

# Memorandum

To: Emily Derenne, Skagit County Public WorksFrom: Colin Butler, EIT, and Jeff Johnson, PE, Watershed Science & Engineering

Date: December 9, 2019

Re: Flow Obstruction Assessment on Edens Road

## INTRODUCTION

A section of Edens Road on Guemes Island passes through a wetland and is overtopped by water most of the winter. The road is an important transportation route on the island, and the County would like to reduce the flooding. The portion of the road that floods was raised by the County in 2010, but rising water levels in the wetland continue to inundate the road. Watershed Science & Engineering (WSE) was retained by Skagit County (County) to determine why water levels in the wetland have risen and to identify some alternatives to address the concern. WSE reviewed existing data and conducted a field inspection to identify the cause of the flooding. The results and conclusions of the investigation are presented below.

## **PROJECT BACKGROUND**

Edens Road is one of two connections between the eastern and western sides of Guemes Island, a small island in western Skagit County located approximately two miles north of Anacortes, WA. The other connection, South Shore Road, runs along the southern shoreline of the island and currently cannot be used by delivery trucks and other large vehicles because it is posted with a vehicle weight limit due to bluff erosion. These vehicles must use Edens Road to reach the eastern half of the island.

Flooding across Edens Road was temporarily alleviated in 2010 after the County raised the road 18 inches and installed two 18-inch corrugated polyethylene pipe (CPEP) culverts through the road fill, in addition to the culvert previously in place. However, since then, water levels in the wetland have continued to rise and once again overtop the raised roadway throughout the wet season. A comparison of 2006 aerial imagery in the Figure 1 location map to the 2018 aerial imagery in Figure 2 shows that wetland has expanded slightly since 2006 and that there is significantly more visible ponded water in 2018, especially in the southern half of the wetland near the inlet to Cayou Creek.

The current wetland that Edens Road passes through is approximately 4100 feet long and 1000 feet wide, occupying an area of almost 90 acres based on 2018 aerial imagery (Figure 2). It has a small outlet at its south end where it connects to Cayou Creek, which flows 1600 feet to the Guemes Channel. The wetland surface maintains a relatively constant elevation of approximately 27 feet between Edens Road and the outlet at Cayou Creek. Cayou Creek descends quickly through an incised channel before flowing through a culvert under South Shore Road to empty into Guemes Channel (Figure 3).

Figure 4 is an image from the north end of the wetland looking south, with the impacted section of Edens Road crossing through the center of the photo. Figure 5 is an image from the south end of the wetland looking north showing more visible ponding near the wetland outlet. Edens Road is not visible in this photo.



Figure 1 – Location map of Edens Road and the wetland basin on Guemes Island (2006 aerial)



Figure 2 – Location map of Edens Road and the wetland basin on Guemes Island (2018 aerial)



Figure 3 – Location map of Edens Road and the wetland basin with a LiDAR background





Figure 4 – View south from Edens Road toward the wetland outlet at Cayou Creek



Figure 5 – View north from the wetland outlet at Cayou Creek (Note: Edens Road is hidden by vegetation and not visible in this photo)



#### SITE INSPECTION AND ASSESMENT

WSE staff conducted a site inspection in June 2019 to assess the extent of flood impacts and to see if the cause of the flooding could be identified. WSE staff walked the section of Edens Road that passes through the wetland and observed ponding on either side of the pavement with some water covering a portion of the travel lanes (See Figure 6). No water was crossing the roadway, but there were obvious signs of sediment deposition from previous overtopping and the county had received service requests as late as May. There was an attempt to confirm the location of two 18-inch CPEP culverts installed when the road was raised in 2010, but they could not be found in the ponded water. The County has them mapped in the database by milepost (MP 0.152, 0.213, 0.214, and 0.571) with the road mileage running from Nootka Lane towards Section Avenue. The culverts at MP 0.213 and 0.214 were installed in 2010.



Figure 6 – Edge of pavement on the north side of Edens Road (looking east)



Following the Edens Road inspection, WSE staff walked the entire length of the Cayou Creek channel from its inlet at the southern edge of the wetland to its outlet at the south side of South Shore Road. The following features of hydraulic significance were discovered. They are presented in order from upstream to downstream, and Figure 7 shows their approximate locations along Cayou Creek:

- Private Wooden bridge Partially submerged structure with a dry deck and wet low chord
- Upstream beaver dam (See Figure 8)
  - Approximately 13 feet long and 2 feet high
  - 2-inch drop in water level from upstream to downstream side of dam
  - Wetted channel is 13 feet wide upstream and downstream
- Downstream beaver dam (See Figure 9)
  - Approximately 10 feet long and 3 feet high
  - o 23-inch drop in water level from upstream to downstream side of dam
  - Wetted channel is 10 feet wide upstream and 4 feet wide downstream
- Natural debris pile in channel The channel went dry at this location
- Concrete pipe culvert Dry channel with 30" diameter concrete pipe (Figure 7 shows a LiDAR elevation that represents the earth covering the top of the pipe culvert)
- Wooden bridge Dry channel with 5 feet between channel elevation and bridge low chord
- Natural debris pile in channel Water reappeared in the channel at this location
- Masonry arch bridge
- Segmented concrete pipe culvert
  - 30" diameter sections under South Shore Road
  - Unobstructed inlet
  - 40% blocked outlet





Figure 7 – Features of hydraulic significance identified in Cayou Creek



Figure 8 – Viewing west across Cayou Creek along the crest of the upstream beaver dam



Figure 9 – Viewing south (downstream) across the crest of the downstream beaver dam



The two beaver dams, especially the taller and narrower downstream dam, have created a significant obstruction across the outlet of the wetland at the start of Cayou Creek. These dams are the reason water levels have increased in the wetland and Edens Road experiences flooding. This finding is confirmed in Figure 9 below, which shows the ground profile through the wetland and in Cayou Creek obtained from 2016-17 LiDAR data. The location of Edens Road and the downstream beaver dam are identified on the plot, and the solid horizontal line represents the elevation of Edens Road while the dashed horizontal line represents the top of the downstream beaver dam. These elevations indicate that the beaver dam crest is approximately 8 inches higher than the road in the 2016-17 LiDAR. The exact relationship between the beaver dam crest elevation in the LiDAR and the current crest elevation is not known as no physical ground survey was collected during the 2019 site inspection.

The LiDAR elevation data is not as precise as a physical survey, but we believe it does confirm that the beaver dams are the cause of the flooding at Edens Road based on elevation comparisons from the wetland profile. Note that the upstream beaver dam apparently did not exist when the LiDAR was collected as it is not visible in the in the profile below, but there are a handful of elevation peaks in the profile that correspond to other hydraulic features of significance and are labeled accordingly on the figure. Based on approximate measurements from the 2019 site inspection, the upstream beaver dam contributes approximately two inches of hydraulic head to the wetland, meaning the downstream beaver dam is still the primary feature controlling wetland water levels.



Figure 10 – Edens Road wetland profile with specific elevations and hydraulic features listed



Figure 11 below shows a cross section of Cayou Creek looking downstream at the location of the downstream beaver dam. The lowest profile line represents an approximate channel cross section under the beaver dam, the middle dash-dotted line represents the beaver dam crest with a minimum elevation of 28.9 feet, and the highest dashed line represents the top of bank elevation based on the Cayou Creek channel profile at the right side of the plot. The cross section reveals that the beavers could theoretically build their dam upwards of three feet higher than it is today to the highest dashed line at an elevation of 32.0 feet, which in-turn would increase the frequency and depth of flooding at Edens Road. An expansion up to the top of bank elevation would require a beaver dam that is more than 45 feet long and is unlikely to occur, but the site characteristics indicate that it is possible nonetheless.



Figure 11 – Cayou Creek cross section along the crest of the downstream beaver dam, approximately showing the channel profile under the dam, the crest of the dam, and the theoretical maximum elevation of the beaver dam.



## CONCLUSIONS AND RECOMMENDATIONS

Based on our investigation, it is clear that beaver dams in Cayou Creek at the wetland outlet are the cause of flooding at Edens Road. It is also clear that water levels at Edens Road could rise even further in the future if the beaver dams are raised. The 2016-17 LiDAR cross section shown on the previous page suggests that the lower beaver dam could theoretically be raised an additional 3 feet, meaning there is the possibility that water levels at Edens Road could exceed the recent record levels that have inundated the road. However, the road would only need to be raised approximately 8" to be above the current inundation level seen in the 2016-17 LiDAR (i.e. the beaver dam crest elevation).

The most direct solution would be to remove all or part of both dams and implement a beaver management program. However, due to the incised character of the stream and the fact that there are many locations along its length where beavers could build dams, common techniques like beaver deceives likely will not be successful. Notching or removing the dams is also unlikely to be a long-term solution because beavers are capable of repairing or rebuilding dams very quickly. Short of trapping and removing the beavers, it is our opinion that any beaver management allowing the beavers to remain on site will likely not resolve flooding across Edens Road. If trapping and removal is not an acceptable solution, we recommend that the County pursue another alternative such as one of the following:

- Do nothing.
- Temporarily close Edens Road when water over the road is deep enough to create a significant hazard to vehicles. During these closures, no trucks would be able to access to the east side of Guemes Island due to the existing South Shore Road vehicle weight restriction.
- Permanently close the flooded section of Edens Road to through traffic. This would require upgrading South Shore Road to eliminate the vehicle weight restriction.
- Raise Edens Road at least 8" so that it is higher than the crest of the existing beaver dam. However in the future, it is possible that the beavers may raise the existing dam, which in turn would likely increase water levels and flood the raised roadway.
- Raise Edens Road through the wetland more than 3.7 feet to an elevation above 32.0 feet, higher than the theoretical maximum elevation of the beaver dam as indicated in Figure 11. This would require expanding the road footprint into the wetland due to the wider road prism of an elevated roadway. The mitigation requirements and resulting costs could be significant.
- Raise a lane-width section at the center of Edens Road more than 3.7 feet to an elevation above 32.0 feet and convert it to a single lane with stop lights at either end to safely allow traffic in both directions. This would raise the road above the theoretical maximum water level while limiting construction to the existing road footprint and not encroaching into the wetland.
- Reroute Edens Road around the north end of the wetland, truncating the existing road on either side of the wetland. This would be an expensive option requiring property acquisition and significant road foundation preparation to manage the soft subsurface soil that exists around the perimeter of the wetland.



Consult a beaver expert to determine if the Cayou Creek channel at the wetland outlet can be
modified in any way to reduce beaver activity. For example, would lowering the ground on one
side of the channel create a floodplain bench that is wide enough to prevent beavers from
blocking it? This action may not be feasible due to the impacts of excavation on the wetland and
vegetation, but is an example of the scale of project that may be required.

