Enclosure #6

APPENDIX A

SUMMARY REPORT FOR D E.I.S.

Hydraulic Investigations:

Cascade Mall at Burlington

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General

A shopping mall is proposed in Burlington between Garl Street and Highway I-5 between Gages Slough and the drive in theater. The property owners requested that John Norman investigate the impact of the proposed mall on adjacent properties. The impacts were evaluated and suggestions were made on ways to minimize the impacts by changing the building layout and reducing the amount of fill to be imported to the project. These suggestions were incorporated by the owner and by the architect into the project design. This report discusses the alternative that is proposed in the E.I.S.

Summary

When flows reach about 150,000 cfs (approximately 50 year flood event) at Burlington, the water spills out into the overbank area. The water flows into Gages Slough and, during higher flows, into Burlington. For the 100 year flood, water surface elevations at the mall site would increase 0.05 feet at the site and 0.02 feet just upstream of the site. Flood water velocities would increase at the site. Storm water runoff would be retained on the site for a 25 year storm and released into Gages Slough at a slower rate than storm water now runs off the site. The water would go through an oil separator prior to discharge into the slough.

Ground Water

The ground water elevations as reported by Converse, Ward, Davis, Dixon, Geotechnical Consultants on November 11, 1980 varied from an

elevation of 13.5 feet adjacent to Gages Slough to 16.5 feet near the north property line of the proposed project. The near surface soils at the project site are fine grained river deposits consisting of sandy silt and silty sand. These soils are fairly slow draining. The existing storm water presently runs off the project into Gages Slough and a small portion is absorbed into the soils surcharging the ground water. The ground water levels are influenced by the amount of precipitation and the surface water levels in Gages Slough. The proposed project will result in very little surface water from the site going into the ground water. The surface water will be controlled on site and discharged at a slow rate through oil reseparating systems so that the water quality in Gages Slough can be maintained. The major portion of the project area will be covered with either buildings or asphalt parking lots and access roads. These are impermeable and would not allow surface water to enter the ground water. As a result, ground water quality would not be affected. However, surface waters on the site would no longer surcharge the ground water on the site. Ground water would have to be surcharged from adjacent properties and from Gages Slough.

Hydrology

The flood plain information study titled, "Skagit River Basin, Washington," dated July 1966 and 1967 by the U.S. Army Corps of Engineers states that the present levee system downstream from Sedro Woolley has been able to withstand a flood of approximately 150,000 cfs per second as measured at Mount Vernon. The subject was later

investigated by the Seattle District Corps of Engineers in a report titled, "Skagit River, Washington: General Design Memorandum, Levee Improvements," dated July 1979 providing additional data on existing hydrology of the drainage basin. The Skagit River drainage basin is 3,093 square miles near Mount Vernon at river mile 16. The largest discharge reported on the Skagit River near Mount Vernon was 180,000 cfs and it occurred on November 16, 1906. The second highest flood was 144,000 cfs and it occurred on February 10, 1951. It should be noted that in 1951 upstream regulation was in effect at Ross Dam. The capacity of Ross Dam was increased by 120,000 acre feet of flood storage in 1953 and upper Baker Dam provided additional water storage capacity in 1959. The Corps conducted extensive hydrology studies to estimate discharges of the Skagit River near Mount Vernon. The estimated discharges for the 100 year event were 220,000 cfs and for the 25 year event approximately 163,000 cfs. This compares with 266,000 cfs at Burlington reported in the 1967 Corps study. The Corps further reported that nearly the entire runoff from the town of Burlington drains into Gages Slough. A gravity drain connects Gages Slough with the Skagit River and a flapgate prevents backflooding during high Skagit River stages. Precipitation reported for a 6 hour storm with a recurrence interval of 100 years was 2.0 inches; for a 24 hour storm, 3.7 inches. For this investigation the Corps supplemented previous steady state flow models for determining water surface elevations with an unsteady flow model which in addition to determining water surface elevations routes the water through the drainage system.

This model was calibrated based on the observed water surface data for the 1975 flood. This flood had a peak discharge 130,000 cfs at the Mount Vernon gage and a recurrence interval of 12 years. The Corps report states that the highway fill for I-5 acts like a dam, dividing the valley and backing the water up until it flows over the highway embankment thus impeding the overflow from the Skagit River. The Corps of Engineers' April 1967 study titled, "Flood Plain Information Studies: Skagit River, Washington" determined the flood plain heights in a slightly different way than the unsteady state model. The 1967 model separated the overbank flow in the lower reaches from the flow in the river. The 1967 study assumed that the maximum flow that could be in the river would be 150,000 cfs and the remaining water would flow in the overbank. A portion would flow between Sterling Hill and Burlington Hill into the Samish River basin. The other portion would flow through Burlington from river mile 19.48 flowing between the bridge and hill and the river to the southeast. This flow would continue on past Bayview Ridge toward the Swinomish Channel. The Corps of Engineers updated the flood insurance study in December 1980. At the project's site all of the various studies completed in the past show 100 year flood elevations of 31.8 feet on the west side of the project adjacent to I-5 rising to 33 feet on the east side of the project just east of Garl Street. The reason for this consistency, in my opinion, is that very little of the water is going into overbank storage compared to the total amount of overbank storage just downstream of I-5 onto Swinomish Channel and Padilla Bay. The Corps of

Engineers' 1967 investigation for the 100 year flood indicated 275,000 cfs at Sedro Woolley and 266,000 cfs at the north edge of Burlington. 150,000 cfs were assumed to be contained in the channel, 53,000 cfs flowed over the overbank into the Samish basin and 63,000 cfs were assumed to flow from Burlington Hill, through Burlington and on past the south side of Bayview Ridge on into the Swinomish Channel and Padilla Bay area. The proposed Cascade Mall lies within the overbank where these latter flows flow through Burlington and Gages Slough on into the Swinomish Channel and Padilla Bay. Computations were made in this investigation to compare hydrographs presented in the Corps' 1967 investigations to determine overbank storage. These investigations were conducted by taking the hydrographs presented by the Corps of Engineers in their 1967 study and placing, over time, water into storage and allowing part of the water to flow into the Swinomish Channel and Padilla Bay. The amount of water flowing on through depended upon water depths in the overbank areas. This reduced the discharges at the study area from 63,000 to 61,000 at the project site. This minor reduction was because of shallow water depths causing the water to flow on through the project site. I-5, which borders the project on the downstream side, acts as a dam with most of the water flowing over the highway. Downstream of I-5 the hydrograph is rapidly reduced by water going into overbank storage and not enough water is available to bring the water surface profiles up to the elevations indicated on the Corps' December 1980 flood plain study. This is based on a 266,000 cfs discharge at Mount

Vernon with only discharges in excess of 150,000 cfs going into overbank storage. For a 1.3 day period it appears that approximately twice the volume of water would be required to maintain the water surface elevations given in the Corps report. This volume of water would be that above 150,000 cfs. This means that downstream of the project if the river hydrograph presented in 1967 reports occurred, the water surface elevations would be lower than indicated on the December 1, 1980 Corps' investigation. This does not affect the proposed Cascade Mall project site except that it demonstrates that if flood plain storage was removed from the proposed Cascade Mall site that it would not be significant because of the storage which is available downstream of the proposed site. It should be noted that if the flood plain was already full and you had a 100 year flood event that you would have flood elevations similar to those reported by the Corps.

Project Hydraulics

A steady state backwater model was used to determine the effect of proposed modifications to the project site on discharges, velocities, and on water surface elevations for 61,000 cfs flowing in the overbank between Burlington Hill and flowing westerly. Elevations on the proposed mall site for existing conditions varied from 31.8 adjacent to I-5 to 32.2 on the east side of the project. The water surface elevation just east of Garl Street was 34 feet. The Gages Slough crossing of Garl Street was designed to wash out during flood conditions. I concur that during 100 year flood conditions that Garl Street would wash out at Gages Slough and that was one basis for the

backwater model input. In the project area, the 61,000 cfs overbank flow is distributed approximately as follows: 20,000 cfs in the overbank between Gages Slough and the river, 14,000 cfs in Gages Slough, 12,000 cfs across the project site and the drive-in theater, and 8,000 cfs in the overbank area north of the drive-in theater. Average discharge velocities in Gages Slough under existing conditions would be 2.3 feet per second and across the project site 1.1 feet per second. The proposed project is designed to minimize obstruction to flood flows and to improve flow characteristics of Gages Slough. The mall floor area will be built up to an elevation of 34.0 feet and the fill would fall away from the building at a slope of 5% until it reaches the existing grade elevations. The overbank bank on the north bank of Gages Slough will be recontoured above its normal elevations. The minimum elevation would be 23.5 feet, which is 2 to 3 feet above the normal high water in Gages Slough. This will provide for better flow characteristics in the flood plain under flood conditions. The bottom of Gages Slough is at an approximate elevation of 16. Approximately 125,000 cubic yards of structural fill would be imported and, of this, 94,000 cubic yards would be placed below the 100 year flood level. 117,000 cubic yards of gravel would be imported for construction of subbase for parking areas and roads. After construction of the project, velocities across the project site would be increased from 1.1 feet per second to 1.4 feet per second and flows in Gages Slough would be increased from 2.3 feet per second to 2.6 feet per second. Velocities downstream and upstream of the project area

would remain as the existing condition. Water surface elevations below the site would remain the same. At the site they would increase .05 feet or just over 1/2 inch and upstream of the project .02 feet or 1/4 inch.

Storm Water Detention

The storm water up to the 25 year event would be stored in underground pipe and on the parking lot surface in the mall and discharged at approximately 1/3 the rate that the existing surface water runs off at the present time. The water would pass through an oil separator before discharging into Gages Slough. The 25 year event was selected to retain water because major flood events would not be expected to occur at the same time. This minimizes the amount of fill needed to provide for public safety in the shopping mall parking areas. The surface water ponding on the parking areas would be conveyed through catch basins underground to a controlled manhole which would control the discharge and provide for oil separation prior to discharge into Gages Slough.

Gages Slough

Gages Slough is a primary conveyor of storm water discharge from the Burlington and project area. The outlet of Gages Slough goes into the Skagit River and has a flap gate on it which cuts off discharges out of Gages Slough into the Skagit River during higher flows in the Skagit River. This results in local stormwater runoff backing up into Gages Slough during high flows in the Skagit River. At the present

time this backwater causes some flooding of properties along the slough. Mr. Nelson of the county offices has suggested the possibility of providing pumping stations at the downstream end of Gages Slough to lower water levels in the slough so that during high river discharges (although in my opinion, the mall project would not contribute to the problem in Gages Slough) flooding problems would be reduced. An investigation was made into the cost of providing such a system. One alternative would be to provide a submersible duplex pump system which would pump 5,000 gallons per minute. This would require a 15 HP pump. Another alternative would be to provide vertical turbine type pumps which would pump 7,200 gallons per minute using 25 HP motors. The first alternative has the advantage of not requiring a building above the ground level. The second alternative would have to have a building above the ground level. However, it would potentially have a lower first cost advantage and the equipment would be more dependable. In my opinion, installing a small duplex pumping station similar to the one described above would be a viable way to minimize flooding problems during most storms in the drainage area of Gages Slough.

Miscellaneous

Several questions have been asked concerning the affect of the mall proposal on hydraulics and related items.

Question: Will the fill cause greater flooding in adjacent and upstream properties?

Answer: The properties upstream of the project will have increased water levels of .02 feet.

Question: Will the slough be dredged?

Answer: The overbank portion north of the slough on the mall side will be excavated to increase the capacity to compensate for disruption by the buildings. This would be above the area in which water normally is conveyed.

Question: Will any fill be discharged near the slough?

Answer: All excavation will be in the dry and will not be discharged. It will be placed with earthmoving equipment and compacted. Provisions will be made to provide that sediments will not be washed into the slough during runoff during the construction period.

Question: Will there be any affect on ground water?

Answer: The buildings and the impervious parking areas and roads will reduce the area available for infiltrationn of water from the surface. This is not expected to significantly affect either the level or quality of the ground water.

Question: Will the impervious nature of the parking lot increase storm water runoff.

Answer: Storm water runoff will be retained on site in surface storage and in pipes and will be released at a slower rate than the existing conditions.

Question: What affect will the mall have on Gages Slough during 25 through 100 year floods?

Answer: 50 year and above floods exceed the capacity of the dikes of the Skagit River and would be expected to have overbank flow through Gages Slough. Provisions have been made so that the mall would not significantly obstruct or modify these flows. The 25 year flood would not be expected to affect the slough or the project site unless a rain storm occurred at the same time and the river was blocking the outlet of Gages Slough.

Question: What if the Skagit River changes course and links up with the slough?

Answer: During discharges of 150,000 cfs or greater it would be expected that the Skagit River would flow overbank through Gages Slough in addition to flowing down the main channel.

Question: What would be the impact of widening Garl Street on flood flows?

Answer: Widening Garl Street on flood flows would have no effect as long as the provision was retained for Garl Street to wash out at the Gages Slough crossing.

Question: Will a storm water management plan be prepared for the mall?

Answer: The mall design will include taking care of the storm water. The storm water outflow will be designed to be less than existing conditions.

Question: What will be the effect of storm water runoff on the slough?

Answer: Storm water runoff, under existing conditions, has some sediments washing from the agricultural land that is adjacent to the slough. With the proposal in place these sediments will no longer enter the slough. An oil/grease separator will be provided to minimize the effects of oil from parking lots going into the slough.

Question: How will storm water runoff affect the ecosystem of the marsh?

Answer: The water quality at the discharge point is not expected to be detrimental.