

60th Street District

The 60th Street District is shown in Figure TH1. The primary stream that drains the district has its headwaters south of Cascade Charter Township in Caledonia Charter Township. It discharges through Caledonia Charter Township and on into Gaines Charter Township. The stream is designated as a Kent County Drain (named the Wenger and Nulty). Upstream of Broadmoor Avenue, the stream is a channelized agricultural drain. The stream appears to be protected from direct runoff from the farm fields with a brush/forest buffer zone along its banks. It shows minor streambank erosion (Photograph TH2) and contains a significant amount of woody debris.

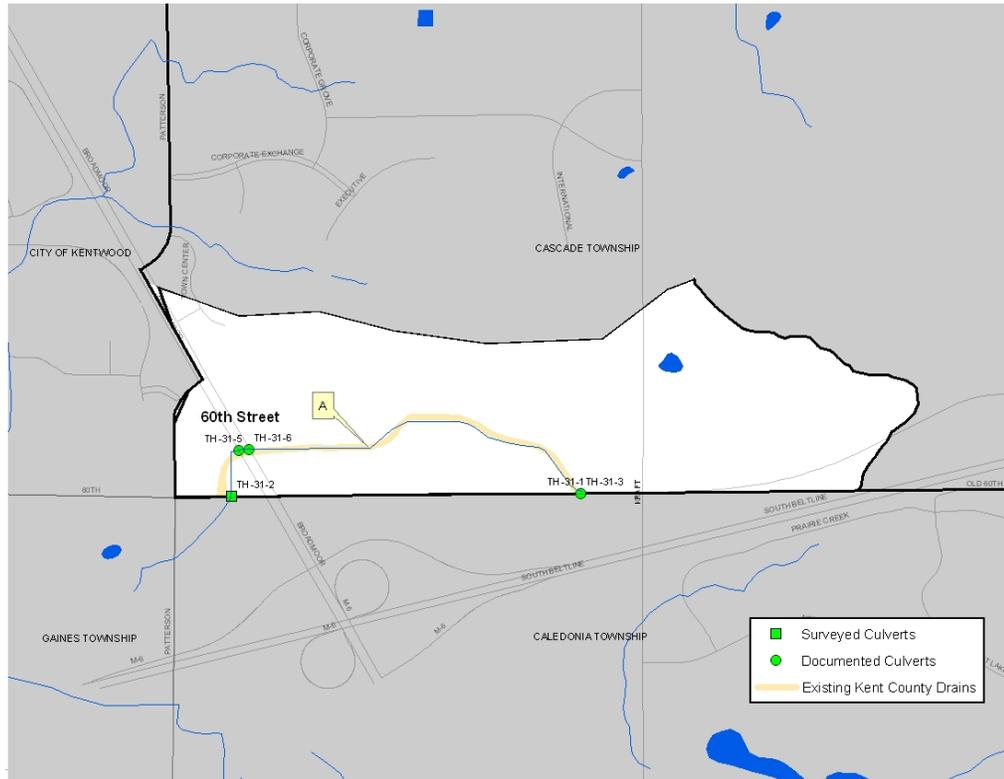


Figure TH1



Photograph TH2 (see flag A, Figure TH1)

GRFIA northeast District

The Gerald R. Ford International Airport (GRFIA) Northeast District is shown in Figure NE1. The stream that drains this district has its headwaters between Thornapple River Drive and M-6. The stream is very minor downstream of 48th Street (Photograph NE2) as it parallels Burger Drive, crosses Burger Drive, and continues onto the western half of the Thornapple Pointe Golf Club property. There are no buffer zones along the stream through the golf course property (Photograph NE-3). After passing under M-6 and the eastern half of the golf course, the stream discharges into the Thornapple River.

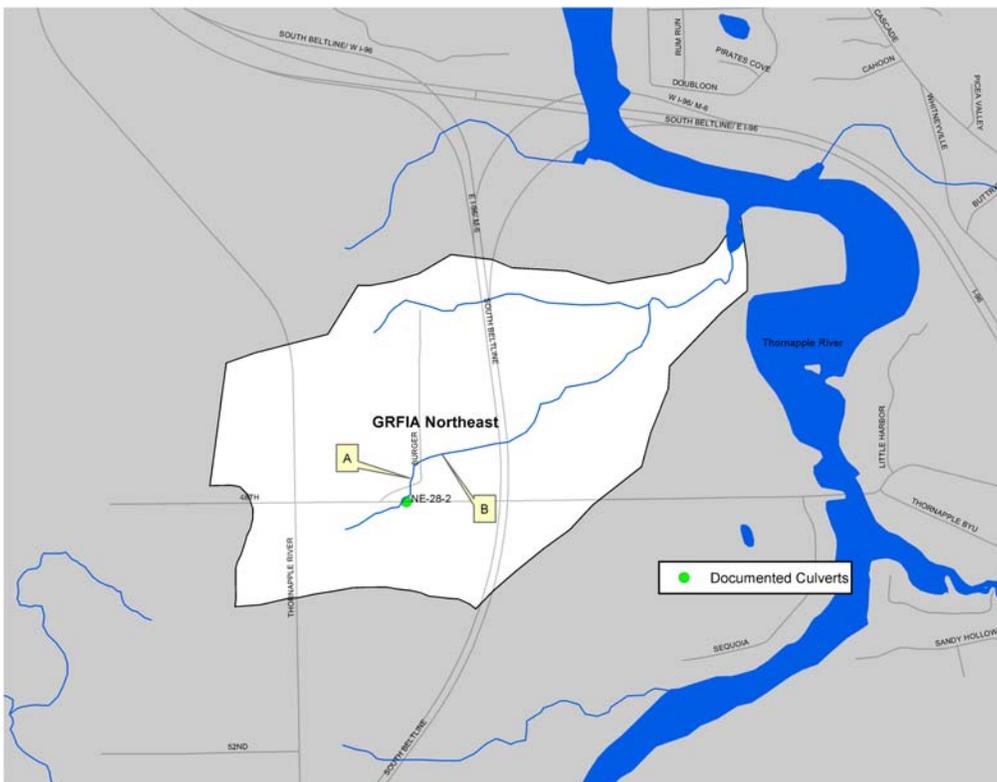


Figure NE1



Photograph NE2 (see flag A, Figure NE1)



Photograph NE3 (see flag B, Figure NE1)

Cascade Road District

The Cascade Road District is shown in Figure CD1. The stream that drains this district has two branches (designated as north and south). Both branches originate east of Quiggle Avenue. The confluence is located about 750 feet east of the intersection of Cascade Road and Buttrick Avenue. The stream discharges to the Thornapple River near I-96.

Along the southern branch, residents have complained about changes that have occurred in the stream since new developments have been constructed in the district. Between the Ada Bible Church driveway (off Cascade Road) and Quiggle Avenue the stream channel appears to be in good condition with little erosion and adequate buffer zones on each bank. Most of the vegetation is grass with a few trees. The stream passes under Quiggle Avenue after picking up some ditch drainage. Downstream of this crossing, the stream passes through a manicured yard with no buffer zones, deep incising, and streambank erosion (photograph CD2). A pond is located along the south bank. The pond is located within the stream's flood plain. The pond has an outlet to the stream near Cascade Road.

Downstream of the easternmost Cascade Road crossing severe streambank erosion and failed stabilization efforts are evident (photograph CD3). Lawns parallel the banks before the stream enters a forest. Through the forest, moderate erosion on the outside of meanders is evident. An old farm crossing has collapsed and fallen into the stream approximately halfway between Cascade Road and Cherry Lane. The forest opens to farm land, where the stream narrows and deepens. It then travels through brush until it reaches the Cherry Lane crossing. Downstream of Cherry Lane, both banks of the stream are covered with small brush and slight sedimentation is noticeable. Just upstream of Cascade Road (western crossing for southern branch) the stream is in a mature forest with moderate streambank erosion and sedimentation (photograph CD4). The upstream end of the Cascade Road culvert is clogged with debris causing some flooding to occur (photograph CD5).

The confluence of the northern and southern branches occurs between the two eastern Cascade Road crossings. The easternmost Cascade road crossing carries flows from both branches. Sedimentation is evident from this crossing all the way to the discharge point at the Thornapple River. Downstream of Whitneyville Avenue streambank erosion is moderate (photograph CD6). Just upstream of I-96, sedimentation is severe resulting in a culvert over half clogged with sediment (photograph CD7).

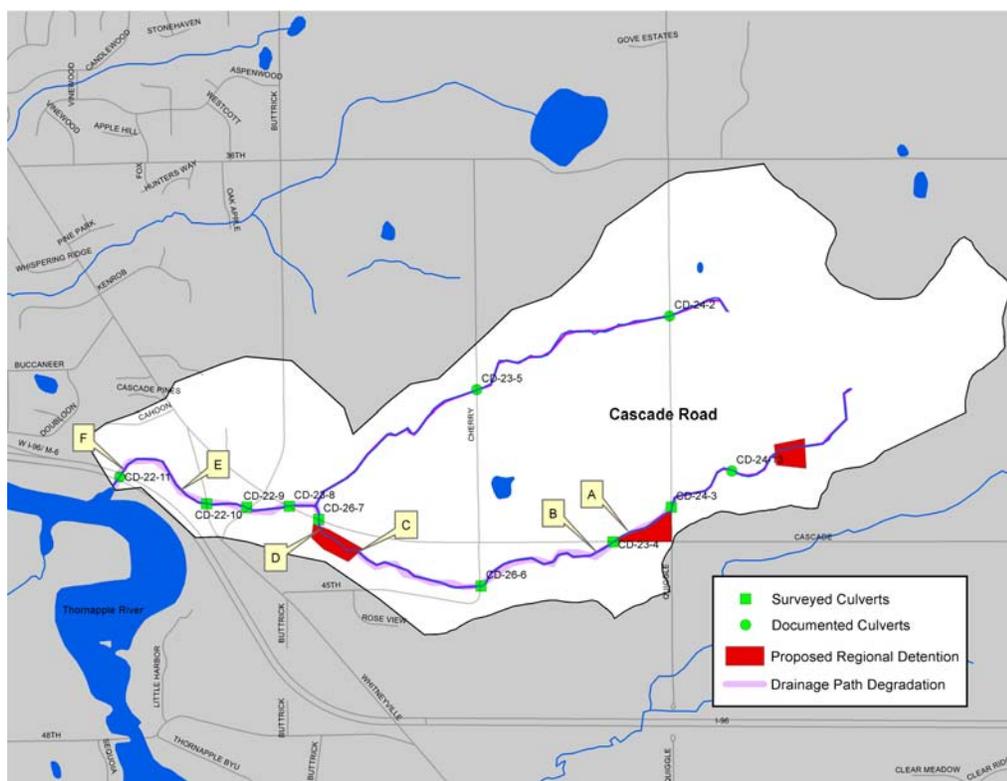


Figure CD1



Photograph CD2 (see flag A, Figure CD1)



Photograph CD3 (see flag B, Figure CD1)



Photograph CD4 (see flag C, Figure CD1)



Photograph CD5 (see flag D, Figure CD1)



Photograph CD6 (see flag E, Figure CD1)



Photograph CD7 (see flag F, Figure CD1)

Cascade Southeast District

The Cascade Southeast District is shown in Figure CS1. The stream that drains this district has its headwaters in both Lowell Charter Township to the east and Caledonia Charter Township to the south. A bayou is located near the confluence of the stream and the Thornapple River. The bayou has many homes built along its banks. Upstream of the Thornapple Bayou Drive bridge moderate streambank erosion is evident on the outside of the meanders and in some places major sloughing (separation and sliding of bank materials due to erosion at the toe of a steep streambank) of the larger banks was observed. Most natural streams contain riffle, run, and pool sequences. A riffle is a section of the stream with shallow depths, high velocities, and coarse channel bottom materials. Riffles tend to dissipate much of the energy as water flows downstream. The section of stream upstream of Thornapple Bayou Drive contains both natural and manmade riffles (photographs CS2 and CS3). The Buttrick Avenue crossing consists of two corrugated metal pipe culverts with one partially filled with sediment (photograph CS4). This culvert is probably in use only during high flow events.

Upstream of Buttrick Avenue the stream continues meandering with erosion visible on the banks and major sloughing on the highest banks. In one location a 50-foot-high slough was noted (photograph CS5). The stream has many riffles and is fast moving. The confluence with the north branch occurs midway between Buttrick Avenue and 52nd Street. The south channel passes under both 52nd Street and Whitneyville Avenue.

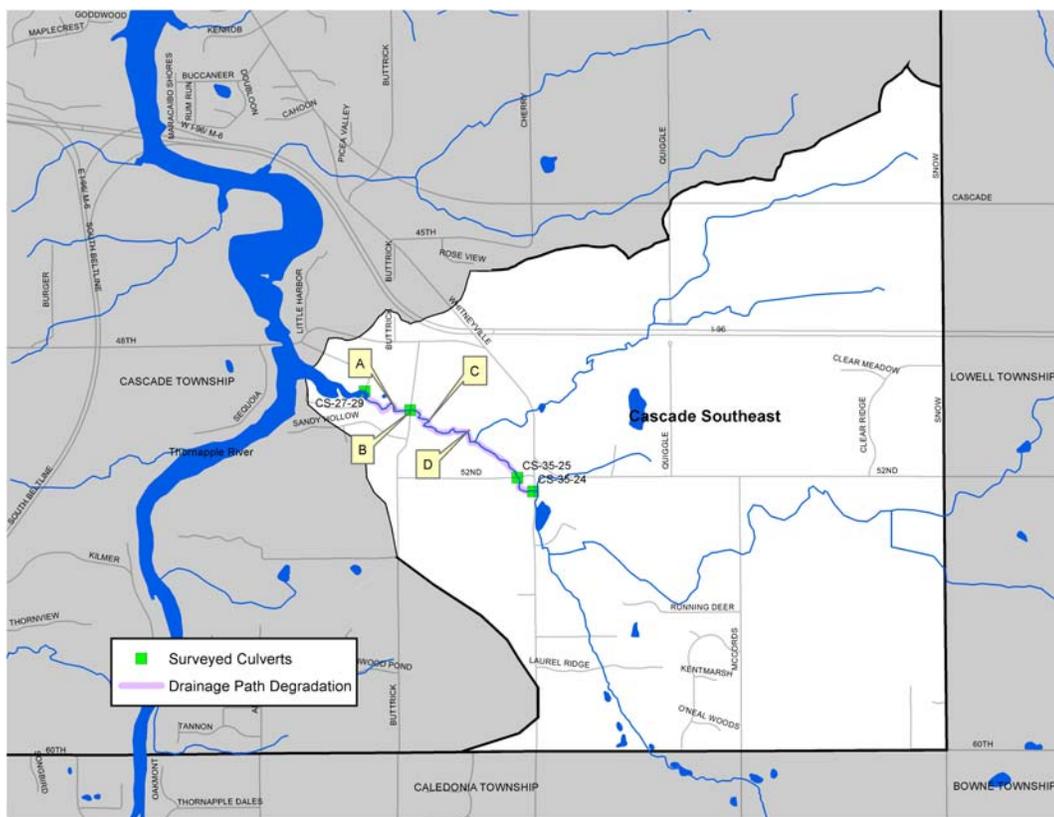


Figure CS1



Photograph CS2 (flag A, Figure CS1)



Photograph CS3 (flag C, Figure CS1)



PhotoCS4 (flag B, Figure CS1)



Photograph CS5 (flag D, Figure CS1)

Cascade West District

The Cascade West District is shown in Figure CW1. The stream that drains the northern part of this district has its headwaters along Spaulding Avenue. It discharges to the City of Kentwood. A crushed culvert was recently replaced by the Kent County Drain Commissioner. Flooding has also been noted upstream of Burton Street. Upstream of the Patterson Avenue crossing the stream appears to be in good shape with only minor streambank erosion and an abundance of woody debris (photograph CW2). The stream passes under I-96 (and Burton Street) less than ¼ of a mile upstream of Patterson Avenue. Upstream of I-96 the stream has steep banks with only minor erosion observed (photograph CW3). Near the pond (by Tall Pines Court) the ground becomes boggy and the stream has low banks (photograph CW4). Several farm crossings pass the water upstream of the pond in the Tall Pines subdivision. In this area the stream is a channelized agricultural drain. Erosion is occurring over a 1000-foot long section (photograph CW5). A culvert-crossing in the channel heading to the north has collapsed (photograph CW6). Near Spaulding Avenue the stream loses velocity and water becomes stagnant (photograph CW7).

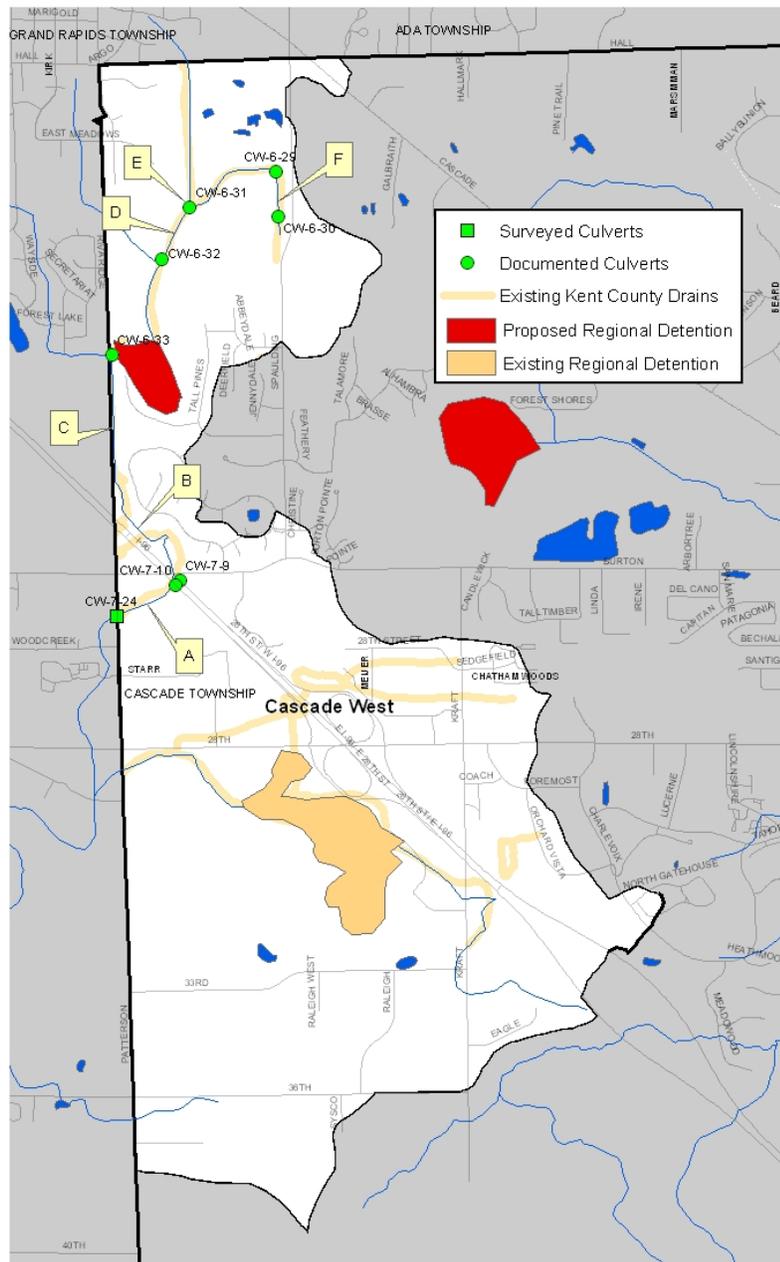


Figure CW1



Photograph CW2 (flag A, Figure CW1)



Photograph CW3 (flag B, Figure CW1)



Photograph CW4 (flag C, Figure CW1)



Photograph CW5 (flag D, Figure CW1)



Photograph CW6 (flag E, Figure CW1)



Photograph CW7 (flag F, Figure CW1)

Forest Creek District

The Forest Creek District is shown in Figure FC1. The stream that drains this district has its headwaters south of Cascade Township Park. Flooding occurs in Cascade Township Park with floodwaters from the Forest Creek district flowing over to the GRFIA Northeast 1 district. There is also a failed, former farm crossing, failed sheet pile weir, and erosion. The stream that drains the Forest Creek district has its headwaters south of Thornapple River Drive. After passing under I-96, the stream flows through Cascade Township Park. In the park the stream passes through three culverts. Two of these culverts (shown in Figure FC1) pass under the park walking path. They were both recently replaced because of flooding issues. During frequent rainfall events this stream would flood and floodwater would pass through the park parking lot over to the Burger 1 district (photograph FC2). Downstream of the Township Park, there is an old farm crossing where the culverts are completely plugged and ineffective (photograph FC3). There is a failed sheet pile weir (photos FC4 and FC5). Some streambank erosion is noted in the lower reaches before the stream discharges into the Thornapple River (photograph FC6).

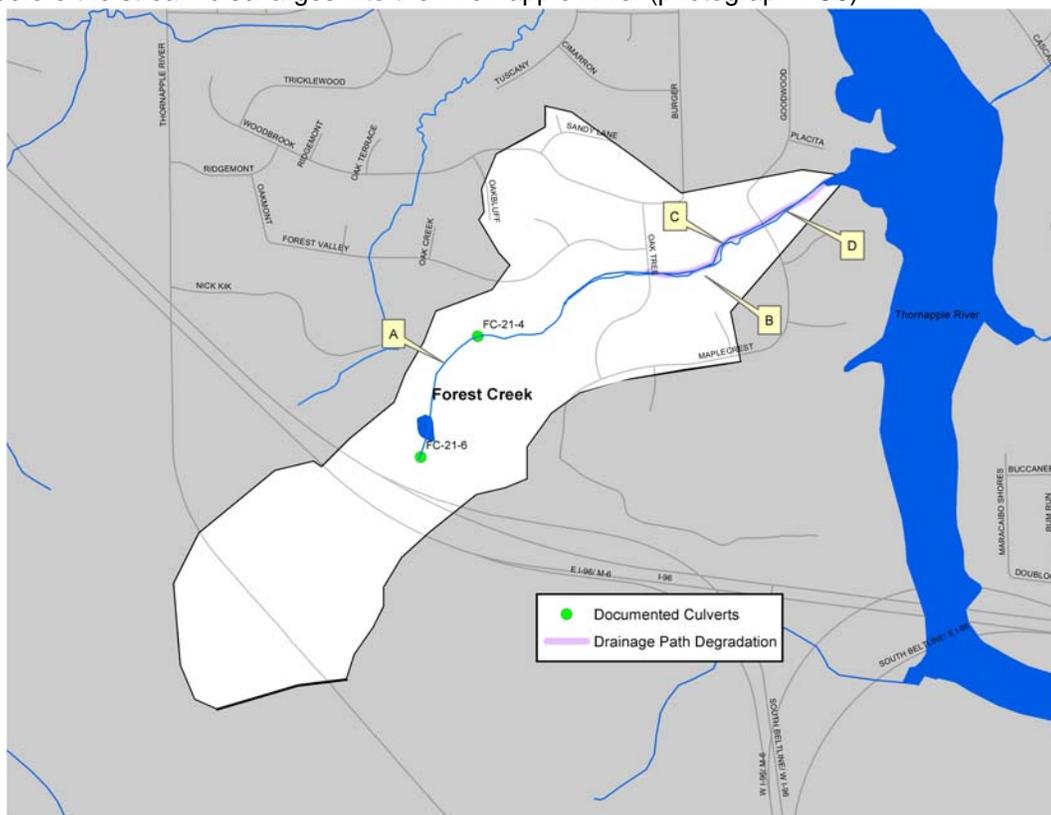


Figure FC1



Photograph FC2 (see Flag A, Figure FC1)



Photograph FC3 (see flag B, Figure FC1)



Photograph FC4 (see flag C, Figure FC1)



Photograph FC5 (see flag C, Figure FC1)



Photo

graph FC6 (see flag D, Figure FC1)

Burger 1 District

The Burger 1 District is shown in Figure B1-1. The stream that drains this district has its headwaters in Cascade Township Park. This stream discharges into a Thornapple River bayou. Flows in the bayou reach the Thornapple River after flowing through the culvert under Burger Drive. Between Burger Drive and Woodbrook Drive there is severe erosion of the streambanks (photograph B1-2). Many meanders exist and there is evidence that new meanders are being created. This gives evidence that the stream is unstable. Between Woodbrook Drive and Forest Valley Drive an attempt was made to stabilize the streambank using GEOWEB Cellular Confinement System to line the channel. The GEOWEB has failed and streambank erosion is still occurring (photograph B1-3). Upstream of Forest Valley Drive the stream becomes a swale through the Cascade Charter Township Park.

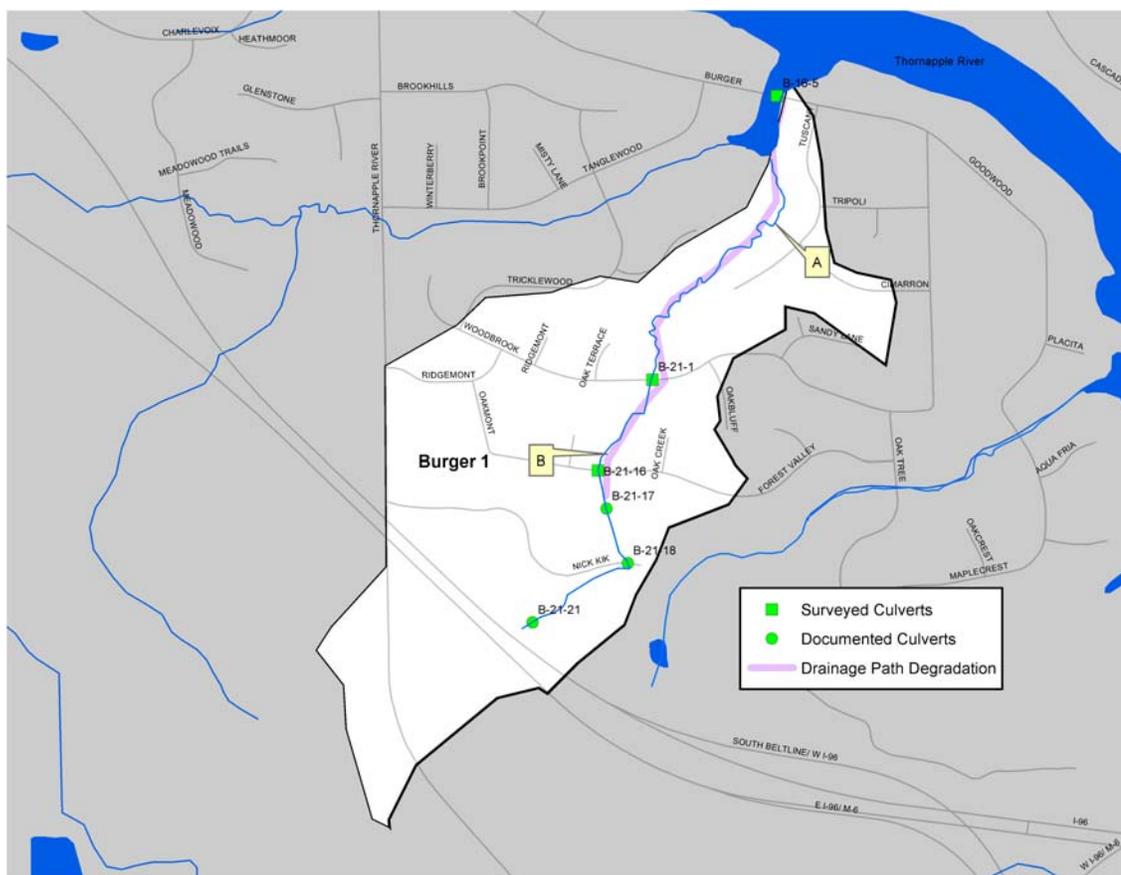


Figure B1-1



Photograph B1-2 (flag A, Figure B1-1)



Photograph B1-3 (flag B, Figure B1-1)

GRFIA Southeast District

The Gerald R. Ford International Airport (GRFIA) Southeast District is shown in Figure SE1. The northern branches of the stream that drains this district have its headwaters on Gerald R. Ford International Airport property. The southern branch originates in Caledonia Charter Township. Because of limited access rights on the airport property, the investigation considered only the section downstream of M-6. Between M-6 and Thornapple River Drive the stream is very muddy and slow moving (photograph SE2). Accumulated debris gives evidence that the stream overtops its banks on a regular basis.

Downstream of Thornapple River Drive the banks of the stream are covered with small brush and the stream itself is practically stagnant. The brush gives way to a dense forest where the stream picks up in velocity. Streambank erosion is evident on the outside of meanders and some sloughing of adjacent streambanks is present (photograph SE3). Small riffles are noted in the stream. The stream discharges to the Thornapple River through a bayou. Banks of the bayou are sloughing, possibly due to manicured lawns eliminating buffer zones (photograph SE4).

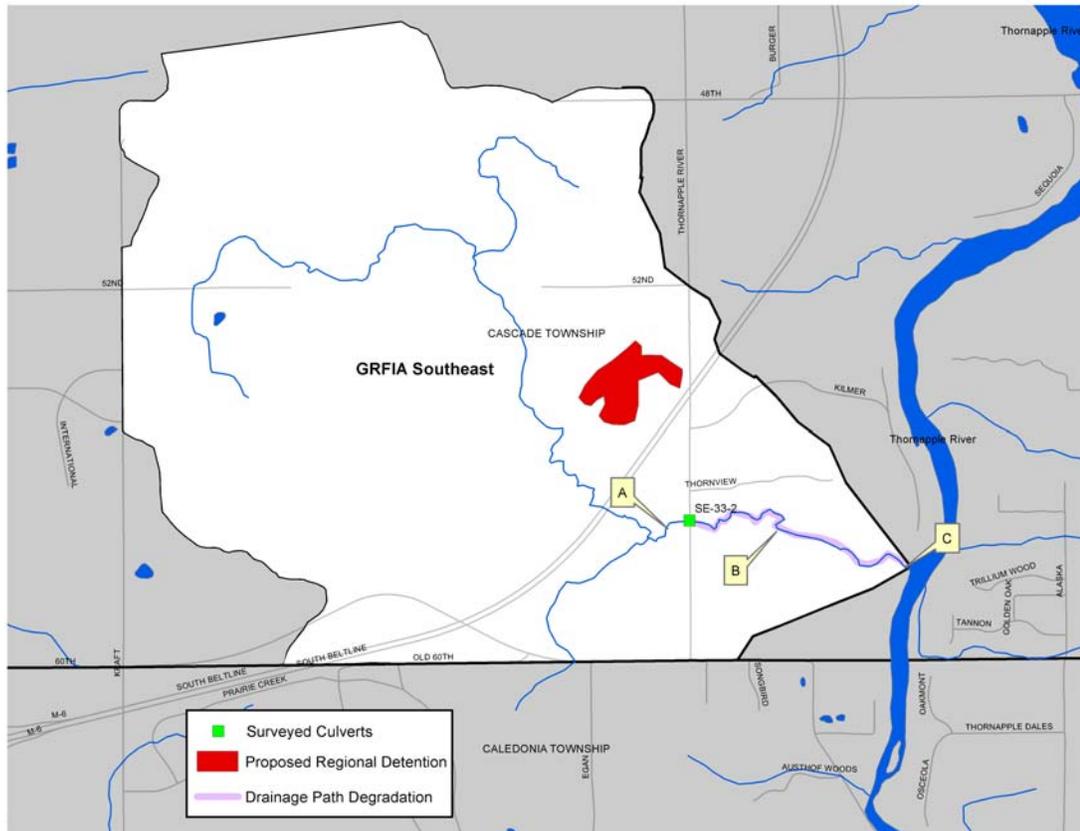


Figure SE1



Photograph SE2 (flag A, Figure SE1)



Figure SE3 (flag B, Figure SE1)



Figure SE4 (flag C, Figure SE1)

Hidden Hills District

The Hidden Hills District is shown in Figure HH1. The stream that drains this district has its headwaters near Buttrick Avenue and is designated as the Apple Hills Kent County Drain. The stream is fed by two ponds – one just east of Buttrick Avenue and one just west of Buttrick Avenue and south of the stream. The stream passes through the backyards of a residential neighborhood and exhibits moderate to severe streambank erosion. Several channel grade control structures, including sheet pile weirs, are located along this reach (photograph HH2). The stream crosses under Vinewood Avenue where it picks up runoff from the street. Downstream of Vinewood Avenue old streambank stabilization efforts were noted. This includes both concrete lining and GEOWEB (photograph HH3). There are no streambank buffer zones between Vinewood Avenue and Cascade Road. Downstream of Cascade Road more GEOWEB is visible. In one location the GEOWEB has failed and is damming the stream (photograph HH4). The stream discharges into a Thornapple River bayou.

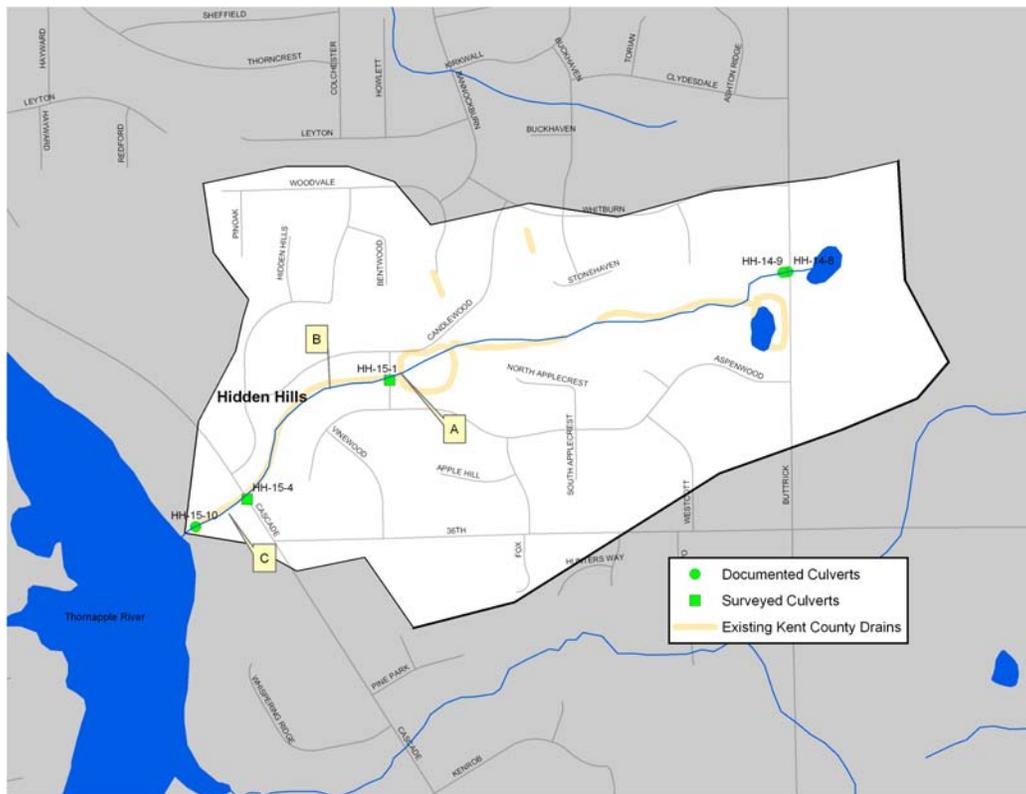


Figure HH1



Photograph HH2 (flag A, Figure HH1)



Photograph HH3 (flag B, Figure HH1)



Photograph HH4 (flag C, Figure HH1)

Highgrove District

The Highgrove District is shown in Figure HG1. The stream that drains this district has its headwaters along Buttrick Avenue. Upstream of Grand River Drive the stream passes through a low density residential development. Along this reach the forest adjacent to the stream is still standing providing streambank buffer. The stream experiences moderated erosion through the development (see flag A in Figure HG1 and photograph in Figure HG2). Upstream of the development, the stream narrows, deepens, and the surrounding ground becomes boggy (see flag B in Figure HG1 and photograph in Figure HG3). Downstream of Bolt Drive the stream is undefined as it passes through a wetland.

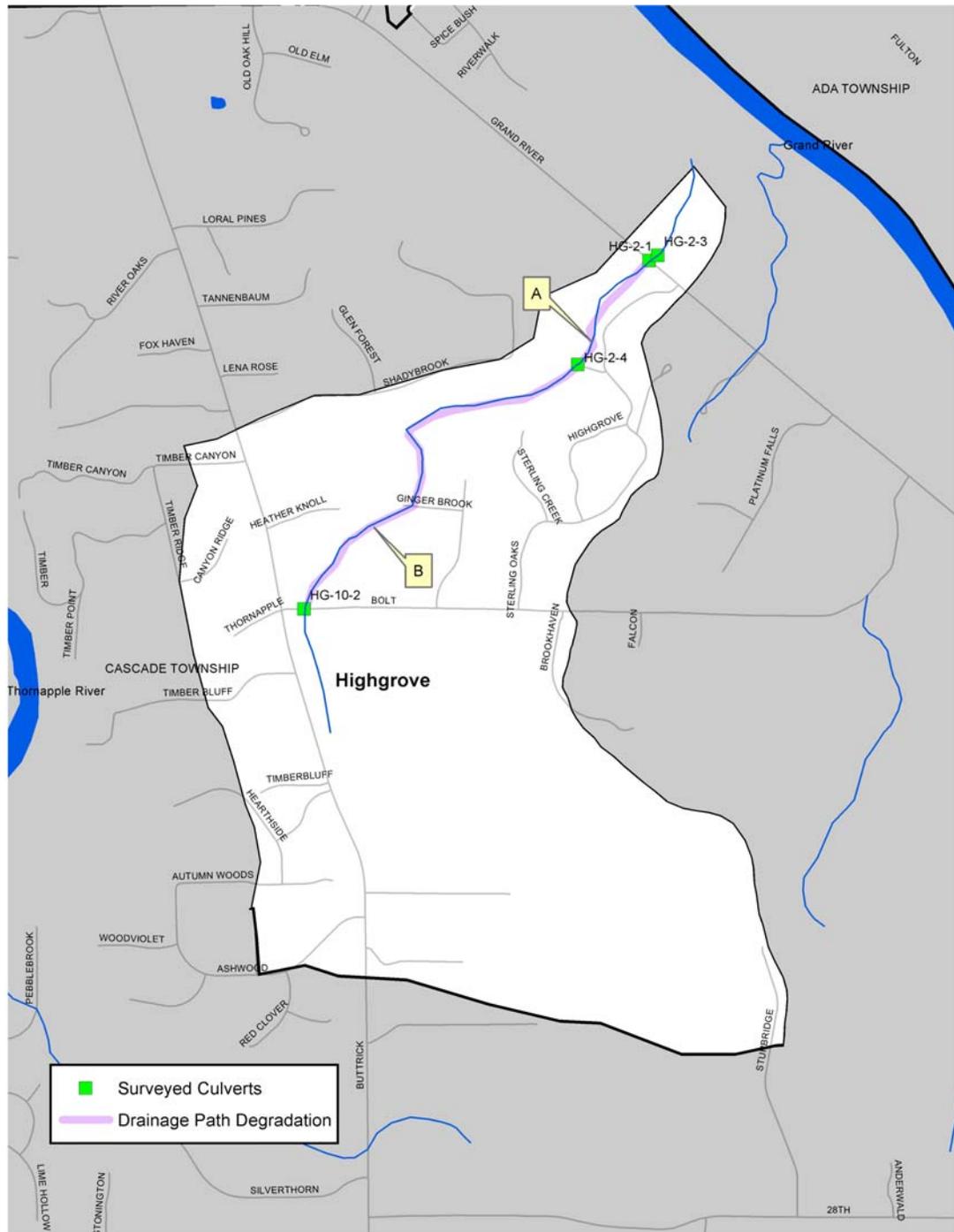


Figure HG1



Photograph HG2 (flag A, Figure HG1)



Photograph HG3 (flag B, Figure HG1)

Quiggle Lake District

The Quiggle Lake District is shown in Figure Q1. The main branch of the stream that drains this district has its headwater in Quiggle Lake. Near the headwaters it is designated as the Humphrey Kent County Drain. Flooding occurs over 36th street just south of the Quiggle Lake. A small wetland exists near the stream outlet at the Thornapple River. A few meanders upstream of the wetland severe erosion is noted. Banks are eroded very high and are being actively undercut. Wooden walls are acting to prevent this erosion but, in some areas, these too are being undermined. This severe erosion occurs up to the stream crossing at Cascade Road (photograph Q2). Upstream of Cascade Road the stream exhibits minor to moderate streambank erosion. This section also shows a natural riffle-pool sequence. Some manmade riffles are also in place and operating appropriately. Moderate erosion occurs upstream of Oak Apple Drive crossing with some undercutting of banks. Upstream of Buttrick Avenue the banks are lower and the ground is boggy. Upstream of 36th Street the ground is very soggy. On Quail Ridge Golf Course property the stream passes through a wetland and a forest (where moderate erosion occurs) and passes under an access drive. Quiggle Lake is at the upstream end of the stream.

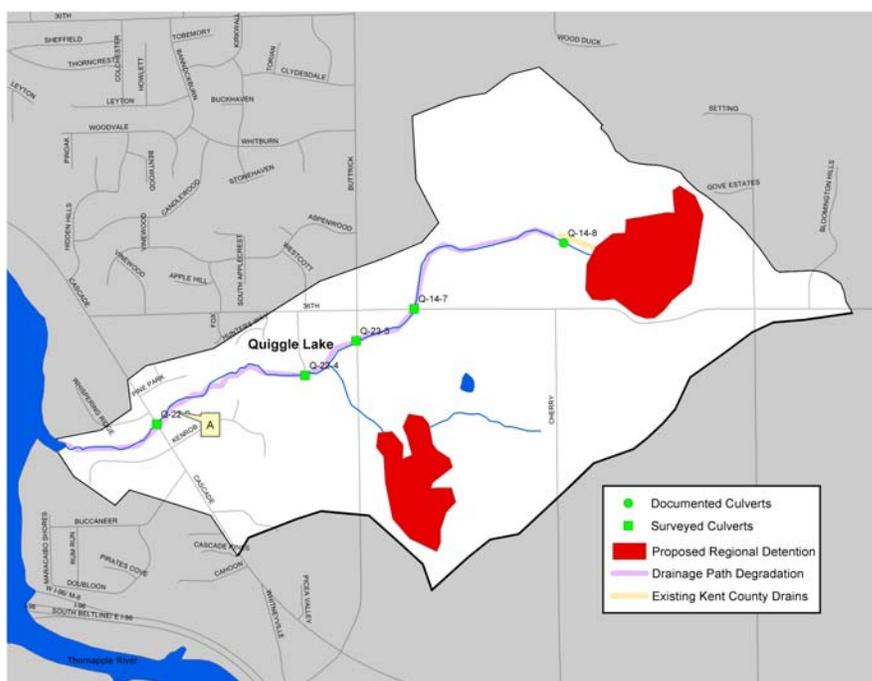


Figure Q1



Photograph Q2 (flag A, Figure Q1)

Schoolhouse Creek District

The Schoolhouse Creek District is shown in Figures SC1 and SC2. Schoolhouse Creek has its headwaters north of Mont-Rue Drive. The upper part of the main branch of this stream is designated as the Walden Lake Kent County Drain. Downstream of Walden Lake it is designated as the Tobias and Walden Kent County Drain. The branch draining the southern section of the district is designated as the Foremost Kent County Drain. Upstream of Thornapple River Drive the channel is concrete lined for approximately 20 yards (photograph SC3). The concrete lining protects the streambank from high velocities discharging from a control weir. The weir controls the level of the pond upstream of Thornapple River Drive (photograph SC4). Upstream of the pond the stream flows through a residential development exhibiting minor to moderate streambank erosion. Lawns extend to the streambank. There are two crossings for Oak Brook Drive. Through this reach the channel is fast moving and has many riffles - some appear to be natural (photos SC5 and SC6). Upstream of the residential neighborhood the stream enters a dense brushy forest. The stream loses velocity in this section and deepens (photograph SC7). The stream then runs parallel Cascade Road for approximately one half mile. In this reach there are no streambank buffer zones and there are several driveway crossings (photograph SC8). Upstream of Cascade Road the stream enters a large wetland. Just upstream of the northern Cascade Road crossing a new wetland has been created as part of a wetland mitigation project (photograph SC9).

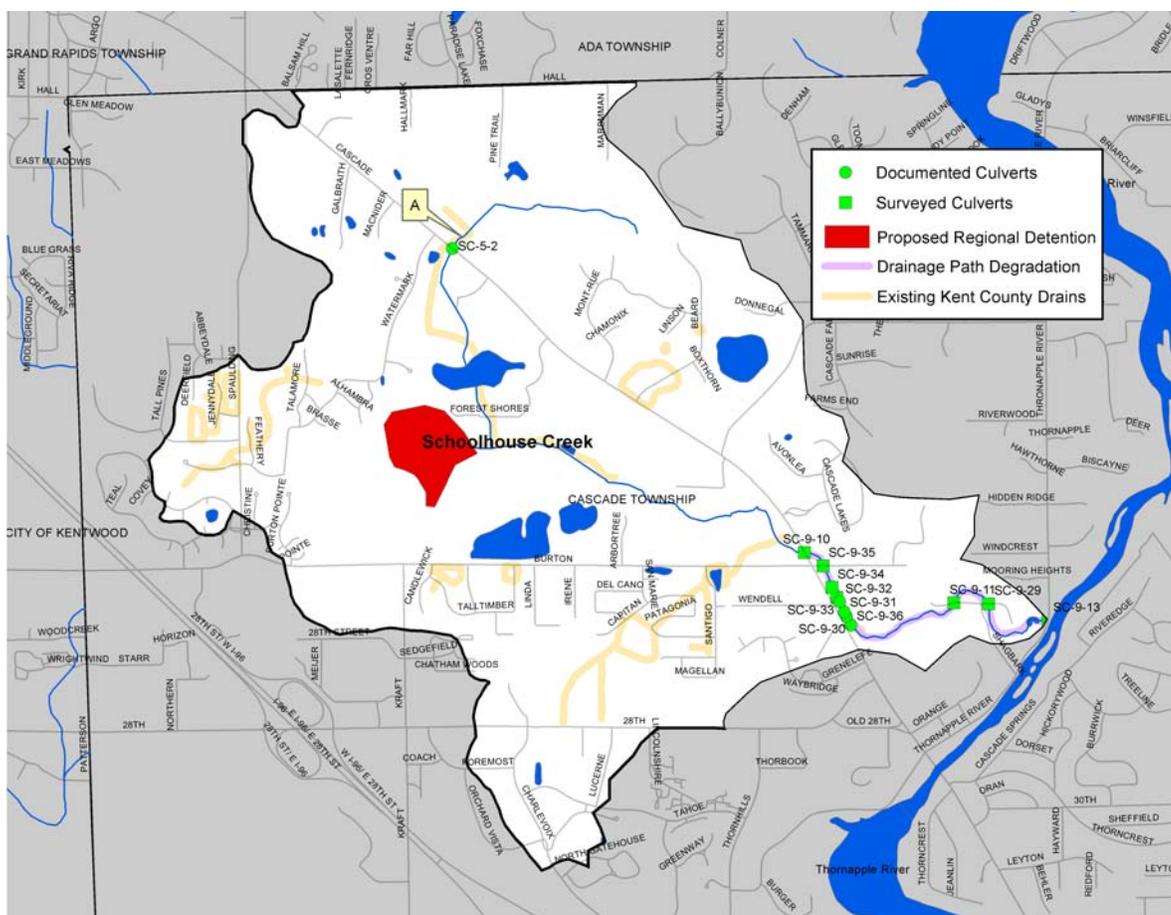


Figure SC1

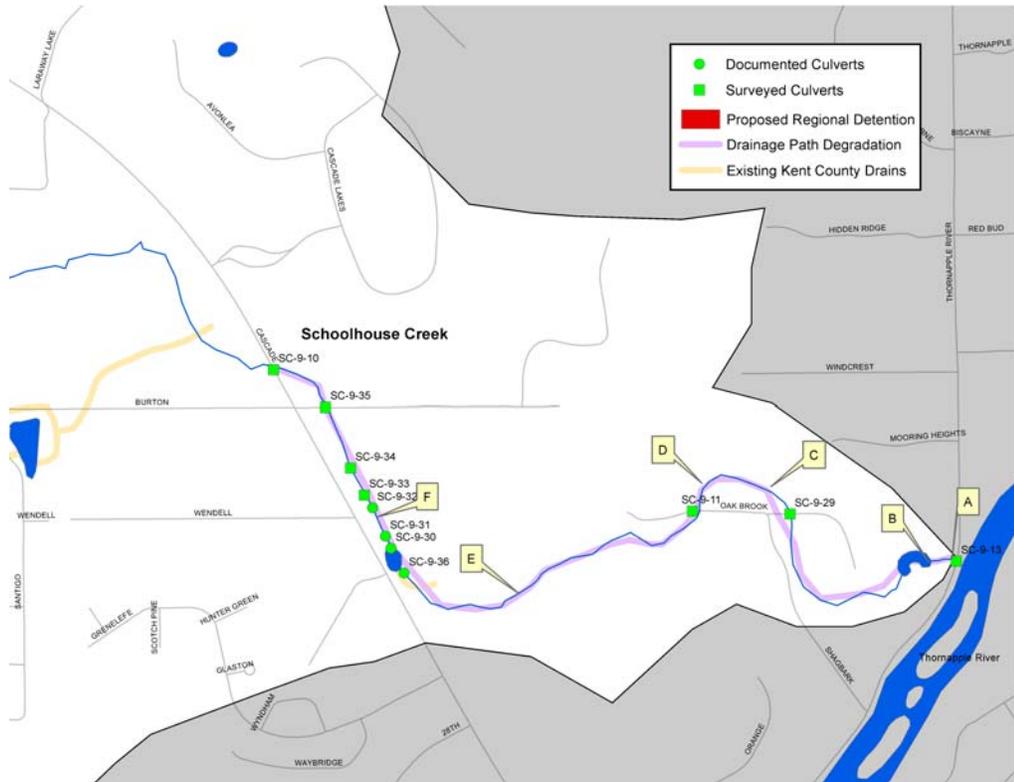


Figure SC2



Photograph SC3 (flag A, Figure SC2)



Photograph SC4 (flag B, Figure SC2)



Photograph SC5 (flag C, Figure SC2)



Photograph SC6 (flag D, Figure SC2)



Photograph SC7 (flag E, Figure SC2)



Photograph SC8 (flag F, Figure SC2)



Photograph SC9 (flag A, Figure SC1)

Sentinel Point District

The Sentinel Point District is shown in Figure SP1. The stream that drains this district has two branches both with headwaters in Sentinel Country Club. The northern branch is designated as the Thornapple Hills Kent County Drain. Streambank erosion was noted along the northern branch, upstream of Thornhills Avenue. In this area the overflow of a detention basin caused severe incising upstream of Thornhills Avenue (photograph SP2). Downstream of Thornhills Avenue a large scour pool exists. Further downstream the channel begins to meander with slight to moderate erosion on the banks. Three or four gabion check dams had been installed between Thornhills Avenue and Thornapple River Drive. All seem to be in good shape (photograph SP3). Just upstream of Thornapple River Drive the north and south branches combine. The stream then crosses Thornapple River Drive and a driveway. Downstream of the driveway moderate erosion has occurred and sedimentation is evident on the channel bottom (photograph SP4). The stream then discharges into the Thornapple River.

The south branch has a lower discharge than the north. Between Thornapple River Drive and Thornhills Avenue the banks are lower and the surrounding land is very mucky. Gabion check dams are used in this reach as well (photograph SP5). Downstream of the Thornhills Avenue crossing a wetland area makes it difficult to locate the stream. The stream is undefined and dry upstream of Thornhills Avenue.

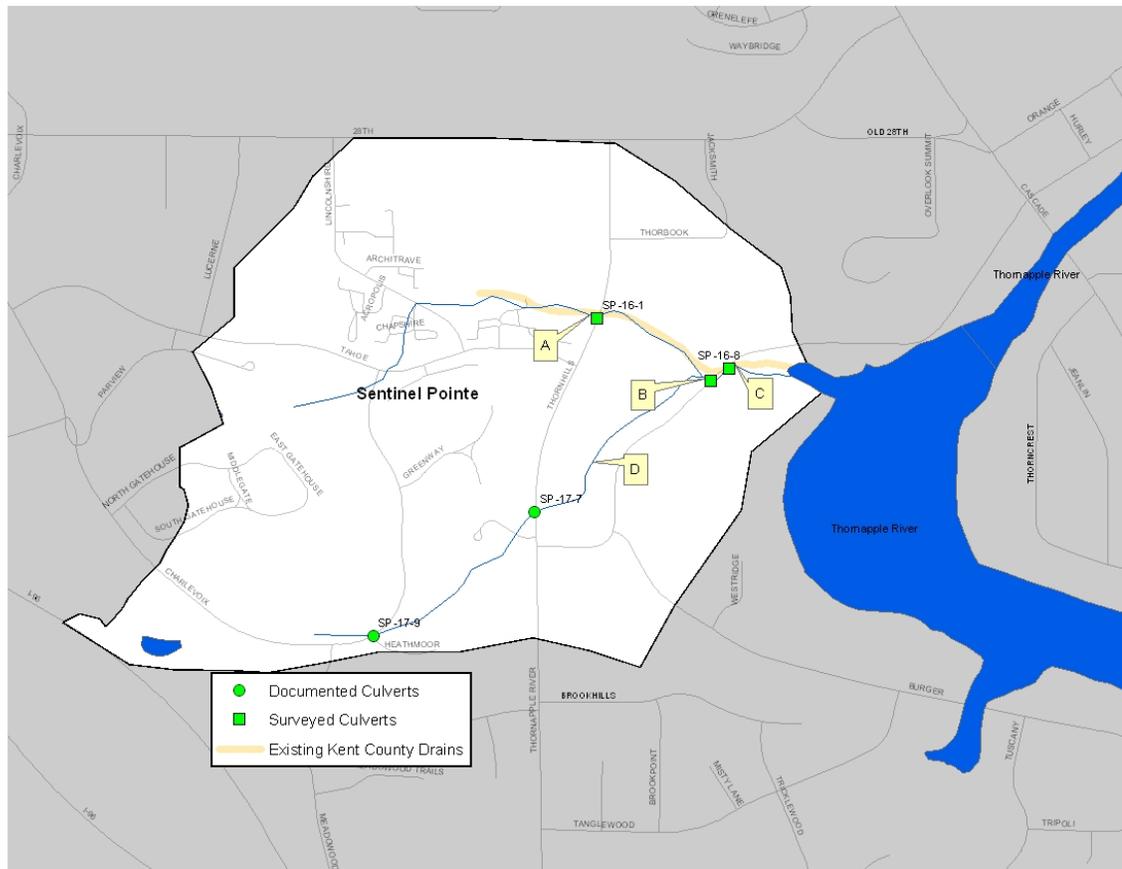


Figure SP1



Photograph SP2 (flag A, Figure SP1)



**Figure SP3 Gabion check dam upstream of Thornapple River Drive
(flag B, Figure SP1)**



Photograph SP4 (flag C, Figure SP1)



Photograph SP5 (flag D, Figure SP1)

Burger 2 District

The Burger 2 District is shown in Figure B2-1. This stream has its headwaters at the Gerald R. Ford International Airport where it is known as the McKnight Kent County Drain. The stream flows north and east under Interstate-96 and several residential streets before its confluence with the Thornapple River.

A construction site with poor soil erosion and sedimentation control is located just upstream of the Kraft Avenue crossing (photograph 2). This site in addition to the new 36th Street extension and interchange could have contributed to the large amount of sediment discovered in the stream. The stream exhibits moderate streambank erosion as it flows through a mature forest upstream of I-96 (photograph 4). Downstream of I-96, the stream flows through a golf course before entering a brushy forest. Downstream of Thornapple River Drive, the surrounding area is mature forest where sedimentation (photograph 3) and streambank erosion are evident. This is consistent up to the bayou at the stream's confluence with the Thornapple River.

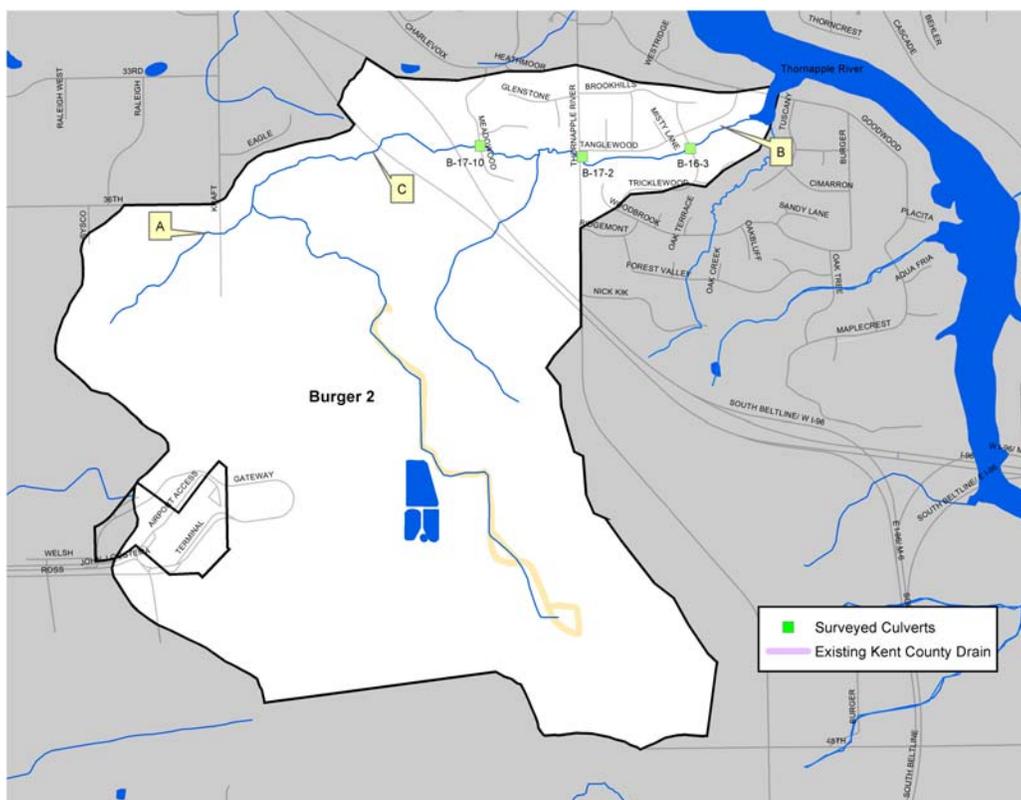


Figure B2-1



Photograph 2 (see flag A, Figure B2-1)



Photograph 3 (see flag B, Figure B2-1)



Photograph 4 (see flag C, Figure B2-1)