I was used to simulate basin hydrology and flows; a second model, FEQ, was used to evaluate six conveyance alternatives for alleviating flooding impacts in the sub-basins where the most flood damage occurred in 1999 (Conveyance alternatives are structural drainage projects to lower flood elevations.) A wide range of potential alternatives were considered by the County and Stakeholders Committee (See section 1.4); selection was based on financial, technical, and regulatory considerations.

In addition to the conveyance alternatives evaluated, the Hickman Sub-Area Drainage Improvement Project was also evaluated using the hydrologic models. Hydrologic modeling predicts that the Hickman project, built in 1999, should reduce flooding in the area of 93rd Avenue. (See Appendix E, Figure 6-7.) All other alternatives were modeled assuming the Hickman Sub-Area Drainage Improvement Project was functioning. An easement that enables Thurston County to maintain this project is set to expire in 2004.

> **Related recommendation**
>
> Thurston County should seek to acquire an easement for the Hickman Sub-Area Drainage Improvement Project and maintain the project in perpetuity.
>
> See Chapter 7 for details.

6.1 ANALYSIS OF ALTERNATIVES

The intent of the computer modeling was to assess the effect of different storage and conveyance mechanisms for Salmon Creek Basin. The Stakeholders Committee and County staff instructed consultants to model these alternatives:

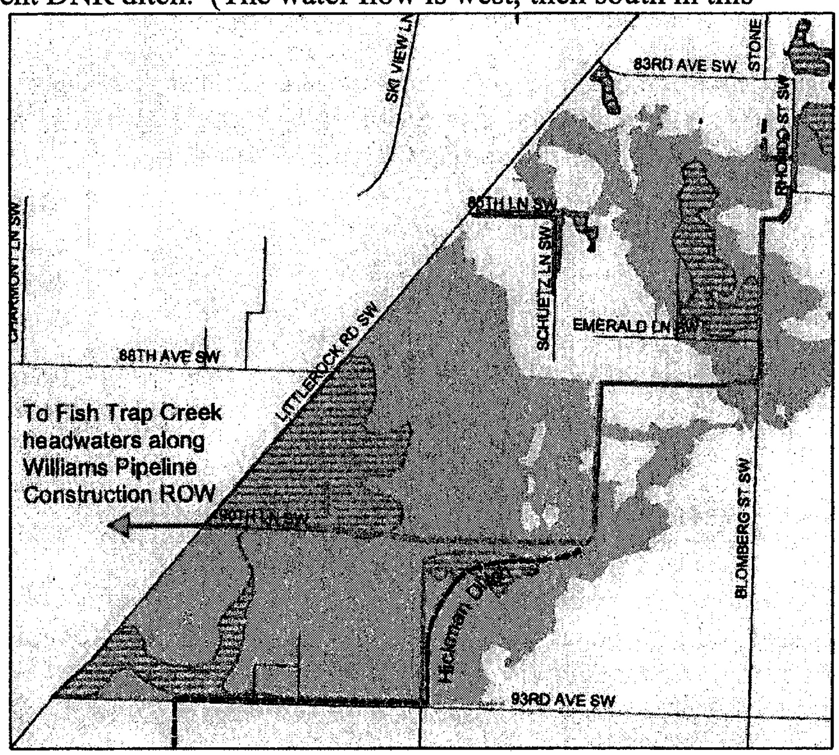
- Rhondo Pond to Fishtrap Creek
- Rhondo Pond to Littlerock Road 1
- Rhondo Pond to Littlerock Road 2
- Rhondo Pond to Jones Road
- 93rd to Jones Road
- East Basin Alternative

Information concerning how far each option would decrease flood-stage levels is based on the computer model simulations and limited topographic information, as described in Chapter 5. Therefore, flood-stage levels should be regarded as approximations suitable for general planning purposes only.

The modeling results shown in this chapter illustrate the effect alternatives would have under existing development conditions if the 1999 flood levels were to reoccur. The alternatives were not modeled under full buildout conditions, because the modeling of existing conditions showed that none of the alternatives would eliminate existing flooding.

6.1.1 Rhondo Pond to Fishtrap Creek (West Basin)

The modeled drainage structures for the *Rhondo Pond to Fishtrap Creek* alternative would begin at Rhondo Pond and continue south along Rhondo Street. After picking up flow from both Rhondo Pond and the western side of Rhondo Street, it would continue to the end of Rhondo Street SW where it would then flow off the road right-of-way and onto private land. It would continue south and enter the current DNR ditch. (The water flow is west, then south in this ditch, until it reaches Williams Pipeline.) The project would continue west along Williams Pipeline construction Right-of-Way (ROW), and discharge into Fish Trap Creek.

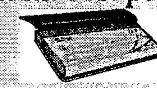


The image above represents a portion of a larger map that features the entire Salmon Creek Basin, along with a legend. For the full map of the Rhondo Pond to Fishtrap Creek alternative, see Figure 6-1, Appendix E.

Similar to the *Rhondo Pond to Jones Road alternative* (described in the following pages), this alternative could be constructed with a combination of pipe and ditch, or pipe could be used for the entire alignment. Only one portion of this alternative (Rhondo Street SW) would need to be pipe because of road right-of-way constraints such as narrowness and/or safety issues As in the Rhondo Pond to Jones Road alternative, the existing DNR ditch would need to be regraded for use in this alternative. The portion along Williams Pipeline could be a ditch, except where it crosses Littlerock Road. It would then be more feasible to continue the pipe from this point to Fish Trap Creek (rather than switch back to a ditch). The distance of the Rhondo Pond to Fish Trap Creek Alternative that could be ditch is appropriately 4,750 feet; pipe would be needed for an extent of approximately 5,190 feet. The minimum slope of this alternative is less than 0.0015. A 36" pipe could carry a flow of 20 cfs of water at this slope.

One area of concern for this alternative is that some ditches would be very deep (up to 15 feet). If a combination of ditch and pipe were used, this feasibility-level cost for this alternative would be approximately $1,300,000. If only pipe were used, the feasibility-level costs for the Rhondo Pond to Fish Trap Creek Alternative would be approximately $1,900,000.

Summary of modeling results for Rhondo Pond to Fishtrap Creek

Modeled decrease in flood levels with Rhondo Pond to Fishtrap Creek alternative (in feet)* 					Approx. cost per acre 	
Monitoring location (See map, Figure 6-1)	Subbasin	1999 flood level (feet) **	Level with alternative (feet)	Decrease in level (feet)	Total cost (millions)	$1.3-$1.9
1	SC9 West near 93rd Ave SW	175.7	175.0	0.7	Approx. acres benefited	480
2	SC9 West upstream	176.0	175.5	0.5	Cost per acre	$2708-$3958
3	SC9 North	182.0	180.2	1.8		
4	Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW	183.2	178.8	4.4		
5	Hickman Sub-Area Drainage Improvement Project upstream	183.9	182.9	1.0		
6	SC10	185.2	183.7	1.5		
7	SC11 - Rhondo Pond	186.2	185.3	0.9		

* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

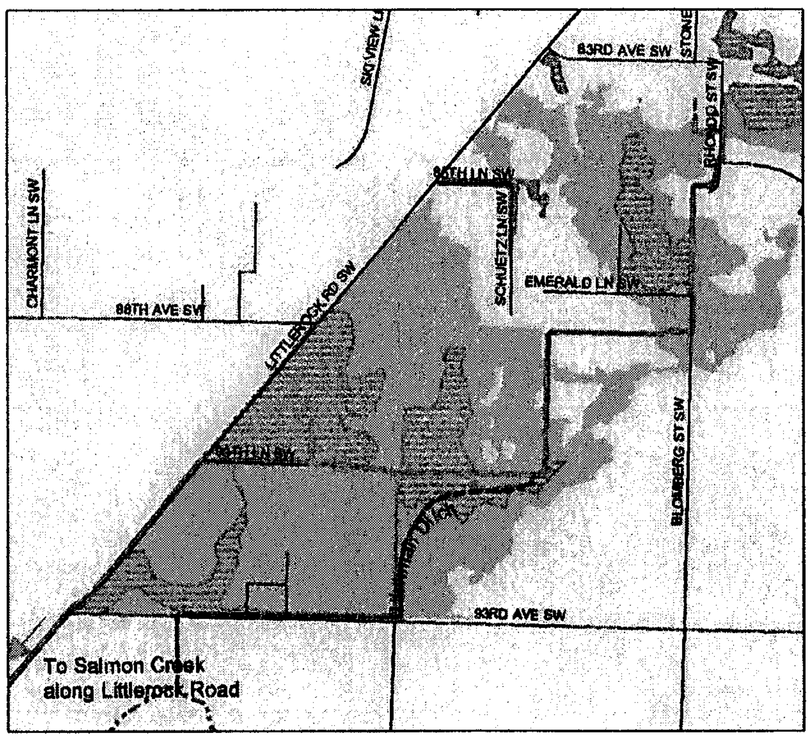
** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

6.1.2 Rhondo Pond to Littlerock Road 1 (West Basin)

The *Rhondo Pond to Littlerock Road 1* alternative would start at Rhondo Pond, head south to the existing DNR ditch, and west along the Williams Pipeline. Upon reaching Littlerock Road, it would turn south and run parallel to Littlerock Road all the way to its discharge at Salmon Creek.

This alternative could be constructed with either a combination of both pipe and ditch, or just pipe. The route segments that might be appropriate for pipe are along Rhondo Road, and along Littlerock Road. This length of pipe is approximately 11,320 feet. The portions that could be ditch are approximately 5,140 feet. Again, the existing DNR ditch must be regraded if it is used for this alternative. The minimum slope is less than 0.0013 feet per foot. A 36" pipe could carry 20 cfs of water at this slope.

If a combination of ditch and pipe were used, this alternative would have a feasibility-level cost of approximately $3,000,000. If only pipe were used, it would cost approximately $3,600,000.



The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the Rhondo Pond to Littlerock Road 1 alternative, see Figure 6-2, Appendix E.

Summary of modeling results for Rhondo Pond to Littlerock Road 1

Modeled decrease in flood levels with Rhondo Pond to Littlerock Road 1 alternative (in feet)* 					Approx. cost per acre 	
Monitoring location (See map, Figure 6-2)	Subbasin	1999 flood level (feet) **	Level with alternative (feet)	Decrease in level (feet)	Total cost (millions)	$3-$3.6
1	SC9 West near 93rd Ave SW	175.7	174.7	1.0	Approx. acres benefited	479
2	SC9 West upstream	176.0	175.5	0.5	Cost per acre	$6263-$7515
3	SC9 North	182.0	180.6	1.4		
4	Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW	183.2	178.8	4.4		
5	Hickman Sub-Area Drainage Improvement Project upstream	183.9	182.7	1.2		
6	SC10	185.2	183.7	1.5		
7	SC11 - Rhondo Pond	186.2	185.3	0.9		

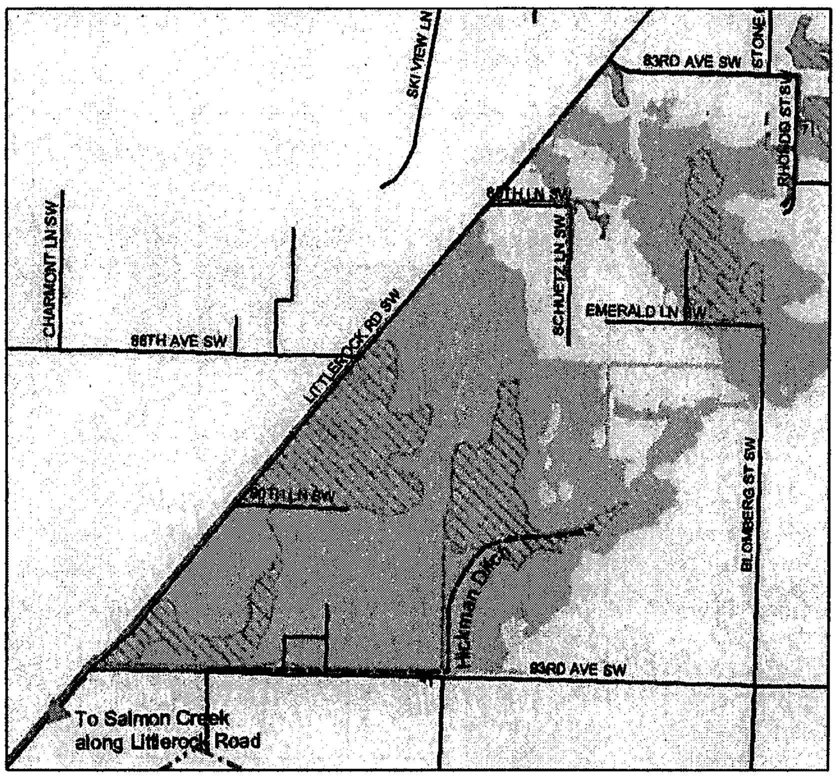
* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

** Existing = Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

6.1.3 Rhondo Pond to Littlerock Road 2 (West Basin)

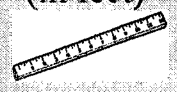
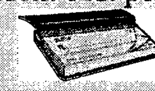
The *Rhondo Pond to Littlerock Road 2* option consists of a proposed drainage structure that is aligned north along Rhondo Street. The project would capture flow from both Rhondo Pond and the western side of Rhondo St. The pipe would proceed west along 83rd Avenue, and southwest on Littlerock Road. After capturing some flow from a pipe along 93rd Avenue, it would continue down Littlerock Road to empty into Salmon Creek. Because the majority of the pipe route would be along a road right-of-way, a ditch would not be feasible (due to safety issues and narrowness of right-of-way), and piping should be considered. There would be a total of approximately 17,000 feet of 36" pipe. The minimum slope occurs along Littlerock Road from the Williams Pipeline to Salmon Creek. Because the drainage pipe must be 2 feet below the Williams Pipeline invert, the slope along this stretch is limited. This minimum slope is less than approximately 0.1% or 0.001 feet per foot. A 36" pipe could carry approximately 20 cubic feet per second (cfs) of water at this slope.

The main concern regarding the *Rhondo Pond to Littlerock Road 2* alternative is the most northerly section of pipe along Rhondo Street. Approximately 1,000 ft long, it would feature a shallow cover of only 1 to 3 feet at this location. The feasibility-level cost for this alternative is approximately $4,400,000, the highest of any structural alternative. As in other structural alternatives, the overall cost of this option is directly related to the extent of water conveyance structures (pipes or ditches) proposed for the alternative.



The image above represents a portion of a larger map that features the entire Salmon Creek Basin, along with a legend. For the full map of the Rhondo Pond to Littlerock Road 2 alternative, see Figure 6-3, Appendix E.

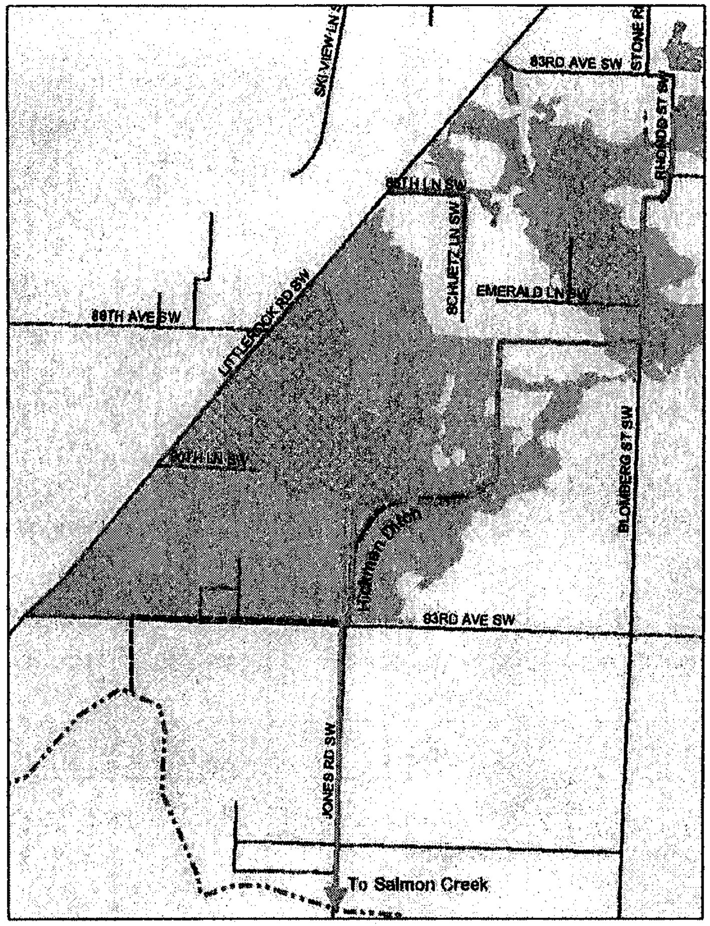
Summary of modeling results for Rhondo Pond to Littlerock Road 2

Modeled decrease in flood levels with Rhondo Pond to Littlerock Road 2 alternative (in feet)* 					Approx. cost per acre 	
Monitoring location (See map, Figure 6-3)	Subbasin	1999 flood level (feet)**	Level with alternative (feet)	Decrease in level (feet)	Total cost (millions)	$4.4
1	SC9 West near 93rd Ave SW	175.7	174.7	1.0	Approx. acres benefited	480
2	SC9 West upstream	176.0	175.5	0.5	Cost per acre	$9,166
3	SC9 North	182.0	180.6	1.4		
4	Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW	183.2	179.0	4.2		
5	Hickman Sub-Area Drainage Improvement Project upstream	183.9	182.8	1.1		
6	SC10	185.2	183.7	1.5		
7	SC11 - Rhondo Pond	186.2	185.3	0.9		

* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

6.1.4 Rhondo Pond to Jones Road (West Basin)



The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the Rhondo Pond to Jones Road alternative see Figure 6-4, Appendix E.

The pipeline route proposed under the *Rhondo to Jones Road* alternative begins at Rhondo Pond and runs south along Rhondo Street. After picking up flow from both Rhondo Pond and the western side of Rhondo Street, the pipeline would continue to the end of Rhondo Street and cross onto private land. It would then continue south and enter the current DNR ditch. The project would run west, then south in the DNR ditch, and subsequently connect to the Hickman Drainage Improvement Project. Drainage in this ditch flows to the west, and south to the existing junction box at 93rd Avenue and Jones Road. From here, the project would proceed south along Jones Road finally discharging into Salmon Creek.

This alternative could use a combination of pipe and ditch, or drainage could be accomplished using all pipes. Portions of the *Rhondo to Jones Road* option that run along roads (such as Rhondo and Jones Road) would have to be piped. The length of these portions is approximately 5,280 feet of 36" pipe. The current DNR and County ditches may be used for drainage; however, they must be regraded in order to provide enough slope. The approximate length of these ditches is 5,000 feet.

The minimum slope of this alternative is less than 0.0005 feet per foot. This is constrained by a limited drop of only 2 feet between Rhondo Pond and the existing junction box at 93rd Avenue and Jones Road. A 36" pipe could carry 11 cfs at this slope. Right-of-way constraints (guard rail/safety issues and narrowness of right-of-way) prohibit the further use of a ditch to increase conveyance.

There are two areas of concern for this alternative. First, the pipe in the north end (approximately 2,000 feet) would be very shallow. Because of the limitations of the survey data, it is not clear whether or not the pipe would be below ground. Second, an inverted siphon was assumed to be necessary to accommodate flow below the Williams Pipeline. Siphons are passive devices that move water from higher to lower elevations and back using a combination of atmospheric pressure and the weight of the water. With an inverted siphon it would be possible to direct water flow under the Williams Pipeline without losing the necessary slope on the pipe to keep it free draining. Initial cost and limited ongoing maintenance to remove debris are the primary constraints to the use of siphons.

If a combination of pipe and regrading of existing ditches were used, this alternative would cost approximately $1,500,000. If piping were used for the entire system, the cost would rise to approximately $2,100,000. Furthermore, the costs to acquire fee simple property or obtain easement for the portions of this alternative that cross private property were not included in the cost.

Summary of modeling results for Rhondo Pond to Jones Road

Modeled decrease in flood levels with Rhondo Pond to Jones Road alternative (in feet)*				
Monitoring location (see map, Figure 6-4)	Subbasin	1999 flood level (feet)**	Level with alternative (feet)	Decrease in level (feet)
1	SC9 West near 93rd Ave SW	175.7	175.6	.10
2	SC9 West upstream	176.0	176.0	0.0
3	SC9 North	182.0	182.0	0.0
4	Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW	183.2	179.5	3.7
5	Hickman Sub-Area Drainage Improvement Project upstream	183.9	182.9	1.0
6	SC10	185.2	184.5	.7
7	SC11 - Rhondo Pond	186.2	185.2	1.0

Approx. cost per acre	
Total cost (millions)	$1.4-$2.0
Approx. acres benefited	478
Cost per acre	$2928-$4184

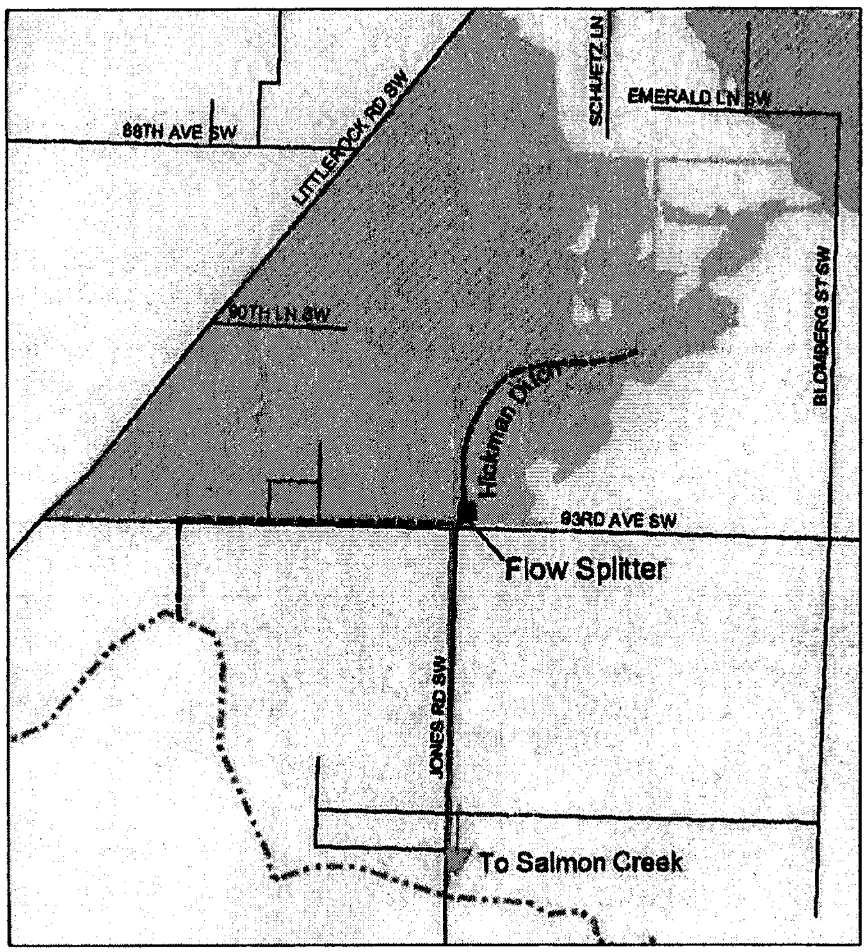
* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

6.1.5 93rd to Jones Road (West Basin)

The *93rd to Jones Road* alternative would include a pipeline beginning at an existing junction box at 93rd Avenue and Jones Road. The pipe would then run south along Jones Road SW to Salmon Creek. This option assumes that the Hickman Sub-Area Drainage Improvement Project would remain open, therefore increasing overall conveyance of floodwater.

This alternative would require piping. The proposed pipe route is along roads, and therefore a ditch would not be feasible due to safety issues and the narrowness of the right-of-way. There would be a total of approximately 2,540 feet of 36" pipe proposed in this option. The slope in this area is less than approximately 0.1% or 0.001 feet per foot. A 36" pipe could carry approximately 16 cfs at this slope. The feasibility level cost for this alternative is approximately $650,000.



The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the 93rd to Jones Road alternative, see Figure 6-5, Appendix E.

Summary of modeling results for 93rd to Jones Road

Modeled decrease in flood levels with 93rd to Jones Road alternative (in feet)* 					Approx. cost per acre 	
Monitoring location (See map, Figure 6-5)	Subbasin	1999 flood level (feet)**	Level with alternative (feet)	Decrease in level (feet)	Total cost (millions)	$0.7
1	SC9 West near 93rd Ave SW	175.7	175.6	.10	Approx. acres benefited	272
2	SC9 West upstream	176.0	176.0	0.0	Cost per acre	$2,574
3	SC9 North	182.0	182.0	0.0		
4	Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW	183.2	179.7	3.5		
5	Hickman Sub-Area Drainage Improvement Project upstream	183.9	183.8	0.1		
6	SC10	185.2	185.2	0.0		
7	SC11 - Rhondo Pond	186.2	186.2	0.0		

* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

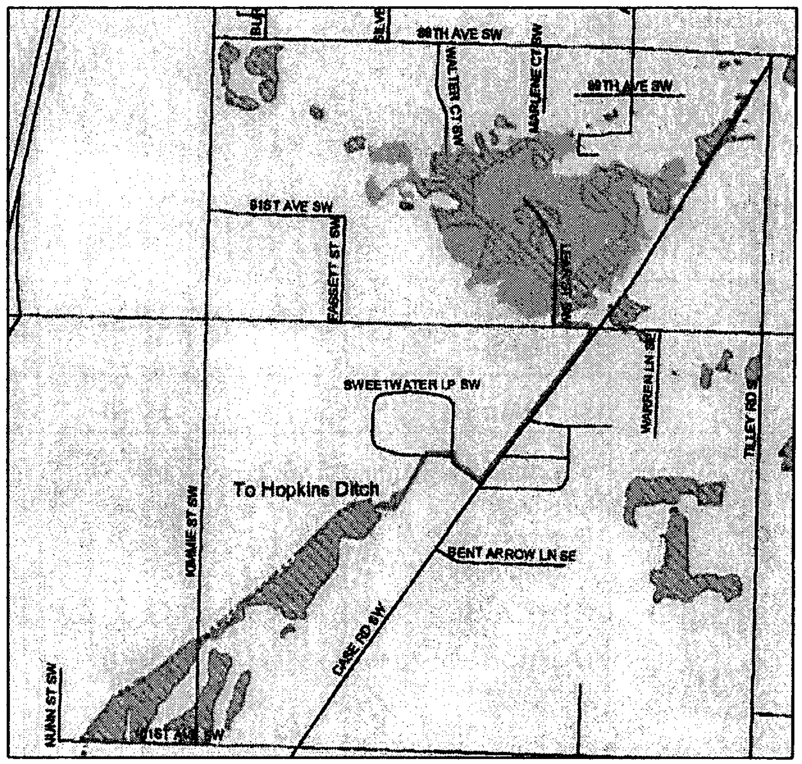
** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

6.1.6 East Basin Alternative (East Basin)

The *East Basin* alternative (EBA) would begin on Lear Street, head south, and continue east on 93rd Avenue. From there would travel south again on Case Road. The route would then proceed north and west on Sweetwater Loop and discharge at Hopkins Ditch.

Pipe would be the most economically feasible option for this alternative as it is along a road right-of-way. There would be a total of approximately 3,270 feet of 24" pipe. In one area, it appears the pipe would not be deep enough to go under a road, so a siphon would be needed. The slope is less than 0.001. A 24" pipe could carry a flow of 6 cfs at this slope. This alternative would cost approximately $700,000, which includes the cost of the siphon.

During examination of the EBA site, the brush-choked state of the downstream channel was noted. Consideration to clearing the brush in the Hopkins Ditch was proposed as an addition to the EBA to accelerate flood flows leaving the East Basin by reducing channel roughness. The channel clearing would begin at the end of a cul-de-sac just south of Sweetwater Loop Lane in a tributary that flows southwest to Hopkins Ditch. The ditch clearing would continue in Hopkins Ditch from where the tributary enters the ditch, near 103rd Lane, flowing westward beneath I-5 until Jones Road.



The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the East Basin alternative, see Figure 6-6, Appendix E.

After clearing the existing brush, which is predominantly reed canary grass, an herbicide approved for the aquatic environment would be applied to prevent immediate return growth. Additionally, conifers would be planted on both sides of the stream channel. When mature in 7-10 years, these trees should shade the channel and inhibit further shrubby growth, thus maintaining the higher flow velocities. The stream channel in this alternative would be approximately 14,500 feet long and average 28 feet wide. There would be about 9.4 acres of clearing, 5.6 acres of hydroseeding (the stream channel itself would be left bare), 2,600 trees planted and mulched, and three years of irrigation and plant maintenance provided.

The addition of brush clearing and channel planting is estimated to cost approximately $1.2 million, which does not include property acquisition costs. The clearing was modeled as a separate analysis. Model results show a 0.1-foot decrease in flood heights in the Walter Court area and approximately 0.5-foot decrease at Jones Road.

Summary of modeling results for East Basin Alternative

Modeled decrease in flood levels with East Basin option (in feet)*				
Monitoring location (see map, Figure 6-6)	Subbasin	1999 flood level (feet)**	Level with alternative + Hopkins clearing (feet)	Decrease in level with alternative + clearing (feet)
N/A	SC13 Walter Court area (1999=192.3)	192.3	191.1	1.2

Approx. cost per acre for East Basin Alternative 	
	East Basin alternative (with Hopkins clearing)
Total cost (millions)	$1.9
Approx. acres benefited	40.7 acres
Cost per acre	$46,700 per acre

6.2 RANKING OF CONVEYANCE ALTERNATIVES

Each modeled alternative was assigned an overall rank as shown in Table 6-1. The rank is based on each project's predicted success in reducing the area of flooding within its service area, as determined through the modeling process. (The ranking is not meant to offer a possible sequence of action, because, in the west basin, the projects were evaluated independently. For example, it would not make sense to construct several projects all having pipes and ditches exiting the Rhondo Pond area and traveling along different routes.)

Linear interpolation between two-foot contours was used to assess flood levels. This method is used for comparison purposes, however, as discussed in Chapter 5, Section 5.6, because of the lack of more detailed topographic information, it will not yield accurate results with the level topography present in the basin. The percentages shown in Table 6-1 are only for rough comparison among alternatives.

Table 6-1 Comparison Of Conveyance Alternatives For Salmon Creek Basin

West Basin Alternatives			
Proposed Structural Alternative[1]	**Total Cost[2] (millions)**	**Effectiveness (% Flood Reduction)[3]**	**Overall Rank**
Rhondo Pond to Littlerock 2	$4.4	52	3
93rd to Jones Road	$0.7	8	5
Rhondo Pond to Jones Road	$1.4 - $2.0	43	4
Rhondo Pond to Littlerock 1	$3 - $3.6	52	2
Rhondo Pond to Fishtrap Creek	$1.3-1.9	55	1
East Basin Alternatives			
Proposed Structural Alternative	**Total Cost (millions)**	**Effectiveness (% Flood Reduction)[3]**	**Overall Rank**
East Basin Alternative (includes Hopkins Ditch Clearing)	$1.9	62	1 of 1

1 All Alternatives assume that Hickman Sub-Area Drainage Improvement Project remains in place and continues to be maintained.

2 Routes follow public right-of-ways where possible. Where private land is involved, land acquisition costs were not included in this estimate.

3 Based on 2-foot contour interval topographic data – rough approximation for planning purposes, see text Section 3.6.

Source: URS Tech Memo, 2002b

6.3 THE NO ACTION ALTERNATIVE

In Phase I of this basin planning process, a hydrologic model was created to simulate flows in Salmon Creek Basin, and to create a "Depth to Water" map indicating how high water tables rose during the 1999 flooding. The modeling and historic observations indicate that Salmon Creek Drainage Basin is prone to flooding and will likely experience flooding again. Under the No Action Alternative, no conveyance options would be constructed to lower flood elevations for existing properties. According to the County's maps, 1999 flood levels were as follows:

Subbasin	1999 flood stage (in feet)
SC9 West near 93rd Ave SW	175.7
SC9 West upstream	176.0
SC9 North	182.0
Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW	183.2
Hickman Sub-Area Drainage Improvement Project upstream	183.9
SC10	185.2
SC11 - Rhondo Pond	186.2
SC13 Walter Court area	192.3

In 1999, Thurston County constructed the Hickman Sub-Area Improvement Project to help lower flood stages in the west basin. Figure 6-7, Appendix E, shows the approximate area that is expected to benefit from the Hickman Project during a future flooding event similar to 1999, assuming that the Hickman project and perpetual easements are in place.

Moreover, Salmon Creek Drainage Basin still faces the possibility of worse flooding than was observed in 1999.

The estimated cost of the No Action Alternative to Thurston County is minimal: Thurston County would incur costs associated with any damage to public property in the future. The cost to private property owners would continue, and would vary based on site-specific conditions.

6.4 MODEL LIMITATIONS

The accuracy of the model results depends on the accuracy of the input data. As discussed previously, all topographic information is based on a GIS layer with a 2-foot-contour interval. All of the alternatives were compared using the same topographic data hence the results should be representative of the differences among alternatives.

The level of analysis is preliminary and intended to support development of the Basin Plan. The pipe and channel design inverts used in this feasibility-level analysis would need to be refined during the pre-design and design phases, when better field information is available.

6.5 FEASIBILITY

6.5.1 Technical Feasibility

As a basis for cost estimating, all of the alternatives use conventional and consistent construction methodologies and materials. The only deviation from normal standards is the use of extremely flat pipe invert slopes, generally flatter than 0.0015 feet/foot. Because of the relatively flat topography throughout the entire project area, these flat gradients are necessary. Even though a pipeline cannot be constructed to exact design elevations with such flat slopes, performance will not be reduced, as long as the pipe is installed at a flatter gradient (overall) than the design slope. (The pipes were designed to flow full at this level of design.)

6.5.2 Regulatory Feasibility

Regardless of the selected alternatives, a project will be subject to the full range of regulatory processes. In Thurston County, the Joint Aquatic Resource Permit Application (JARPA) will often require a State Environmental Policy Act determination (SEPA). Permits may be required from:

- Washington Department of Fish Wildlife – Hydraulic Project Approval
- Department of Ecology – Groundwater and water quality
- Department of Natural Resources – Discharge into waters of the State
- US Army Corps of Engineers, 404 permit
- National Oceanic Marine Fisheries, ESA, Section 7 Consultation

The SEPA process would solicit comments from the public and state and federal agencies that could adversely affect permit feasibility of any of the alternatives. There are some concerns that may require special measures to mitigate or prevent environmental impacts or special studies to demonstrate that there will be no significant, unmitigated, adverse environmental impacts. These include:

- Water quality;
- Depletion of base stream flows;
- Impacts to existing wetlands; and
- Water rights.

Endangered Species

At the time this publication went to press, there were no listed threatened or endangered species in Salmon Creek Basin that warrant statutory protection under the Federal Endangered Species Act (ESA). However, Coho Salmon are classified as a candidate species, meaning that the species could warrant listing at some point in the future. While there are no mandatory federal protections under the ESA for candidate species, NOAA Fisheries urges voluntary protection of candidate species.

The Olympic Mud Minnow and the Peregrine Falcon, both found in Salmon Creek Basin, are listed on the State's Priority Habitat and Species List as State Sensitive Species, defined as "any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of a threat." State sensitive species are not covered under any statutory protections. Conservation is strongly encouraged and project proponents should take into account the species habitat, and life history. The Mazama (Western) Pocket Gopher, also found in the basin, is listed as a State Candidate Species.

The Oregon Spotted Frog is listed on the State's Priority Habitat and Species List as a State Endangered Species, however, while populations have been found in the Black River drainage (Dempsey Creek area), none have been found in Salmon Creek Basin. It is possible that Oregon Spotted Frog habitat may exist in the basin.

No rare plants on the Washington State Heritage list have been found in Salmon Creek Basin.

Since there are no federal endangered or threatened species, consultation with agencies under the endangered species act would not be required. However, federal and state regulatory agencies would have the opportunity to comment on projects during the JARPA and SEPA review process. Voluntary pre-project consultation could save project proponents time and money during the permitting process.

Finally, a change in a species listing status could occur at any time that new data warrants additional protections. Project proponents should check the most current federal and state endangered species list prior to initiating projects.

Black River Total Maximum Daily Load (TMDL) Studies

Concerns for water quality in the Black River Basin began in 1989 when a large fish kill was discovered around river mile 7.1 at the Moon Road Bridge (Ecology, 1989). This discovery led to follow-up water quality monitoring efforts.

In a 1991 screening survey of the Chehalis River Basin, Ecology discovered, "the Black River Basin had one of the most notable fecal coliform problems of any subbasin (within the Chehalis

Basin)" (Ecology 1992). As a result of these preliminary studies, Ecology performed two Total Maximum Daily Load (TMDL) Studies on the Black River in 1994, a wet season TMDL and a dry season TMDL. During the dry season TMDL study, water quality violations were not observed at the Salmon Creek sampling site at Creekwood Drive. The same was true for the wet season TMDL, when the Black River was sampled downstream of Salmon Creek at the Black River Bridge at 110th. Despite the relatively good water quality in and around the vicinity of Salmon Creek's discharge to the Black River, Ecology found that seven of the ten Black River segments established in the studies will require fecal coliform load reductions to meet proposed load allocations. To meet overall water quality requirements for the Black River Basin, the segment from 110th to River Road will be required to reduce fecal coliform loads by up to 6%. (This load reduction is required under the EPA-approved TMDL process.) Thus, any drainage project that proposes to send floodwaters into Salmon Creek, and therefore ultimately into Black River Basin, would likely face regulatory difficulties because of the possibility that fecal coliform bacteria from failing septic systems or animals would be transported in the water.

6.6 CONCEPTUAL ANALYSIS

6.6.1 Horizontal Directional Drilling

As work on this basin plan progressed, a very conceptual alternative for reducing the groundwater levels in the west basin was assessed. This concept involved using trenchless technology or horizontal direct drilling (HDD) techniques to install slotted stainless steel pipe or perforated pipe. The intent of installing slotted or perforated pipe would be to pre-emptively dewater or lower the water table.

Though the Stakeholders Committee initially screened out preemptive dewatering measures, the HDD concept was advanced since the effectiveness of the other previously discussed alternatives was less than hoped for. As a result, URS Corp. was requested to provide a conceptual analysis of the HDD approach.

A HDD pipe route was selected for illustrative purposes. This route would generally begin somewhere in the vicinity of Fish Trap Creek and extend along the Williams Pipeline construction right-of-way (ROW) to a point east of Littlerock Road. Other means of site drainage at the intersection of the DNR ditch and the Williams ROW would connect at the ground surface (See Appendix E, Rhondo Pond to Fish Trap Creek).

In order to determine the potential effectiveness of the HDD alternative, URS had to make some very gross assumptions. These assumptions included: (1) The area would experience 60 inches of average precipitation (net infiltration) over a 6-month period; (2) Two 12-inch slotted or perforated pipelines would be installed; (3) The average transmissivity of the underlying sands and gravels would be180 feet per day; and (4) A depth to the till aquitard (a layer that retards groundwater movement) would be 25 feet below the ground surface on average.

In a technical memorandum, conceptual calculations indicated that the HDD alternative may achieve a draw down of groundwater between 0.5 to 1.3 feet at the mid-point between the Williams Pipeline construction ROW and 93rd Avenue. Using the above assumptions along with the modeling results of the other basin conveyance alternatives, URS indicated, "it appears likely that groundwater levels in 1999 would not have reached the ground surface in the area surrounding the Williams Pipeline and 93rd Avenue had such a system been in place".

URS further indicated that for a more accurate assessment of any pre-emptive alternative (HDD) in dewatering flooded areas, additional scientific analysis would be necessary to determine more accurately its effectiveness. The HDD alternative cannot be modeled using the same hydrological and hydraulic principles used in assessing conventional conveyance alternatives, such those as proposed for the west basin. Therefore, a direct comparison of the estimated reduction in flood levels at the ground surface due to the 1999 spring season should not be made.

An independent third party (Brown and Caldwell) retained to provide technical assistance and review of the basin plan offered additional recommendations on the suitability of the HDD alternative. Brown and Caldwell pointed out many of the technical and environmental challenges associated with such construction techniques.

The current HDD construction techniques may be limited in their application and suitability for installing slotted or perforated pipes as a cost-effective, pre-emptive dewatering alternative. The equipment used in HDD construction consists of a large drill rig, which advances a drill bit horizontally in the earth's surface. When advancing, the drill bit may be subjected to hidden objects, which cause unintended deflections, and in severe cases, may result in multiple drilling attempts in order to advance the drill bit. This can result in unacceptable outcomes when attempting to achieve specific horizontal locations and grades. When large diameter pipes are used, the risk associated with deflections increases. Construction techniques are therefore considered risky for large diameter pipe installation in areas of geologic uncertainly (glaciated areas), and may not be favorable for project cost-containment.

Lubricants are also necessary to advance the drill bit. Some of these lubricants can effectively seal or otherwise limit the capture of groundwater by clogging perforations and surrounding soil openings.

Construction costs can also be proportionate to the diameter pipe used. Brown and Caldwell indicated that the two 12-inch slotted pipes suggested might have a very localized, unquanitified effect in lowering the groundwater table. Further, additional scientific study would be required to determine effective pipe sizes, as well as to assess the performance and determine the extent to which the underground perforated pipes would alleviate flooding at the ground surface during the spring 1999 conditions.

Aside from the construction costs, HDD (or other pre-emptive dewatering) alternatives may pose environmental and regulatory challenges. For example, groundwater would be withdrawn from the upper soil mantle at artificial rates. By decreasing groundwater levels, there can be an adverse impact to down gradient wetlands, streams, shallow wells, and other surface water bodies. Removal of groundwater from the upper aquifer may also have unintended affects on the deeper aquifer, which is used to supply area drinking water.

These environmental challenges could potentially be addressed by designing a special valve to limit pipe flow during dry periods and address regulatory challenges. However, additional scientific study would be required to determine the extent and potential environmental effects and address any regulatory concerns.

6.7 CONCLUSION

All conveyance alternatives would provide limited flood relief in localized areas. In a given alternative's service area, the onset of flooding would be delayed; the duration of flooding would be reduced; and in areas where flooding still occurred, the depth of flooding would be reduced. However, even in the best cases, groundwater elevations would likely remain at or just below the surface, thus affecting septic systems, contaminating domestic wells, and preventing the infiltration of stormwater runoff from existing development.

Of the six conveyance alternatives evaluated in detail, one was found to be the most feasible and potentially effective: the Rhondo Pond to Fishtrap Creek Alternative on the west side of Salmon Creek Basin. The East Basin Alternative was found to carry a high cost-per-acre with much of the benefits occurring on undeveloped land.

Related recommendations

☛ Thurston County should incorporate the Rhondo Pond to Fishtrap Creek Alternative into the Storm and Surface Water Utility's long term (20-year) Capital Facilities Plan, which annually determines project priorities based on uniformly applied criteria.

☛ Thurston County should not pursue a conveyance project for the East Basin at this time due to the estimated costs, and benefits afforded, based on the results of this study. Instead, the County should seek funding sources to flood-proof or purchase homes in high groundwater areas.

See Chapter 7 for details