

SUMMARY OF TRIBUTARIES TO THORNAPPLE RIVER: WATERSHED ASSESSMENT KENT, MICHIGAN

BY: MELANIE HAVEMAN, STUDENT ASSISTANT
AND JANICE TOMPKINS, SENIOR WATER QUALITY ANALYST
FIELD OPERATION SECTION
WATER DIVISION

INTRODUCTION

The Tributaries to Thornapple River watershed are located all along the main stem of the Thornapple River in south-central Kent County. The first survey site is a small tributary just south of Kettle Lake; the final survey site is at the northern point of Cascade before the Thornapple joins the Grand River.

DESCRIPTION: The majority of the tributaries drain a predominantly forest and residential use area including the urban centers of Cascade and Caledonia. The Michigan Department of Environmental Quality (MDEQ) field staff surveyed road/stream crossings within the watershed to quickly assess the health of the watershed. The survey combined both qualitative and quantitative assessment of the Tributaries to Thornapple River and provided a basis upon which to identify any potential sources of non point source pollution negatively affecting the watershed. In total, 30 road/stream crossing locations were surveyed during the assessment of the Tributaries to Thornapple River Watershed. Refer to Attachment A, Road Stream Crossings Inventory for a summary of the survey locations conducted during September of 2004, as well as survey location maps. Site identification codes were developed using three letter identifiers for the subwatershed followed by the two digit site location number. Sites were numbered successively from the headwaters to the mouth of the Thornapple River.

METHODS

The DEQ's stream crossing watershed survey procedure was developed as a quick screening tool to assess general water quality and possible pollutant sources, causes and problems within the watershed. The survey procedure provides standardized visual assessments that can be conducted by DEQ staff or trained volunteers. Only observations that can be made from the road stream crossings are recorded; recording "educated guesses" or suspicions is prohibited. Because this assessment is based on visual observations, designed to be conducted quickly and by many different types of people and knowledge backgrounds, the survey results are only qualitative in nature.

A minimum of 30% of the road stream crossings within a watershed are to be surveyed with attention given to balanced geographical coverage and assessment across major land use changes and possible pollutant sources. Surveys are always conducted in one general direction (upstream to downstream), and the attempt is made to keep the surveyors and weather conditions consistent to limit bias and subjectivity between surveyors. This survey was conducted from the upstream to downstream direction and was completed in one day by two DEQ field staff. The right and left bank designations are always assigned based on looking downstream at each road stream crossing location.

At each survey location the following stream conditions are visually assessed:

- Weather and any event conditions
- Culvert/bridge conditions
- Channel conditions (width, depth, high water mark, riffles, pools, natural, maintained, recovering)
- Stream appearance (color, turbidity, algae, aquatic plants, trash, oil sheen, bacteria, foam)
- Substrate composition (boulder, gravel, silt, sand, unknown)
- In-stream Cover (undercut banks, overhanging vegetation, woody debris, pools, boulders, plants)
- Stream corridor (riparian vegetation type and width, bank erosion, canopy cover, adjacent land use)
- Potential Pollutant Sources (source and pathway identification)

At each survey location the following stream conditions are directly measured:

- Water temperature
- Dissolved oxygen content
- pH
- flow velocity
- latitude and longitude coordinates (GPS)

In addition each site was photo-documented with a digital picture taken in the downstream direction, upstream direction and of the road crossing. Refer to the DEQ's *Stream Crossing Watershed Survey Procedure* for further information and a complete description of the above conditions.

OBSERVATIONS

Water Temperature, pH, and Dissolved Oxygen

Survey locations were assessed in the order of upstream sites (in the headwaters) to downstream sites (towards the mouth). 29 locations were measured for temperature, pH, and dissolved oxygen content. pH values ranged from 7.25 to 8.59, which were not outside of the normal range for streams within Michigan. Overall the average temperature was 60.2°F. A few of the sites had temperatures in the mid-70s. Normal stream temperatures capable of supporting a coldwater fishery with few diseases are below 57°F. Walleye, northern pike and some trout are adapted to temperatures between 57° to 68°F while temperatures over 68°F are characteristic of fish communities characterized by bass, crappie, bluegill, carp and sucker with occurrence of fish disease high. Temperatures recorded in these tributaries could be a limiting factor to some species in this stream. The average dissolved oxygen content is 8.01 ppm; it varies from 11.79 ppm at station THO-02, on Woodland Creek, to a measurement of 2.57 ppm in a stagnant tributary. The dissolved oxygen requirement for native bass and crappie growth and well-being is 5 ppm and for trout it is at least 6 ppm. Given the dissolved oxygen content and moderate flow, tributaries to the Thornapple River could be a comfortable environment for some aquatic life, but dissolved oxygen could also be a limiting factor in many small tributaries. Refer to Figure 1 in Attachment B, which depicts the temperature, pH, and DO levels for sites on tributaries along the main stem of the Thornapple River.

Substrate

Substrate was observed and quantified for both the upstream and downstream stretch at each survey location. In all, 60 substrate observations were recorded at 30 locations. Substrate type is important when considering habitat suitability for desired species within the system (i.e. trout and other fish species). Cobble and gravel substrates with a low degree of embeddedness are the most suitable for reproduction in many fish species and are important for macro invertebrates as well. Evidence of silt and sand dominated substrate could indicate problems within the watershed such as erosion and sedimentation. Among the survey locations within the tributaries to Thornapple River Watershed, approximately 25% were dominated (50 to 100% covered) by silt, detritus or muck, and 40 % were sand dominated. 10% of the observations were dominated by gravel, and 8% were unable to be categorized due to turbidity or other factors, and in 17% of the sites the substrate was equally distributed. Refer to Figure 2 for substrate data for each of the main stem Tributaries to the Thornapple River sites.

In-Stream Cover

The presence of in-stream cover was assessed at each location for both the upstream and downstream stretches. In-stream cover, such as overhanging vegetation, undercut banks, deep pools, boulders, plant cover and large woody debris provide habitat for macro invertebrates and aquatic organisms such as amphibians and fish. Of the 60 observations made, 92% had overhanging vegetation, 63% had woody debris, 23% had deep pools, and 35% had boulders. Aquatic plants and undercut banks were each found in approximately 8% and 12% of the observations respectively. Refer to Table 1, in Attachment B for a summary of the in-stream cover observations made at each survey location.

Physical Appearance

The physical appearance of the stream at each survey location was assessed based on the presence or absence of aquatic plants, floating algae, filamentous algae, bacterial slimes, turbidity, oil sheen, foam and/or trash. In all, 60 observations at 30 sites were assessed for physical appearance; observations were recorded and rated as either present or abundant. In general, trash, foam, floating algae, and oil sheen were the least common. 22% of the sites exhibited turbidity. Approximately 30% exhibited aquatic plants (including duckweed), and 23% had filamentous algae. Refer to Table 2, in Attachment B for a summary of the physical appearance observations made for each survey location.

Stream Corridor

The width of riparian vegetation was assessed at each survey location for the both the right and left banks of the upstream and downstream stretches. The presence of riparian vegetation reduces the amount of surface water runoff to streams, provides a filter strip for nutrients within runoff waters, provides overhanging vegetation for stream habitat, provides a source of woody debris, stabilizes stream banks against erosion and determines the availability of sufficient stream canopy cover for temperature regulation. 30 survey locations were assessed, resulting in 120 observations of riparian vegetation width recorded. The observations fell similarly into all four categories. 26% had 10-30 feet of riparian vegetation, and 13% of the observation had 30-100 feet of riparian

vegetation. 33% had more than 100 feet, and the riparian width class of <10 feet was the least common and was observed 28% of the time.

The streamside land cover, estimated bank erosion and percent stream canopy were evaluated at each of the 30 survey locations for both the upstream and downstream stretches. In all, 60 observations were made for each of the above listed characteristics. Of the survey locations, 12% were recorded as having streamside land cover predominantly grasses, 43% predominantly shrubs, 43% dominated by trees, and one site consisting of bare ground. In general, vegetation such as grasses and shrubs and residential and agricultural land uses are associated with narrow riparian widths. More extensive riparian vegetation is usually associated with forests and old fields. Erosion of the banks was a problem in the tributaries to Thornapple River Watershed with 13% described as having moderate bank erosion. Refer to Table 3, in Attachment B for the distribution of riparian width and vegetation observations made for both the right and left bank at each survey location.

Stream canopy cover is important for providing shade and maintaining cool temperatures within the stream. Cooler temperatures also helps keep dissolved oxygen levels from depleting, an important habitat requirement for many fish species and other aquatic organisms. Of the 60 upstream and downstream sites assessed, 18% had less than 25% cover, 42% had between 25 and 50% cover and 40% had over 50% cover.

Adjacent Land Uses

Adjacent land uses were recorded at each survey location for both the upstream and downstream stretches as well as both the right and left banks. Because the entire section of stream that can be seen from the road crossing is evaluated, multiple land uses can be recorded for each site. Land uses within the watershed play an important role in nutrient input, erosion, and in-stream conditions that affect water quality, quantity and habitat. The most common adjacent land use was maintained lawn. Forest, shrub/old field, and impervious surfaces also appeared at many of the sites. There were also a few observations for disturbed ground and cropland. Refer to Attachment B, Table 4 and Figure 3 for a summary of all the adjacent land uses recorded within the watershed.

Potential pathways of non-point source pollution

During the completion of the road stream crossing surveys, field staff also evaluated the *potential* for non point source pollution. This assessment focuses on the severity of potential pollutant *inputs*, not pollutant *impacts*. As part of this evaluation process field staff look for 1.) a possible pollutant source, 2.) a potential pathway to the water body and 3.) potential severity of the input. Because each potential source was given a ranking of slight, moderate and high for severity, the values recorded were weighted before they were summed for each category (Refer to Figure 4, Attachment B). Observations recorded as slight were considered to be the basis for comparison, therefore observations recorded as moderate were multiplied by 1.5 and observations recorded as high were multiplied by 2. Potential non point source pollution from transportation and urban/residential runoff related sources were the most serious, while streambank erosion and development/construction related sources were also considered common sources of non-point source pollution. Refer to Table 5 in Attachment B for a summary of the non point source pollution observations identified for each survey location.

RESULTS

Tributaries to the Thornapple River:

The Tributaries to Thornapple River watershed are located all along the main stem of the Thornapple River in south-central Kent County. The first survey site is a small tributary just south of Kettle Lake; the final survey site is at the northern point of Cascade before the Thornapple joins the Grand River. Stations on tributaries to the main branch of the Thornapple River are denoted by TUPP prefixes. Refer to Attachment C for site photos and to Attachment D for site survey forms. The following conditions and comments were recorded on the survey forms:

THO-01: 84th east of Whitneyville Road

Water temperature was ~65°F, pH was measured at 8.07, and the DO was 7.16 ppm. The stream was <10 feet wide and <1 foot deep. Equal amounts of silt, detritus, and muck and sand were available for substrate observations. Some overhanging vegetation and woody debris were available for in-stream cover. Some filamentous algae, floating algae upstream, and turbidity downstream were also seen. Moderate riparian vegetation (10-30 ft) was observed which consisted of shrubs. Adjacent land uses included shrub land and forest. Potential non point source pollution (NPS) was categorized as slight for transportation non point sources. Comments were: *N/A*

THO-02: 92nd east of Whitneyville Road

Water temperature was ~75°F, pH was measured at 8.48, and the DO was 11.79 ppm. The stream was less than ten feet wide and less than one foot deep. Silt, detritus, and muck, sand, and gravel were all available for substrate observations in similar quantities. Some overhanging vegetation, woody debris, and aquatic plant cover were available for in-stream cover. Some aquatic plants and filamentous algae were also observed. Little riparian vegetation (less than 10 feet) was observed on the upstream and downstream right sides, and (10-30 feet) on the left sides of the stream. Both riparian vegetation observations consisted of shrubs. Adjacent land uses included maintained lawn and shrub/old field upstream. Potential non point source pollution (NPS) was categorized as slight upstream and moderate downstream for urban/residential runoff upstream and slight for transportation on both stream sides. Comments were: *N/A*

THO-03: Whitneyville Road north of 100th

Water temperature was ~72°F, pH was measured at 7.91, and the DO was 7.56 ppm. The stream was less than 10 feet wide and less than 1 foot deep. Sand makes up most of the substrate with lesser amounts of gravel and silt, detritus, and muck. Some upstream overhanging vegetation, upstream aquatic plant cover, and woody debris were available for in-stream cover. Some aquatic plants and downstream filamentous algae were also observed. Little

riparian vegetation (<10 feet) was observed on all stream sides but the upstream right, which had 10-30 feet of riparian vegetation. The riparian vegetation consisted primarily of trees upstream and grasses downstream. Adjacent land uses included maintained lawn and upstream forest. Potential non point source pollution (NPS) was categorized as slight upstream and moderate downstream for transportation NPS and high for downstream urban/residential runoff. Comments were: *Grass mowed right to ledge on downstream side.*

THO-04: 100th west of Whitneyville Road

Water temperature was ~70°F, pH was measured at 8.00, and the DO was 7.74 ppm. The stream was <10 feet wide and <1 foot deep. The substrate contains mostly sand with some silt, detritus, and muck. Some overhanging vegetation and woody debris were available for in-stream cover downstream. Some downstream aquatic plants were also observed. Little riparian vegetation (<10 feet) was present on all stream sides but the upstream right side, which had 10-30 feet of riparian vegetation. The vegetation upstream was characterized as trees; downstream riparian vegetation was mostly grasses. Adjacent land uses included forest and maintained lawn. Potential non point source pollution (NPS) was categorized as moderate for upstream impoundment and slight for upstream urban/residential runoff. Comments were: *Upstream impoundment with warmer temperatures; lots of fish!!*

THO-05: 100th west of Alaska

Water temperature was ~56°F, pH was measured at 8.37, and the DO was 9.55 ppm. The stream was <10 feet wide and less than one foot deep. Sand appeared to dominate the substrate with lesser amounts of Silt, detritus and muck. Some overhanging vegetation, woody debris, undercut banks and downstream deep pools were available for in-stream cover. Moderate riparian vegetation (10-30 feet) was observed upstream, and >100 feet of riparian vegetation was present downstream. Adjacent land uses included forest and upstream maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation, streambank erosion, and upstream urban/residential runoff. Comments were: *Two streams converge upstream into one at culvert.*

THO-06: Alaska Avenue south of 84th

Water temperature was ~60°F, pH was measured at 8.17, and the DO was 8.63 ppm. The stream was less than ten feet wide and less than one foot deep. Silt, detritus, and muck appeared to dominate the substrate with lesser amounts of sand present upstream. Only overhanging vegetation was available for in-stream cover. Some aquatic plants were also observed upstream. Moderate riparian vegetation (30-100 feet) was present on the upstream and downstream right sides, and >100 feet of riparian vegetation was present on the stream left sides. All riparian vegetation consisted of

shrubs. Adjacent land uses included shrubs/old fields, forest, and impervious surfaces. Potential non point source pollution (NPS) was categorized as slight transportation. Comments were: *N/A*.

THO-07: M-37 north of 100th

Water temperature was ~58°F, pH was measured at 7.43, and the DO was 2.57 ppm. The stream was less than ten feet wide and less than one foot deep. Silt, detritus, and muck appeared to dominate the substrate with lesser amounts of sand downstream. Only overhanging vegetation was available for in-stream cover. Moderate amount riparian vegetation (10-30 feet) was present downstream, and upstream there was little riparian vegetation (<10 feet); all consisted of shrubs. Adjacent land uses included shrub/old field, upstream forest and maintained lawn, impervious surfaces, downstream maintained lawn, and upstream disturbed ground. Potential non point source pollution (NPS) was categorized as moderate for transportation, urban/residential runoff, and upstream development/construction. Comments were: *Stream crossing located in Caledonia; high amount of traffic on M-37; construction on upstream side.*

THO-08: 84th east of Kraft Avenue

Water temperature was ~56°F, pH was measured at 8.05, and the DO was 8.55 ppm. The stream was less than ten feet wide and less than one foot deep. Gravel appeared to dominate the substrate with lesser amounts of silt, detritus, and muck and sand also present. Some upstream overhanging vegetation, downstream boulders, upstream deep pools, and woody debris were available for in-stream cover. Some upstream aquatic plants, upstream filamentous algae, upstream bacterial slime, and downstream foam were also witnessed at this site. Little riparian vegetation (<10 feet) was present downstream; on the upstream right side, >100 feet of riparian vegetation was available, and on the upstream left side, 30-100 feet of riparian vegetation was present. Upstream the land cover consisted of tress; downstream the land cover was bare ground. Adjacent land uses included upstream forest, upstream impervious surfaces, and maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation, high for downstream hydrology, and slight upstream and moderate downstream for urban/residential runoff. Comments were: *Stream has good substrate as well as good pool and riffle combinations upstream. Downstream has been severely altered by residence; rock/concrete walls have been put in place on streambanks; bridge and various other ornamental objects have been placed along stream.*

THO-09: 84th west of Kraft Avenue

Water temperature was ~59°F, pH was measured at 7.25, and the DO was 6.73 ppm. The stream was <10 feet wide and <1 foot deep. Silt, detritus, and muck appeared to dominate the substrate with lesser amounts of sand

also present. Only overhanging vegetation was available for in-stream cover. Some downstream filamentous algae and upstream bacterial slime were observed. Moderate riparian vegetation (10-100 feet) was present on all observations, but on the downstream right side, there were >100 feet of riparian vegetation. Land cover consisted of mostly shrubs. Adjacent land uses included, shrub/old field, downstream forest, and upstream cropland and maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation on both stream sides, slight for urban/residential runoff upstream, and moderate for upstream crop related sources. Comments were: *Low flow; bacterial sheens upstream.*

THO-10: M-37 north of 84th

Water temperature was ~58°F, pH was measured at 7.96, and the DO was 8.69 ppm. The stream was less than ten feet wide and less than one foot deep. Substrate downstream was mostly sand with less silt, detritus, and muck. Upstream, there were similar parts of gravel, sand, and silt. Some overhanging vegetation, downstream deep pools, and woody debris were available for in-stream cover. Some turbidity was also observed. Moderate riparian vegetation (10-100 feet) was present on all observations, but on the upstream left side, there was <10 feet of riparian vegetation. The land cover consisted of primarily of trees. Adjacent land uses included maintained lawn, downstream forest and upstream disturbed ground. Potential non point source pollution (NPS) was categorized as slight for transportation, slight for urban/residential runoff, and moderate for upstream development/construction. Comments were: *Upstream has some development/construction; silt fence has been properly installed.*

THO-11: Thornapple River Drive north of 84th

Water temperature was ~58°F, pH was measured at 8.16, and the DO was 9.25 ppm. The stream was <10 feet wide and <1 foot deep. Sand appears to make up the substrate with lesser amounts of gravel and silt, detritus, and muck also present. Some overhanging vegetation, boulders, woody debris and downstream deep pools were available for in-stream cover. Abundant riparian vegetation (>100 feet) was observed which consisted of trees. Adjacent land uses included forest. Potential non point source pollution (NPS) was categorized as slight for transportation. Comments were: *One culvert is filled with sand from high water events.*

THO-12: 68th east of Egan Avenue

Water temperature was ~56°F, pH was measured at 8.04, and the DO was 7.97 ppm. The stream was <10 feet wide and <1 foot deep. Sand appeared to dominate the substrate with lesser amounts of silt, detritus, and muck. Some overhanging vegetation, aquatic plant cover, and upstream boulders were available for in-stream cover. Some aquatic plants, abundant filamentous algae, and some turbidity were also observed. Upstream,

moderate riparian vegetation (10-30 feet) was present and consisted of grasses. Downstream, little riparian vegetation (<10 feet) was present and consisted of shrubs. Adjacent land uses included maintained lawn, downstream forests, and upstream impervious surface and shrub/old field. Potential non point source pollution (NPS) was categorized as slight for transportation and slight upstream and moderate downstream for urban/residential runoff upstream. Comments were: *Low flow; abundance of filamentous algae upstream and downstream.*

THO-13: Thornapple River Drive north of 68th

Water temperature was ~59°F, pH was measured at 8.37, and the DO was 9.28 ppm. The stream was <10 feet wide and less than one foot deep. Sand appeared to dominate the substrate with gravel and boulders upstream and silt, detritus, and muck downstream. Some overhanging vegetation and upstream boulders and woody debris were available for in-stream cover. Moderate riparian vegetation 10-30 feet) was present upstream, and downstream little (<10 feet of vegetation was available. The land cover consisted of trees upstream and shrubs downstream. Adjacent land uses included upstream forest, downstream shrub/old field, and upstream maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation and moderate for urban/residential runoff. Comments were: *Downstream side of the stream is the mouth.*

THO-14: Alaska Avenue north of 68th

Water temperature was ~58°F, pH was measured at 7.88, and the DO was 9.22 ppm. The stream was less than 10 feet wide and less than one foot deep. Sand appeared to make up most of the substrate with lesser amounts of silt, detritus, and muck, gravel, and boulders downstream. Some overhanging vegetation, woody debris, and boulders were available for in-stream cover upstream. Some aquatic plants were observed upstream. Abundant riparian vegetation (>100 feet) was present on all stream sides, but on the downstream right side, there was 30-100 feet of riparian vegetation. The land cover consisted primarily of trees. Adjacent land uses included forest, maintained lawn, and impervious surfaces. Potential non point source pollution (NPS) was categorized as slight for transportation, moderate for streambank erosion, and slight for urban/residential runoff. Comments were: *High streambank erosion during high water events. Bacterial slime (possibly iron bacteria) present upstream.*

THO-15: Thornapple River Drive north of 68th

Water temperature was ~58°F, pH was measured at 7.90, and the DO was 6.80 ppm. The stream was less than 10 feet wide and 1-3 feet deep. Sand appears to make up the substrate with lesser amounts of silt, detritus, and muck. Some overhanging vegetation, woody debris, downstream undercut banks, downstream deep pools, and downstream boulders were available for

in-stream cover. Some turbidity was also observed. Abundant riparian vegetation (>100 feet) was observed on all stream sides but the downstream right, which has 30-100 feet of riparian vegetation width. The land cover consisted primarily of shrubs. Adjacent land uses included shrubs/old field, downstream forest, and maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation and for upstream urban/residential runoff. Comments were: *Some bank erosion near road.*

THO-16: 60th west of Mc Cords Avenue

Water temperature was ~59°F, pH was measured at 8.25, and the DO was 10.12 ppm. The stream was less than ten feet wide and 1-3 feet deep. Sand appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, and upstream gravel also present. Some overhanging vegetation, upstream deep pools, and downstream woody debris were available for in-stream cover. Some aquatic plants were also present. Moderate riparian vegetation (10-100 feet) was observed on all sides but the upstream left, which had abundant riparian vegetation (>100). The vegetation consisted of mostly shrubs. Adjacent land uses included shrubs/old field, upstream forest and impervious surface, and downstream maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation and downstream urban/residential runoff. Comments were: *Stream is very clear with nice substrate and cover.*

THO-17: Mc Cords Avenue south of 52nd

Water temperature was ~60°F, pH was measured at 8.22, and the DO was 9.04 ppm. The stream was less than ten feet wide and less than one foot deep. Upstream, sand appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, and gravel also present. Downstream, silt, detritus, and muck dominated the substrate with also some boulders present. Some overhanging vegetation, woody debris, downstream boulders, and downstream undercut banks were available for in-stream cover. Some turbidity also observed downstream. Little riparian vegetation (<10 feet) was observed which consisted of grasses and trees on all stream sides but the downstream right, which had more than 30-100 feet of riparian vegetation width. Adjacent land uses included upstream shrub/old field and downstream maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation and moderate for downstream urban/residential runoff. Comments were: *Upstream flow through a possible old pasture; abundance of fish downstream.*

THO-18: Whitneyville Road south of 52nd

Water temperature was ~63°F, pH was measured at 8.39, and the DO was 9.36 ppm. The stream was 10-25 feet wide and 1-3 feet deep. Upstream, silt, detritus and muck appeared to dominate the substrate with lesser amounts of sand and boulders also present. Downstream, Gravel appeared to

dominate the substrate with lesser amounts of silt, detritus, and muck also present. Some overhanging vegetation, boulders, and upstream woody debris were available for in-stream cover. A moderate amount of riparian vegetation (10-100 feet) was observed which consisted of shrubs and trees on all stream sides but the downstream right, which has <10 feet of riparian vegetation width. Adjacent land uses included maintained lawn, downstream shrubs/old field, upstream forest, and upstream impervious surfaces. Potential non point source pollution (NPS) was categorized as slight for transportation and urban/residential runoff and moderate for upstream municipal point source pollution. Comments were: *Flows out of a large pond through the community of Whitneyville. Large municipal empties into stream on upstream side.*

THO-19: Whitneyville Road north of 52nd

Water temperature was ~56°F, pH was measured at 7.44, and the DO was 7.27 ppm. The stream was <10 feet wide and 1-3 feet deep. Sand appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, and gravel also present. Some overhanging vegetation, boulders, woody debris, and downstream deep pools were available for in-stream cover. Some foam was also seen downstream. Abundant riparian vegetation (>100 feet) was available, which consisted primarily of trees. Adjacent land uses included only forest. Potential non point source pollution (NPS) was categorized as slight for transportation and streambank erosion. Comments were: *Downstream has formed a large area where the stream has become stagnant.*

THO-20: Buttrick north of 52nd

Water temperature was ~54°F, pH was measured at 8.18, and the DO was 9.85 ppm. The stream was <10 feet wide and 1-3 feet deep. Upstream, gravel appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, and sand also present. Downstream, sand appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, and gravel. Some overhanging vegetation, deep pools, and woody debris were available for in-stream cover. Abundant riparian vegetation (>100 feet) was present on the upstream and downstream left sides, and there was <10 feet of vegetation on the right stream sides. The land cover consisted primarily of trees. Adjacent land uses included maintained lawn and forest. Potential non point source pollution (NPS) was categorized as slight for transportation, urban/residential runoff, and upstream streambank erosion. Comments were: *One culvert is obstructed with sand/sediment.*

THO-21: 45th Street south of Cascade

Water temperature was ~55°F, pH was measured at 7.63, and the DO was 3.26 ppm. The stream was <10 feet wide and 1-3 feet deep. Upstream, silt, detritus and muck appeared to dominate the substrate with lesser amounts of

sand and gravel also present. Downstream substrate observations were prohibited. Some overhanging vegetation and downstream deep pools were available for in-stream cover. Abundant riparian vegetation (>100 feet) was observed which consisted of shrubs. Adjacent land uses included shrub/old and forest. Potential non point source pollution (NPS) was categorized as slight for transportation. Comments were: *Extremely low flow through the culvert.*

THO-22: Buttrick south of Cascade

Water temperature was ~57°F, pH was measured at 8.25, and the DO was 9.20 ppm. The stream was <10 feet wide and <1 foot deep. Upstream, there were similar parts sand and gravel with lesser amounts of silt and boulders. Downstream, gravel dominated the substrate with lesser amounts of sand and boulders. Some upstream overhanging vegetation, upstream boulders, and upstream woody debris were available for in-stream cover. Abundant riparian vegetation (more than 100 ft) was observed on all stream sides but the downstream left side, which had 30-100 feet of riparian vegetation. The land cover consisted of shrubs. Adjacent land uses included shrub/old field, forest, and maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation. Comments were: *Stream has low flow*

THO-23: Cascade south of 36th

Water temperature was ~58°F, pH was measured at 8.29, and the DO was 7.64 ppm. The stream was <10 feet wide, and <1 foot deep. Silt, detritus and muck appeared to dominate the substrate with lesser amounts of sand and gravel also present. Some overhanging vegetation, woody debris, and downstream undercut banks were available for in-stream cover. Abundant riparian vegetation (>100 feet) was present on all observations, but on the downstream right side, there were 30-100 feet of riparian vegetation. The land cover consisted primarily of trees. Adjacent land uses included forest, upstream shrub/old field, and downstream maintained lawn. Potential non point source pollution (NPS) was categorized as slight for downstream streambank erosion and downstream urban/residential runoff. Comments were: *Stream has quite low flow; downstream has some streambank erosion issues as well as erosion around the 3-12 inch perched culvert.*

THO-24: Kraft Avenue south of 36th

Water temperature was ~68°F, pH was measured at 8.59, and the DO was 5.17 ppm. The stream was less than 10 feet wide and less than one foot deep. Downstream, sand appeared to make up most of the substrate with lesser amounts of boulders and gravel. Upstream, substrate observations were prohibited by turbidity. Some overhanging vegetation, woody debris, and downstream deep pools, boulders, and undercut banks were available for in-stream cover upstream. Some aquatic plants were observed upstream.

Moderate riparian vegetation (10-100 feet) was present on the upstream and abundant (>100 feet) riparian vegetation was present downstream. The land cover consisted primarily of shrubs upstream and trees downstream. Adjacent land uses included shrub/old field, maintained lawn, and disturbed ground upstream and forest downstream. Potential non point source pollution (NPS) was categorized as slight for transportation and hydrology, moderate for upstream development/construction, and high for urban/residential runoff and downstream riparian vegetation removal. Comments were: *Upstream is possibly a gravel pit/ impound lake; some erosion of banks surrounding impound upstream; high amounts of streambank erosion downstream.*

THO-25: Thornapple River Drive north of I-96

Water temperature was ~55°F, pH was measured at 7.75, and the DO was 7.23 ppm. The stream was less than 10 feet wide and 1-3 feet deep. Sand appears to make up the substrate with lesser amounts of gravel and some silt, detritus, and muck upstream. Some overhanging vegetation, boulders, woody debris, and upstream deep pools were available for in-stream cover. Some upstream turbidity was also observed. Moderate riparian vegetation (10-100 feet) was present on the upstream and downstream left sides, and >100 feet was observed on the right sides in both stream directions. The land cover consisted primarily of shrubs upstream and trees downstream. Adjacent land uses included forest, impervious surfaces, upstream shrubs/old field, and downstream maintained lawn. Potential non point source pollution (NPS) was categorized as slight for transportation and urban/residential runoff. Comments were: *Stream flows through a large urban area; impound lake; some erosion of banks surrounding impound upstream; high amounts of streambank erosion downstream.*

THO-26: Burger north of 28th

Water temperature was ~69°F, pH was measured at 8.39, and the DO was 10.96 ppm. The stream is 25-50 feet wide and 1-3 feet deep. Due to level of turbidity and water depth substrate observations were prohibited. Some overhanging vegetation, woody debris, and downstream deep pools were available for in-stream cover. Upstream, some aquatic plants, some bacterial slime, and abundant floating algae and turbidity were present. Downstream, some filamentous algae and abundant bacterial slime was seen at this site. Moderate riparian vegetation (10-30 feet) was observed upstream; downstream, there was little riparian vegetation (<10 feet). The vegetation consisted of primarily trees. Adjacent land uses included forest, maintained lawn, and upstream wetlands. Potential non point source pollution (NPS) was categorized as slight for transportation, urban/residential runoff, upstream impoundment and downstream hydrology. Comments were: *Road crossing is impounding the stream so much that it has created a small wetland; downstream culvert sticks out into the Thornapple River.*

THO-27: Thornapple River Drive south of Cascade

Water temperature was ~54°F, pH was measured at 8.20, and the DO was 9.98 ppm. The stream was less than ten feet wide, and 1-3 feet deep. Upstream, gravel appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, and sand also present. Downstream, there are similar amounts of gravel, sand, and silt, detritus, and muck. Some overhanging vegetation and boulders were available for in-stream cover. Downstream, moderate riparian vegetation (10-30 feet) was observed. On the upstream left side, <10 feet of riparian vegetation was available; upstream right had abundant riparian vegetation (>100 feet). Adjacent land uses included forest, maintained lawn, and downstream impervious surfaces. Potential non point source pollution (NPS) was categorized as slight for transportation and moderate for urban/residential runoff. Comments were: *Downstream has been renovated and wrapped rocks have been installed to dam up the stream and create riffles and pools. Streambanks on left side have recently been covered with grass matting.*

THO-28: Buttrick Avenue north of 28th

Water temperature was ~58°F, pH was measured at 7.71, and the DO was 4.01 ppm. The stream was less than 10 feet wide and less than one foot deep. Silt, detritus, and muck appear to make up the substrate. Only upstream overhanging vegetation was available for in-stream cover. Little riparian vegetation (<10 feet) was present on the upstream right side, and there was more than 100 feet of vegetation on all stream sides but the upstream right which had 30-100 feet of riparian vegetation available. The land cover consisted primarily of grasses. Adjacent land uses included shrubs/old field, maintained lawn, and upstream wetlands. Potential non point source pollution (NPS) was categorized as slight for transportation and urban/residential runoff. Comments were: *Low flow.*

THO-29: Cascade north of Burton

Water temperature was ~53°F, pH was measured at 7.37, and the DO was 7.76 ppm. The stream was less than 10 feet wide and 1-3 feet deep. Silt, detritus, and muck seemed to dominate the substrate with lesser amounts of sand and boulders on the upstream side. Some overhanging vegetation and upstream undercut banks, deep pools, and boulders were available for in-stream cover. There were also abundant filamentous algae and some aquatic plants observed. Downstream, little riparian vegetation (<10 feet) was available. On the upstream left side, there was >100 feet, and on the right side, 10-30 feet of riparian vegetation were present. The land cover consisted primarily of shrubs upstream and grasses downstream. Adjacent land uses included maintained lawn, upstream shrub/old field, and downstream impervious surfaces. Potential non point source pollution (NPS) was categorized as moderate for transportation and urban/residential runoff. Comments were: *Stream has an abundance of filamentous algae. Stream flows through a large urban area.*

THO-30: Thornapple River Drive north of Cascade

Water temperature was ~66°F, pH was measured at 8.05, and the DO was 7.72 ppm. The stream was <10 feet wide and 1-3 feet deep. Downstream, due to level of turbidity and water depth, substrate observations were prohibited. Upstream, gravel appeared to dominate the substrate with lesser amounts of silt, detritus, and muck, boulders, and sand also present. Some overhanging vegetation downstream and boulders upstream were available for in-stream cover. Moderate riparian vegetation (30-100 feet) was present downstream, and there was <10 feet of vegetation upstream. The land cover consisted primarily of grasses upstream and shrubs downstream. Adjacent land uses included maintained lawn, upstream forest, and downstream impervious surfaces. Potential non point source pollution (NPS) was categorized as slight for transportation and downstream urban/residential runoff and moderate for urban/residential runoff upstream. Comments were: *Upstream is an impoundment with a waterfall and a maintained stream channel lined with concrete and rock. Downstream empties into the Thornapple River and is stagnant.*

The majority of the impacts to the stream in this area seem to result from possible nutrient runoff from lawns, and transportation erosion or erosion due to the road stream crossing (sand/gravel roads, road washout). There are also a few instances where streambank erosion, hydrology, and construction could play a part in the health of the Thornapple River through its tributaries.