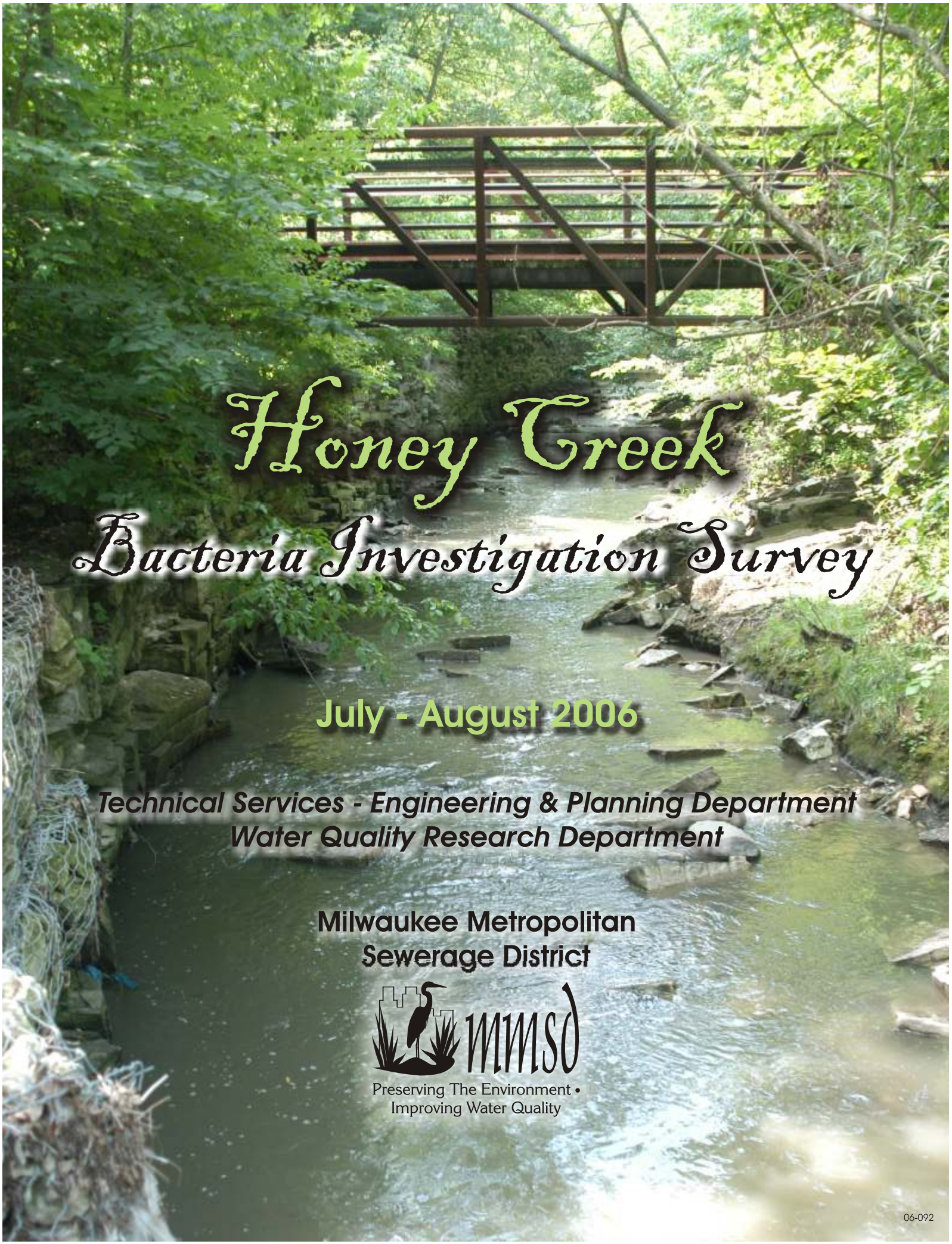

Honey Creek

Bacteria Investigation Survey

July - August 2006

Technical Services - Engineering & Planning Department
Water Quality Research Department

Milwaukee Metropolitan Sewerage District

MMSD

Preserving The Environment •
Improving Water Quality

06-092

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EXECUTIVE SUMMARY

Background

Honey Creek has a history of high bacteria levels. Routine water quality monitoring by the Milwaukee Metropolitan Sewerage District (MMSD) has shown chronically high levels of fecal coliform bacteria in the creek. A small subwatershed of the larger Menomonee River watershed, Honey Creek resides in portions of Greenfield, Milwaukee, Wauwatosa, and West Allis, including a portion that lies underneath the property of Wisconsin State Fair Park.

Much of the Honey Creek watershed is highly urbanized with significant portions of it having been heavily modified to include numerous municipal stormwater conveyance systems and outfalls. Approximately 2 miles of Honey Creek is contained in an underground concrete conduit. While these alterations accommodate high stream flows and provide a stable, low-maintenance channel, the lining and channelizaton of Honey Creek has severely degraded its overall biological integrity and function.

High bacteria concentrations have been observed along portions of Honey Creek during dry weather, low precipitation events, in wet weather conditions, as well as during the run of the Wisconsin State Fair. Past investigations have looked into potential discharges from the Wisconsin State Fair and select storm sewers in the area, in order to determine if these factors contributed to the high bacteria levels observed in Honey Creek. No conclusive findings emerged from these previous projects, due primarily to limited or sporadic data collection efforts.

Investigative Study

An intensive Honey Creek monitoring survey was conducted by MMSD's Water Quality Research Department in July and August of 2006. The goal of this investigation was to identify specific areas that may be contributing high levels of bacteria and determine if further exploratory work is necessary or if regulatory intervention is required. Listed in Table ES -1 and shown in Figure ES-1 are the sampling locations selected for this investigation.

Table ES -1. Honey Creek Bacteria Monitoring Locations - 2006

SITE ID	Location
HC-1S	81st Street & Arthur Avenue (Honey Creek downstream of McCarty Park)
HC-2S	84th Street & O'Conner Street (Honey Creek downstream of State Fair Park)
HI-3B	Honey Creek Parkway near 80th & Stevenson Streets (Storm sewer outfall)
HI-4B	79th Street & Mt. Vernon Avenue (Storm sewer outfall)
HI-5B	Honey Creek Parkway & Mary Ellen Place (Storm sewer outfall)
HC-3S	80th Street & Wisconsin Avenue (Honey Creek at Wisconsin Avenue)

Sampling was undertaken before, during, and after the Wisconsin State Fair. Three storm sewer discharge outfalls along Honey Creek were also examined concurrently with in-stream monitoring.

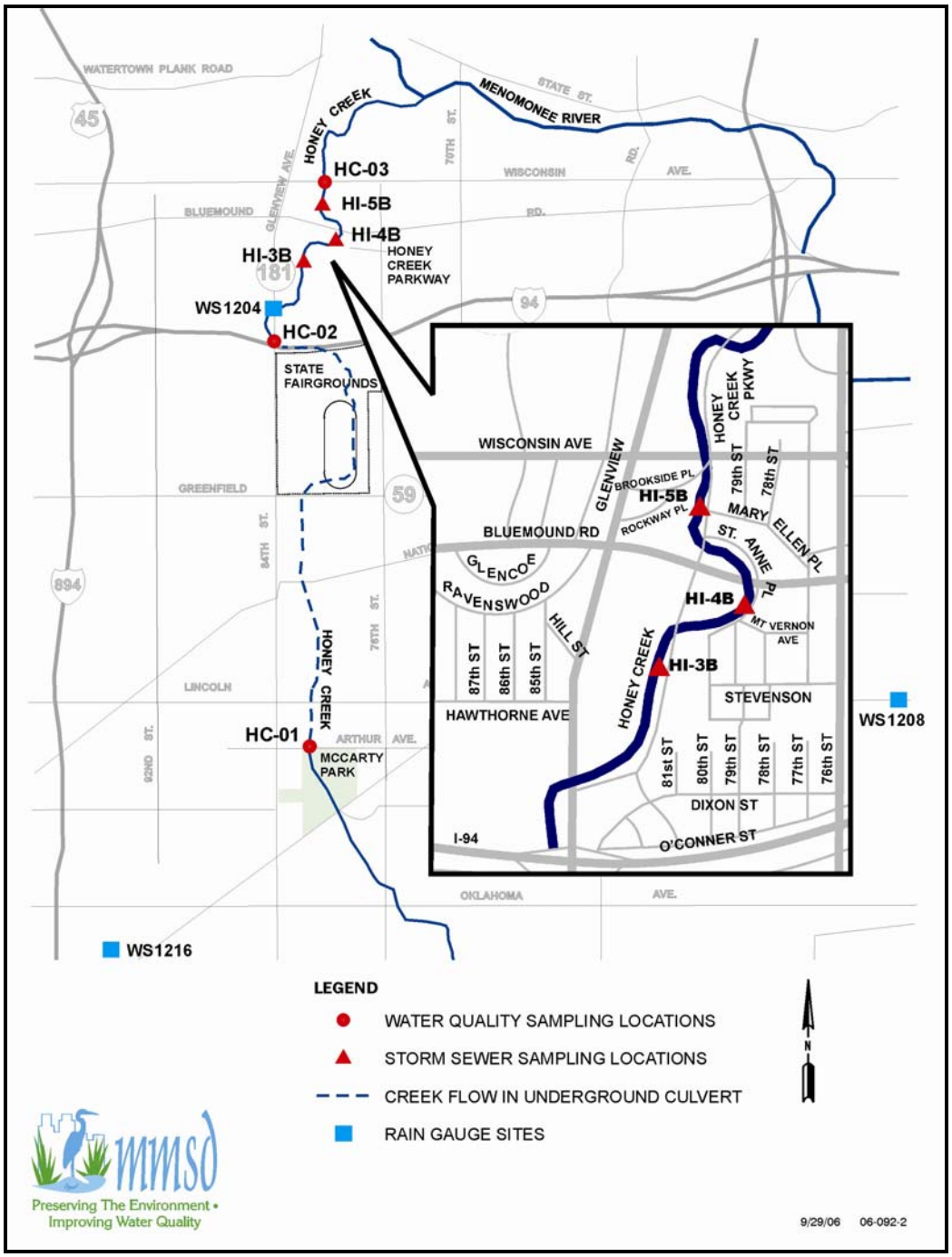

Figure ES-1. Honey Creek Bacteria Investigation Monitoring and Rain Gauge Locations

Two baseline surveys were completed before the State Fair began, six surveys were conducted during the run of State Fair and three surveys were concluded after State Fair was complete. The monitoring timeline and frequency is shown in Table ES-2:

Table ES-2. Monitoring Timeline and Frequency - 2006

Pre-State Fair (Baseline)	During State Fair	Post-State Fair
July 26th – 1 time/day	August 3rd – 1 time/day	August 14th -16th – 1 time/day
July 31st – 1 time/day	August 7th-10th – 3 times/day	
	August 11th – 2 times/day	

Fecal coliform and *E. coli* analyses were performed by the MMSD Central Laboratory. In addition the University of Wisconsin-Milwaukee's Great Lakes WATER Institute (GLWI) carried out *Bacteroides* testing, a sensitive and specific bacteria marker capable of distinguishing human sources of fecal contamination.

Samples were also collected by field monitoring crews in-pipe within select storm sewers on the State Fair grounds or in nearby municipal streets prior to discharging to Honey Creek. These direct connections to the enclosed Honey Creek channel lie beneath the State Fair grounds. Locations of the storm sewer in-pipe sampling locations are listed in Table ES-3. Samples were collected on two dates; August 9th, 2006 during the State Fair and on August 15th, 2006 after the State Fair had finished. Samples were analyzed for both fecal coliform and *E. coli* bacteria. The intention of the State Fair storm sewer monitoring was to isolate which areas of the State Fair grounds that may be adding to the high bacteria counts being detected in Honey Creek. The 84" diameter storm sewer connection under the Milwaukee Mile Track oval on the State Fair grounds displayed the highest levels of bacteria contamination on both monitoring dates (Table ES-3).

Table ES-3. Storm sewer Locations and Fecal coliform (FC) and *E.coli* (EC) counts

Site ID	Location	August 9th FC/EC counts/100 ml	August 15th FC/EC counts/100 ml
StWE01	36" diameter pipe at 77th and Madison Sts.	1900/1500	No Sample
StWE02	39" diameter pipe at 77th and Washington Sts.	450/630	No Sample
StWE03	48" diameter pipe at 77th and Walker Sts.	48,000/24,000	2300/2500
StWE05u	78" diameter pipe at 84th and Walker Sts.	No Sample	1000/590
StWE05	84" diameter pipe on State Fair Grounds; under Milwaukee Mile Track	600,000/610,000	240,000/4600

Sanitary Sewer Dyeing Efforts

The storm sewer located at 79th Street and Mount Vernon Avenue (HI-4B) consistently had the highest bacteria counts measured throughout the investigation. In an effort to determine the cause of the high bacteria levels dye was introduced into the sanitary sewer system in three locations to see if there was a flow exchange taking place from the sanitary sewer into the storm sewer in this residential neighborhood. The most downstream sanitary sewer was viewed to determine when the dye made its way through the subject area. The 79th Street and Mount Vernon Avenue storm sewer outfall (HI-4B) was also viewed to determine if any of the dye transferred from any of the sanitary sewer system lines to the storm sewer outfall. No dye was observed entering in the storm sewer outfall during the dye testing. Though no dye was evident in the storm sewer line, not all

possible routes of sanitary sewage entry were examined. Direct private lateral connections to the storm sewer could be one possibility, if only remotely, since there was no physical evidence of sanitary waste. A more likely scenario is failing laterals that are allowing seepage of sanitary contamination to reach the storm sewer.

MMSD Sanitary Sewer Evaluation

Throughout this investigation the MMSD's sanitary sewer system was routinely checked for any evidence of leakage or bypassing of sanitary waste into the local storm sewers serving Honey Creek. Systems monitoring personnel evaluated computer records of current and historical flow monitoring meters and field monitoring crews visually inspected specific metering locations along Honey Creek. No evidence of overflow bypassing or leakage was found from MMSD's sewer system during this investigation.

Results

Extremely high values of fecal coliform and *E. coli* were observed during the entire sampling period. High bacteria numbers appear both in Honey Creek and in all of the storm sewer outfalls (Figure ES – 2).

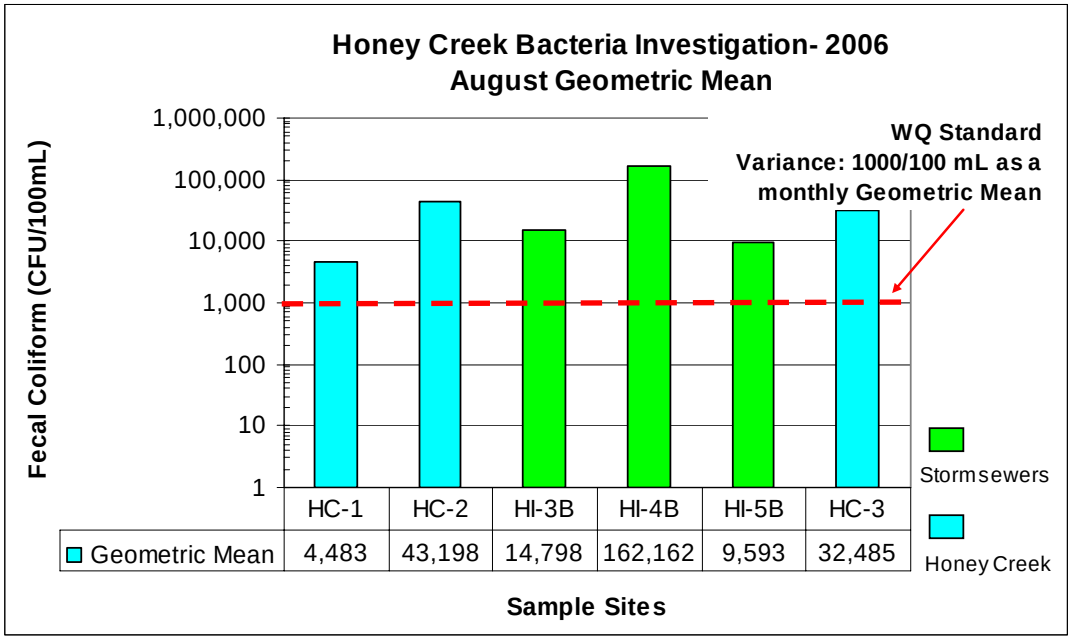

Figure ES-2. Honey Creek –Geometric Mean Fecal coliform Values for August 2006

A number of key findings were determined from the bacterial source investigations that are listed below:

- Fecal coliform bacteria levels in Honey Creek (in-stream) greatly exceed the Wisconsin Recreational Water Quality Standard for Full Body Contact and even greatly exceed the fecal coliform variance established for Honey Creek (1000 counts/100mL as a monthly geometric mean).

- The highest bacteria counts generally occurred during the morning to noon sampling time periods as measured in the three monitored storm sewers (HI-3B, HI-4B, and HI-5B).
- The storm sewer outfall at 79th Street & Mt. Vernon Avenue (HI-4B) had the highest levels of both fecal coliforms and *E. coli* throughout the investigation period. Fecal coliform levels at this location exceeded 162,000 counts/100mL as a monthly geometric mean (August 2006).
- The storm sewer outfall at 79th Street & Mt. Vernon Avenue (HI-4B) also appears to have a negative impact on the in-stream Honey Creek monitoring site downstream at 80th and Wisconsin Avenue (HC-3).
- The human specific genetic bacteria marker (*Bacteroides*) test showed positive results at all Honey Creek in-stream locations (HC-1, HC-2, and HC-3) and storm sewer outfall locations (HI-3, HI-4, and HI-5), indicating sanitary sewage contamination.
- The storm sewer outfall at 79th Street & Mt. Vernon Avenue (HI-4B) had the highest incidence of positive human specific *Bacteroides* results; with 95% of the samples testing positive.
- Storm sewer outfalls located on the Wisconsin State Fair Park grounds also contain levels of fecal coliform and *E. coli* bacteria far in excess of the Wisconsin Recreational Water Quality Standard.
- There also appears to be higher bacteria levels in Honey Creek downstream of Wisconsin State Fair Park and a distinct increase during, and shortly after the run of the State Fair.
- It is very apparent that storm water runoff and storm sewer discharges are negatively affecting the water quality of Honey Creek and downstream reaches of the Menomonee River.

Conclusions

The results of this investigation strongly imply that storm sewer inputs of fecal coliform and *E.coli* bacteria are significant to Honey Creek and that evidence of sanitary sewage is present both in the tested storm sewer system and in Honey Creek even though there were no reported sanitary sewer overflows or bypasses during the entire monitoring period by any of the communities in the study area. Monitoring of the human specific *Bacteroides* indicated that a chronic problem exists at 79th Street and Mount Vernon Avenue (Site HI-4B). Older residential areas could have exfiltration occurring from leaking sanitary sewers due to damaged lateral pipes or poor connections/seals due to subsidence. Infiltration of sanitary waste in to the storm sewers can occur though these leaking joints and poor connections or could enter the storm sewer more directly from foundation drains or sump pumps connected to the storm sewer. The presence of the human specific *Bacteroides* indicates the likelihood that sanitary waste is entering the storm system through either failing leaking pipes or perhaps some type of cross connections in this area.

It also appears that the Wisconsin State Fair negatively impacts the water quality on downstream portion of Honey Creek during its run in August.

Recommendations

Additional investigation and testing on some of the storm sewer outfalls in the study vicinity is warranted. It is recommended that the drainage area for the storm sewer outfalls that exhibited unacceptable and persistent levels of fecal bacteria be examined and potential entry routes evaluated. It must be kept in mind that both fecal colifom and *E. coli* are not considered pathogenic but rather act as indicator organisms indicating the potential presence for more serious human pathogens (viruses, protozoans). The pathogen source tracking study currently underway by MMSD should continue to determine how widespread this problem is and what are the associated health risks. Additionally, future monitoring, near the time that State Fair is operating (2007), should again be undertaken using these results to tailor a specific monitoring and remediation strategy.

The results of this evaluation should be shared and discussed with representatives from each of the communities in the study area, Wisconsin State Fair and the Wisconsin Department of Natural Resources.

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INTRODUCTION

Background

Honey Creek has a history of high bacteria levels (WDNR 1992; MMSD 1997). Since 2001, routine water quality monitoring by the Milwaukee Metropolitan Sewerage District (MMSD) has shown chronically high levels of fecal coliform bacteria, both in Honey Creek and near the confluence of Honey Creek with the Menomonee River just upstream of 70th Street in the City of Wauwatosa. Water quality modeling being conducted as part of the MMSD's 2020 Facilities Planning (FP) program has indicated unaccountably high levels of fecal coliform and *E. coli* bacteria throughout all of the Greater Milwaukee area watersheds but in particular the Menomonee River watershed near the confluence with both Underwood and Honey Creeks.

Over the last several years, high bacteria concentrations have been observed on portions of Honey Creek during dry weather, low precipitation events, and wet weather, as well as during the run of the Wisconsin State Fair. It has been shown nationally, that pollutant inputs from dry-weather flows originating from storm sewers can be high enough to significantly degrade receiving water quality because of their substantial contributions to the annual mass loading. These dry-weather flows may originate from many sources, the most important being sanitary wastewater or industrial and commercial pollutant entries, failing septic tank systems, and vehicle maintenance activities (USEPA, 1993). Past investigations have separately looked into the potential that discharges from the Wisconsin State Fair and select storm sewers in the area may contribute to the high bacteria levels seen in Honey Creek (MMSD, 1997). No conclusive consistent findings or bacterial sources came out of these previous studies; primarily due to limited or sporadic sample collection. These results prompted need for additional evaluation.

The focus of this investigation centers on identifying the potential source(s) for these high bacteria levels in Honey Creek. As such, an intensive monitoring survey was conducted by MMSD's Water Quality Research Department in July and August of 2006. It is hoped that new results may help in identifying specific areas that may be the sources of this bacteria. Samples were also analyzed for *Bacteroides,* a human bacteria indicator, used to help differentiate between human and non-human sources of fecal bacteria. If bacteria associated with presence human waste is detected further investigative work and remediation of possible sanitary sewer cross contamination will be required.

Watershed Overview

Honey Creek originates from a storm sewer outfall at South 43rd Street in the City of Greenfield. It flows primarily in a northerly direction for a distance of approximately 8.8 miles, until joining the main Menomonee River at approximately 72nd Street (Figure 1) in the City of Wauwatosa.

Honey Creek is a small subwatershed (11 square miles) of the larger Menomonee River watershed (135 square miles). The Honey Creek drainage area includes portions of the communities of Greendale, Greenfield, Milwaukee, Wauwatosa, and West Allis. The land use within the Honey Creek subwatershed is highly urbanized with approximately 65%

of the land in medium to high density residential developments. A full range of municipal street improvements are included in this subwatershed, paved streets having curbs and gutters and attendant storm sewers, which conveys stormwater runoff to Honey Creek. Parklands make up 14.7% of the land use, while commercial/industrial enterprises and institutional properties comprise 8.1%, and 9.4% of the remaining land use respectively (WDNR 1992).

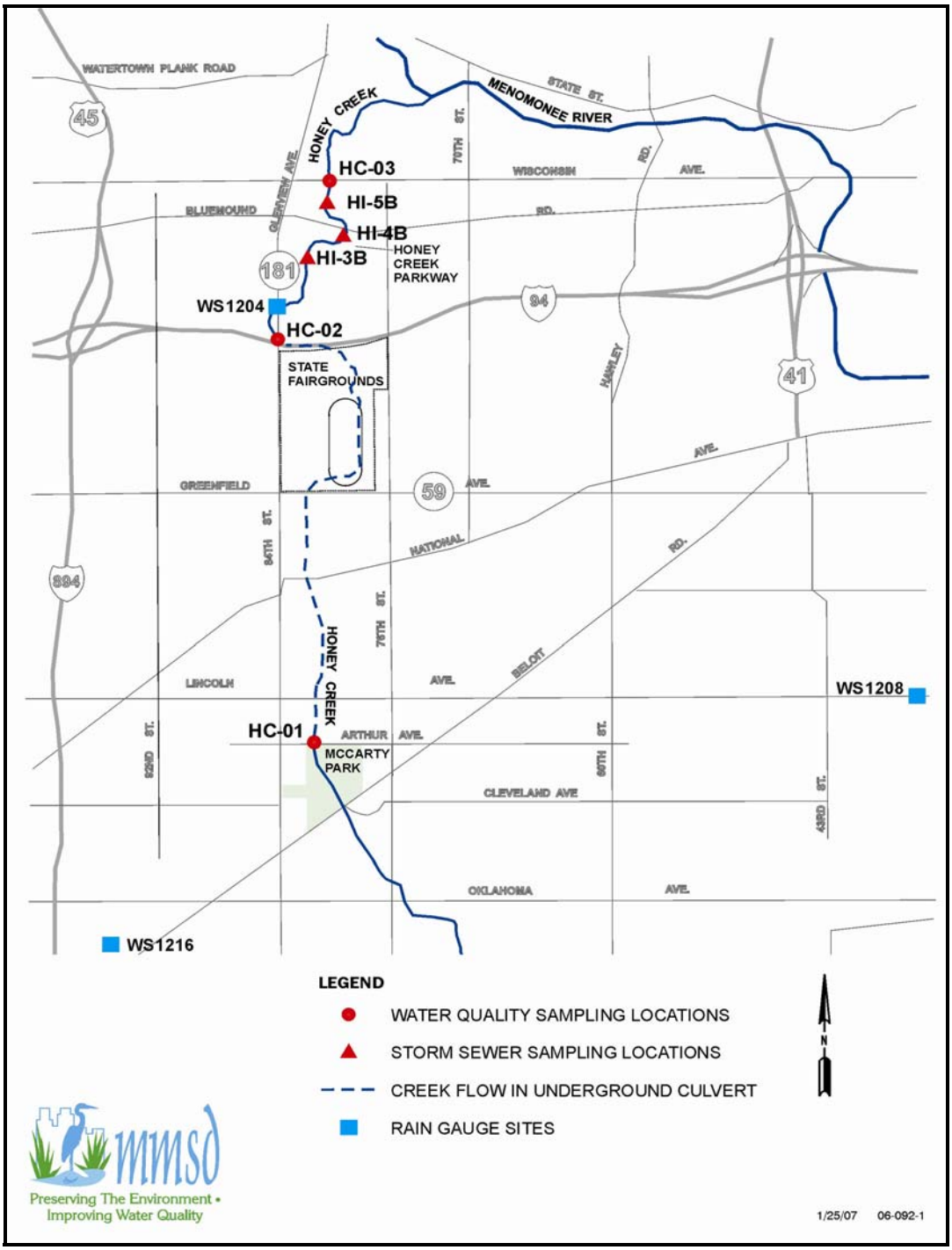

Figure 1 - Honey Creek Water Quality Monitoring Locations *(Source: MMSD)*

In addition, the Wisconsin State Fair Park is also contained within the Honey Creek watershed, located in the City of West Allis. Honey Creek flows beneath State Fair Park in an enclosed concrete channel that consists of three 10' X 15' box culverts that emerge immediately north of Interstate Highway 94 (I-94) at 84th Street and O'Connor Avenue. The enclosed, realigned channel lies directly underneath the Milwaukee Mile Race Track oval (Figure 2).

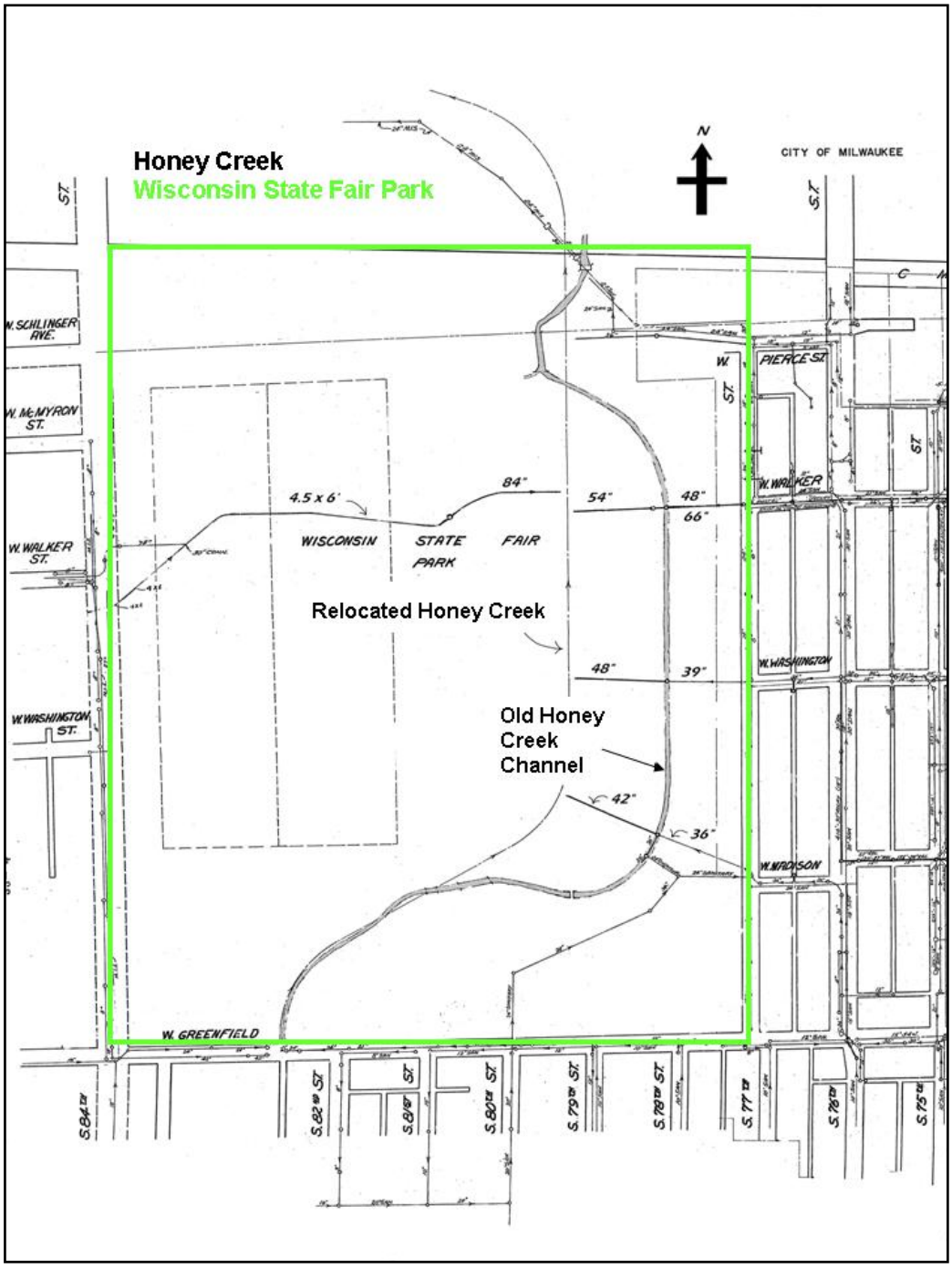

Figure 2. Honey Creek Channel Re-Located Under Wisconsin State Fair Park

Past channel modifications to Honey Creek included deepening, straightening, lining with concrete and placing in an underground, enclosed conduit for approximately two miles extending from McCarty Park to I-94 (Figure 3). Approximately 7.1 miles of Honey Creek has been changed in at least one of these manners, representing 87 percent of creek's length. These alterations were made in an attempt to accommodate increased stream flows due to development and to provide a stable, low-maintenance channel (Figure 4).

Figure 3. Honey Creek entering underground conduit at 81St Street and Arthur Avenue (north end of McCarty Park).

Figure 4. Honey Creek - Concrete Lined Channel; low-flow invert and sidewalls.

The channelizaton of Honey Creek has degraded the overall biological integrity and function of the creek from an ecological perspective. Honey Creek is classified as a Warm Water Forage Fish Community (WDNR 1992). Streams classified as such are capable of supporting an abundant, diverse community of forage fish and other aquatic life. Currently however much of Honey Creek does not meet these goals and there is a variance to the water quality standards for Honey Creek for both bacteria and dissolved oxygen levels (NR 102.02 (4)).

METHODS

Variables

The MMSD Laboratory performed fecal coliform and *E. coli* analyses on all samples (Standard Methods, 2005). Concurrently, the University of Wisconsin-Milwaukee's Great Lakes WATER Institute (GLWI) also carried out *Bacteroides* testing (Bernard and Field, 2000), a sensitive and specific marker indicating human sources of fecal contamination on most samples. These samples were collected in pre-cleaned, sterile (autoclaved) 500 milliliter polypropylene plastic bottles. Water samples were stored on ice or in a refrigerator until delivery to the laboratories for analysis. Twenty-four hour holding times were used by MMSD for all sample analysis.

Sampling Locations

Site selection and the number of surveys scheduled were determined by previous routine Honey Creek monitoring as well as earlier Honey Creek special investigations. Listed below are the 6 site identifiers and locations (Figures 5 and 6).

Site ID	Location
HC-1S	81st Street & Arthur Avenue (Honey Creek downstream of McCarty Park)
HC-2S	84th Street & O'Conner Street (Honey Creek downstream of State Fair Park)
HI-3B	Honey Creek Parkway near 80th & Stevenson Streets (Storm sewer outfall)
HI-4B	79th Street & Mt. Vernon Avenue (Storm sewer outfall)
HI-5B	Honey Creek Parkway & Mary Ellen Place (Storm sewer outfall)
HC-3S	80th Street & Wisconsin Avenue (Honey Creek at Wisconsin Avenue)

Precipitation and Stream Discharge

Precipitation and stream discharge (flow) is one of the most important factors affecting water quality. Rain gauge data collected during this investigation came from averaging daily or hourly totals from 3 area gauges (Figure 5). All sites are located in the City of Milwaukee, but are also near the other communities that are part of the Honey Creek sub-watershed. Rain gauge sites are listed below:

- Station number WS1204, 300 S. 84th Street
- Station number WS1208, 3715 W. Lincoln Avenue
- Station number WS1216, 3563 S. 97th Street

These 3 gauges were used to obtain a broader coverage of precipitation in the study area. Also stream discharge measurements in cubic feet per second (cfs) were obtained from the gauging station maintained by the United States Geological Survey (USGS) located at N. 72nd Street in the City of Wauwatosa.

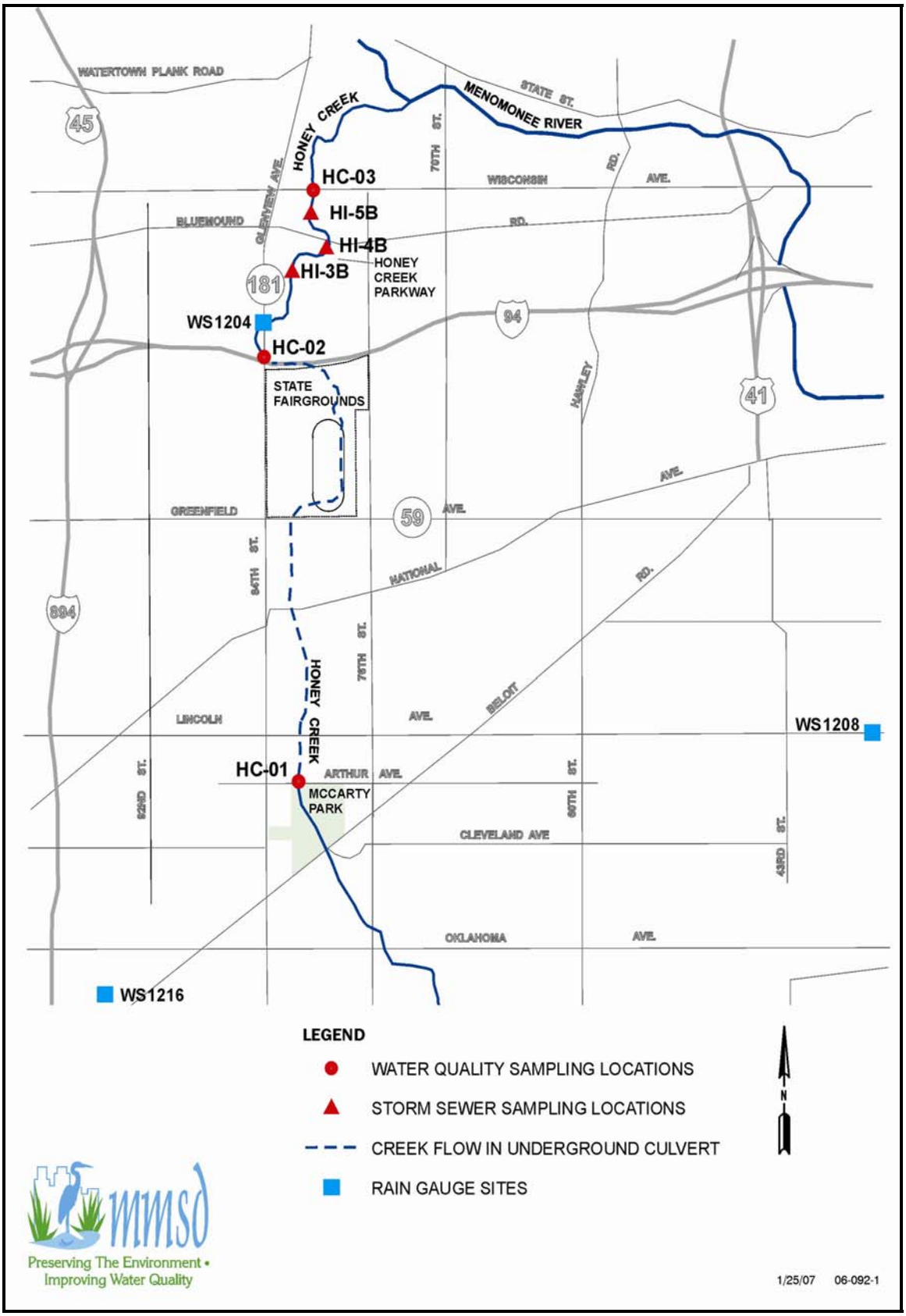

Figure 5. Rain Gauge Locations (Blue Squares) and Honey Creek Water Quality Sampling

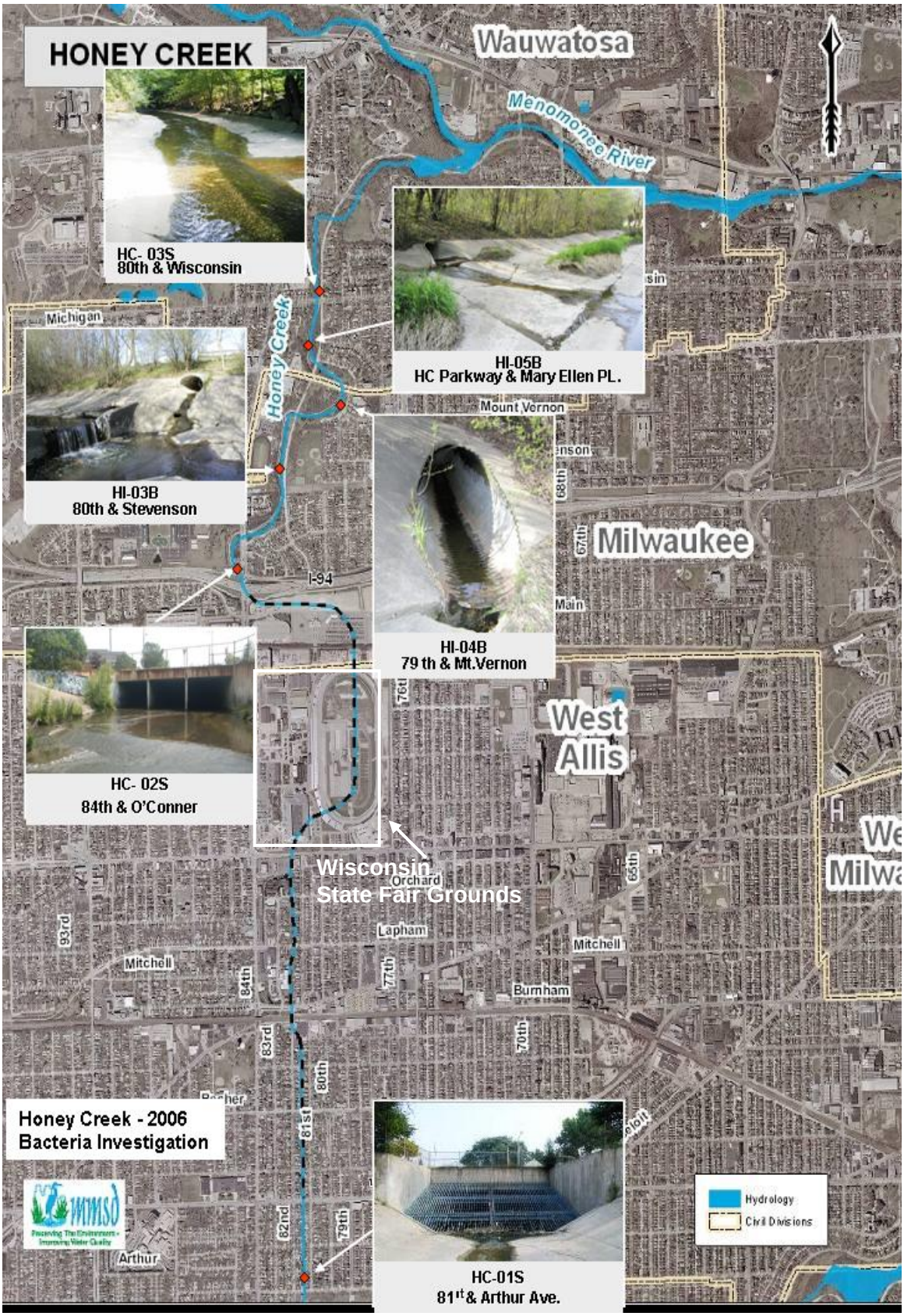

Figure 6. Spatial View (Aerial) of Honey Creek and Storm Sewer Monitoring Locations

Sampling Schedule

Sampling was conducted before, during, and after Wisconsin State Fair to determine the impact that the Fair's activities may have on Honey Creek. Select storm sewer discharge outfalls between O'Conner Street and Wisconsin Avenue along Honey Creek were also monitored at the same time (HI-3B, HI-4B, and HI-5B). Two surveys were completed before the State Fair to serve as a baseline. Fifteen surveys were completed during the run of the State Fair and three surveys were completed after State Fair had concluded. Sampling dates coincided with both dry and wet weather conditions. The monitoring timeline and frequency are detailed below.

Pre-State Fair (Baseline):

July 26, 2006 – 1 time during day
July 31, 2006 – 1 time during day

During State Fair 8/3-8/13/2006:

Samples were collected once on August 3, 2006. During the following week from August 7 through August 10, 2006, sampling occurred 3 times per day (early morning, noon time, and mid-to-late afternoon). On August 11, 2006 sampling occurred once in the morning and once in the afternoon. Multiple samplings during the day were conducted to determine whether time of day would be a factor in identifying potential sources of bacteria.

Post State Fair:

Sampling occurred 3 times during the week of August 13, 2006, at a frequency of once per day, on August 14, 15 and 16, 2006.

State Fair Grounds Monitoring

In addition to monitoring Honey Creek during the Wisconsin State Fair, samples were collected by field monitoring crews from several storm sewers (in-pipe) prior to discharging to Honey Creek. These storm sewer in-pipe sampling locations were on the Fair grounds or on the municipal streets on the perimeter of the State Fair property (Table 1). These storm sewers have direct connections to the enclosed Honey Creek channel that lies beneath the State Fair grounds. Samples were collected for both fecal coliform and *E. coli* on two separate occasions; during the State Fair (August 9th) and after the State Fair had concluded (August 15th).

Table 1. Wisconsin State Fair Storm sewer In-pipe Sampling Locations

Site ID	Location	Stormwater flow Direction to Honey Creek
StWE01	36" diameter pipe at 77th and Madison Streets	East
StWE02	39" diameter pipe at 77th and Washington Streets	East
StWE03	48" diameter pipe at 77th and Walker Streets	East
StWE05u	78" diameter pipe at 84th and Walker Streets	West
StWE05	84" diameter pipe on State Fair grounds under Milwaukee Mile Track Oval	West

Results and Discussion

Fecal Coliform and *E. coli* Bacteria

Fecal coliform and *E. coli* data were very high during the entire sampling period. These high values appear both in Honey Creek and at the monitored storm sewer outfalls. A summary of all the bacteria data collected can be found in Appendix A (Table A-1).

Sampling intervals are broken down for fecal coliform bacteria and *E. coli* interpretation into pre, during and post State Fair time frames. Bacteria counts for multiple samplings collected over the course of one day are combined and evaluated both as a daily average and as individual time of day intervals. All graphical analysis can be found in Appendix B.

Pre-State Fair - Fecal Coliforms

Two dates were sampled prior to the beginning of the State Fair on July 26 and July 31, 2006 to establish baseline conditions (Figure 7). All fecal coliform and *E.coli* samples are measured as colony forming units per 100 milliliters of sample (cfu/100mL).

As illustrated in Figure 7, the highest fecal coliform counts on July 26th occurred at all three storm sewer outfalls (HI-3B - 70,000 cfu/100 mL; HI-4B - 460,000 cfu/100 mL; HI-5B - 220,000 cfu/100 mL). These values are extremely high; nearly an order of magnitude greater than what would be considered typical for urban stormwater runoff (Novotny and Olem, 1994).

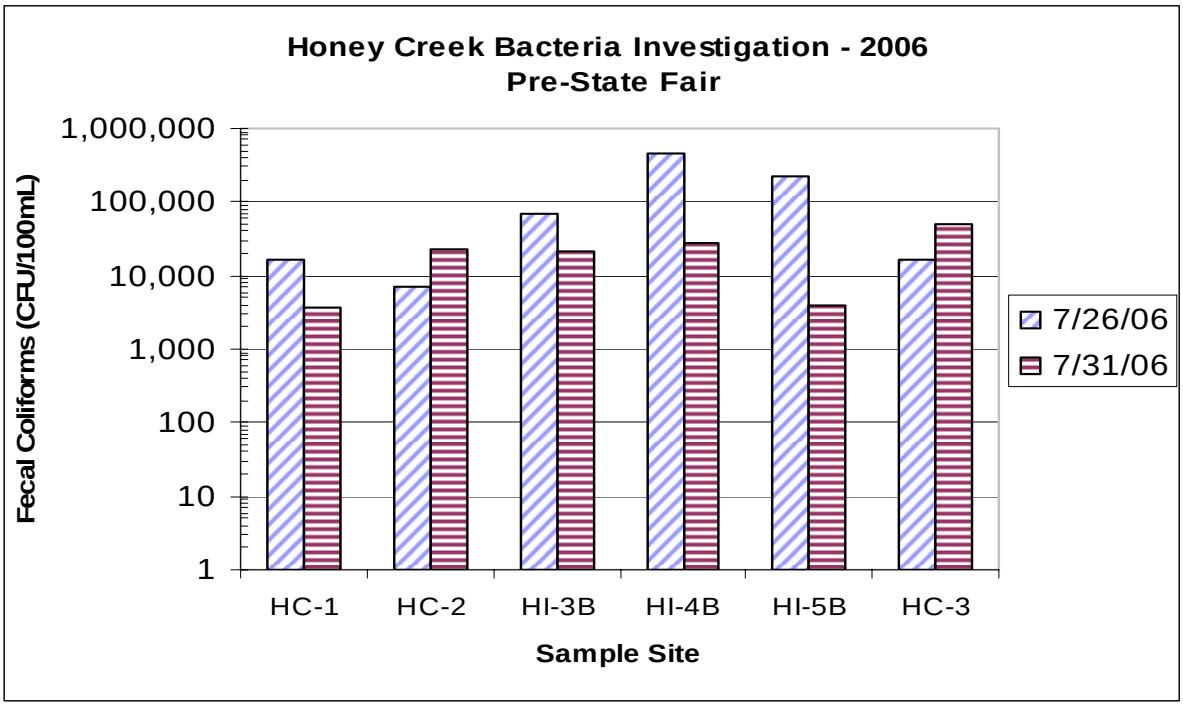

Figure 7. Honey Creek Fecal coliform bacteria – Pre-State Fair

Bacteria counts at these levels suggest the possibility of sanitary sewer input. These three storm sewer outfalls are located in a residential area downstream of State Fair and therefore have no association with activities stemming from the State Fair grounds.

On July 31, 2006, three days prior to the start of the State Fair, the highest fecal bacteria value was found in Honey Creek at Wisconsin Avenue (HC-3), where the fecal coliform value was 49,000 cfu/100 mL.

During State Fair - Fecal coliforms

Six dates were sampled while the State Fair was in progress, August 3rd and August 7th - 11th, 2006. This generated a substantial amount of bacteria data for evaluation during the actual 10 day run of the State Fair (Figure 8). Storm sewer outfall located at 79th Street and Mount Vernon Avenue (site HI-4B) consistently had most of the highest fecal values. One sample collected on August 11, 2006 had a fecal coliform count in excess of 600,000 cfu/100mL. Another date of note was on August 3rd, when Honey Creek at 80th Street and Wisconsin Avenue (HC-3) registered an in-stream fecal coliform value of 430,000 cfu/100mL. Other very high fecal coliform counts were routinely seen throughout the monitoring time period.

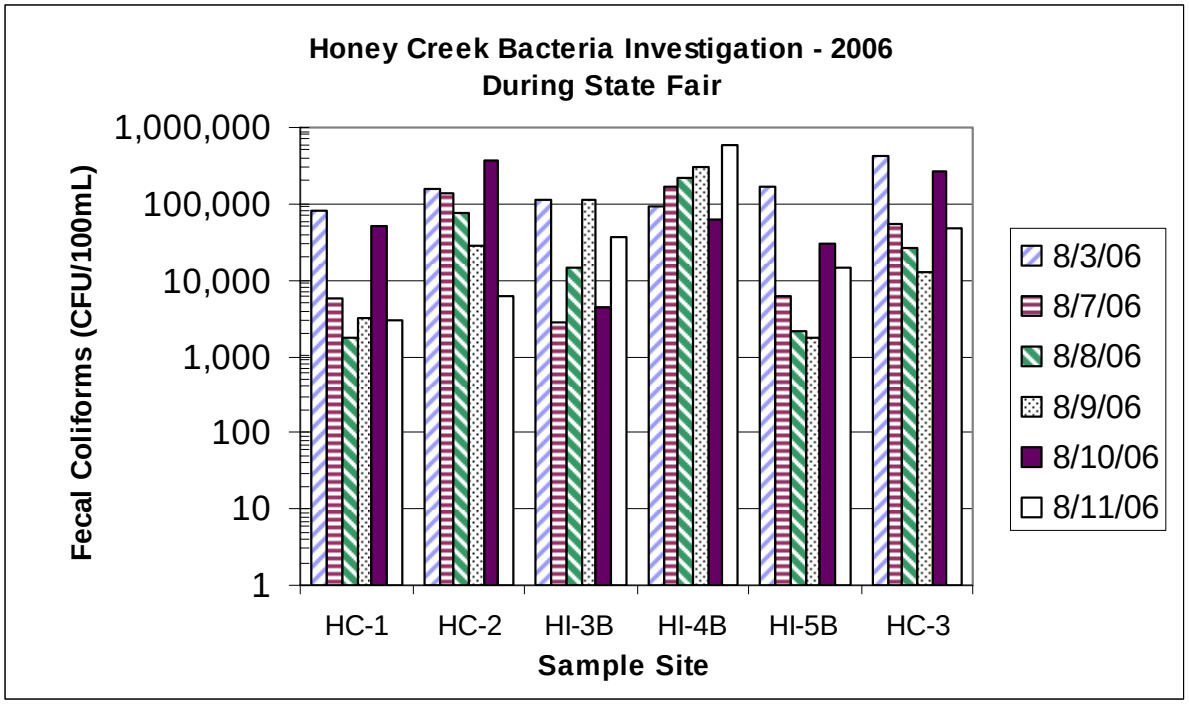

Figure 8. Honey Creek Fecal coliform bacteria – During State Fair

Post-State Fair - Fecal Coliforms

After the conclusion of the State Fair (August 13, 2006), three additional dates were sampled (August 14th - 16th , 2 006) as a post-State Fair follow up. In general, as time after the State Fair increased; fecal coliform bacteria values downstream of the Fair

grounds in Honey Creek decreased. For example, three days after State Fair ended (August 16th), in-stream fecal coliform bacteria counts both at 84th Street and O'Conner Avenue (HC-2) and 80th Street and Wisconsin Avenue (HC-3) downstream of the State Fair declined several fold, with counts no higher than 2,500 cfu/100 mL. The three storm sewer outfalls located spatial between the Honey Creek sampling sites, HC-2 and HC-3, however continued to show the same high fecal coliform concentrations. As seen previously, the storm sewer outfall located at 79th Street and Mount Vernon Avenue (HI-4B) had the highest fecal values on each of the three sampling days (Figure 9). The highest fecal coliform count at HI-4B exceeded 600,000 cfu/100mL on August 14th and a count of 540,000 cfu/100mL occurred on August 16th .

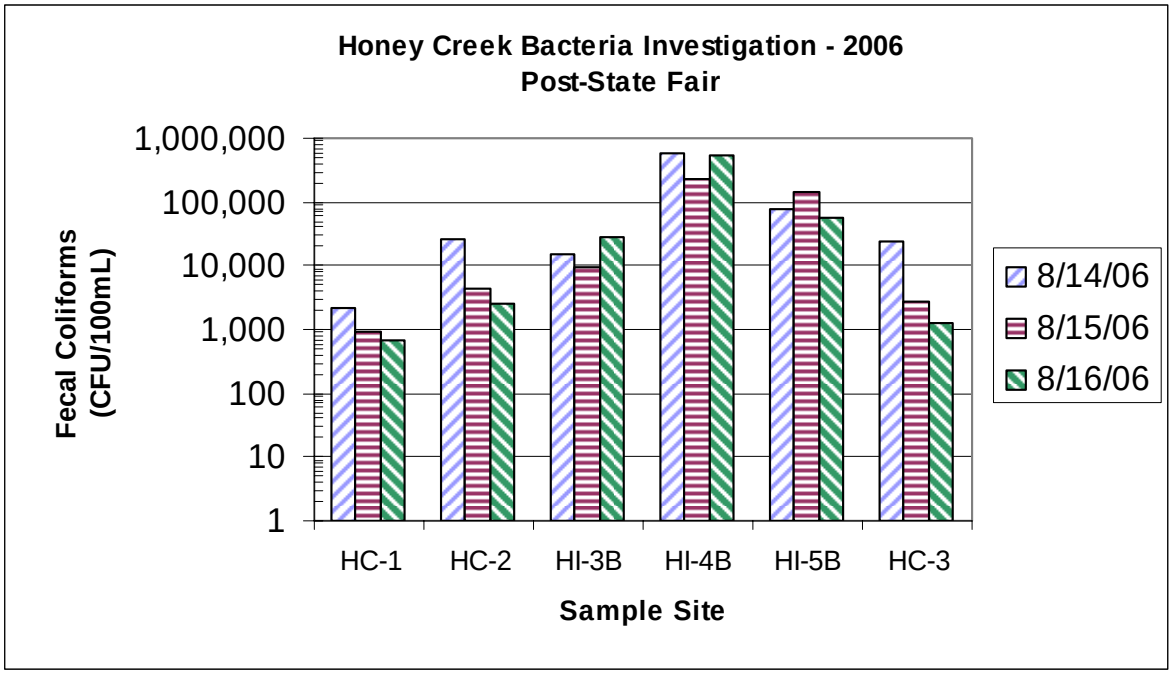

Figure 9. Honey Creek Fecal coliform bacteria – Post-State Fair

Pre-State Fair – *E. coli*

The presence of *E. coli* bacteria were also analyzed during this entire investigation and exhibited similar spatial treads and high values as did the fecal coliforms. All of the *E. coli* bacteria values are measured as most probable number per 100 milliliters (mpn/100 mL). Baseline sampling information for the two dates prior to State Fair (July 26th and 31st), are displayed in Figure 10. The highest *E. coli* count (240,000 mpn/100 mL) was measured at the storm sewer outfall located at Honey Creek Parkway and Mary Ellen Place (HI-5B) on July 26th , 2006.

The next two highest *E. coli* counts were measured at the storm sewer outfall located at 80th and Stevenson Streets (HI-3B), with concentrations of 27,000 mpn/100 mL and 28,000 mpn/100 mL on July 26th and July 31st respectively.

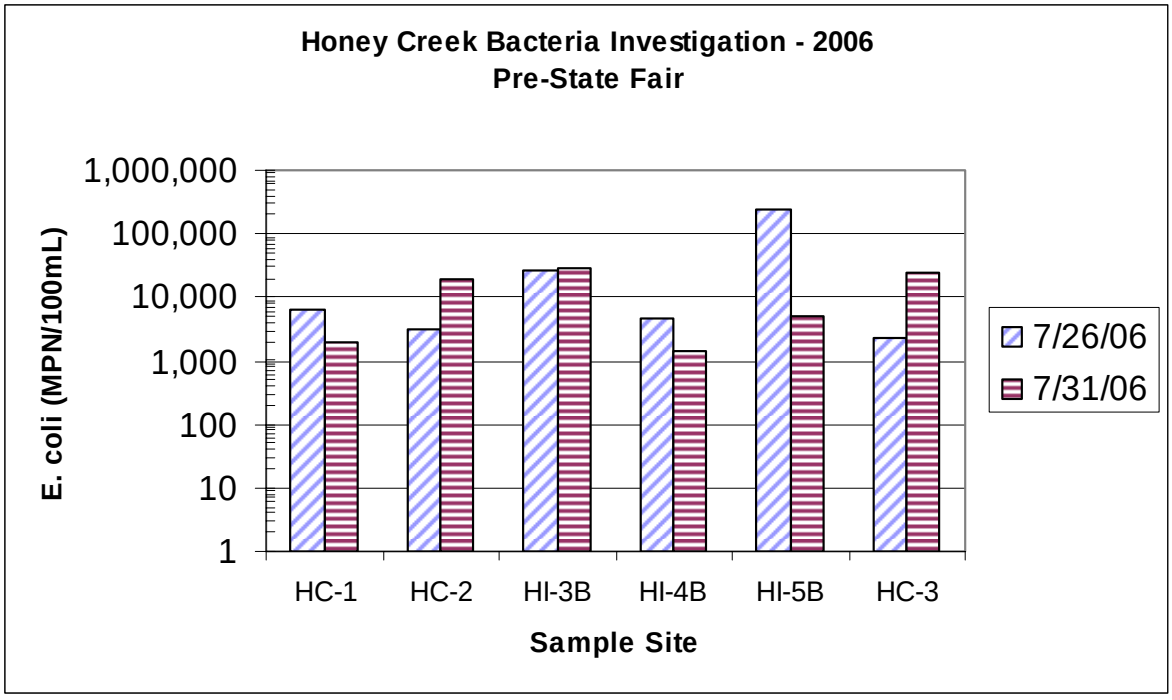

Figure 10. Honey Creek *E. coli* bacteria – Pre-State Fair

During State Fair – *E. coli*

The six dates of sampling during the run of the State Fair (August 3rd and August 7th -11th, 2006) were also analyzed for *E. coli* bacteria (Figure 11). As was seen previously with fecal bacteria, the storm sewer outfall located at 79th Street and Mount Vernon Court (HI-4B) exhibited the highest *E. coli* counts (323,000 mpn/100 mL on August 8th, 421,000 mpn/100 mL on August 9th, and 955,000 mpn/100 mL on August 11th).

The highest daily average for *E. Coli* counts for in-stream sampling sites occurred at 84th and O'Conner Streets (HC-2) on August 10th (618,000 mpn/100 mL). This date coincided with a slight amount of rainfall (0.07 inches) and modest increase in stream flow; rising from 2.1 cubic feet per second (cfs) on August 9th to 13.8 cfs on August 10th.

On two dates in-stream *E.coli* concentrations at 80th Street and Wisconsin Avenue (HC-3) were quite high; August 3rd (100,000 mpn/100 mL) and August 10th (110,000 mpn/100 mL). Rainfall is associated with both of these dates. High *E. coli* numbers, as with fecal colifom bacteria, are routinely seen at nearly all the sampling sites, both in-stream and at the storm sewer outfalls during this time period.

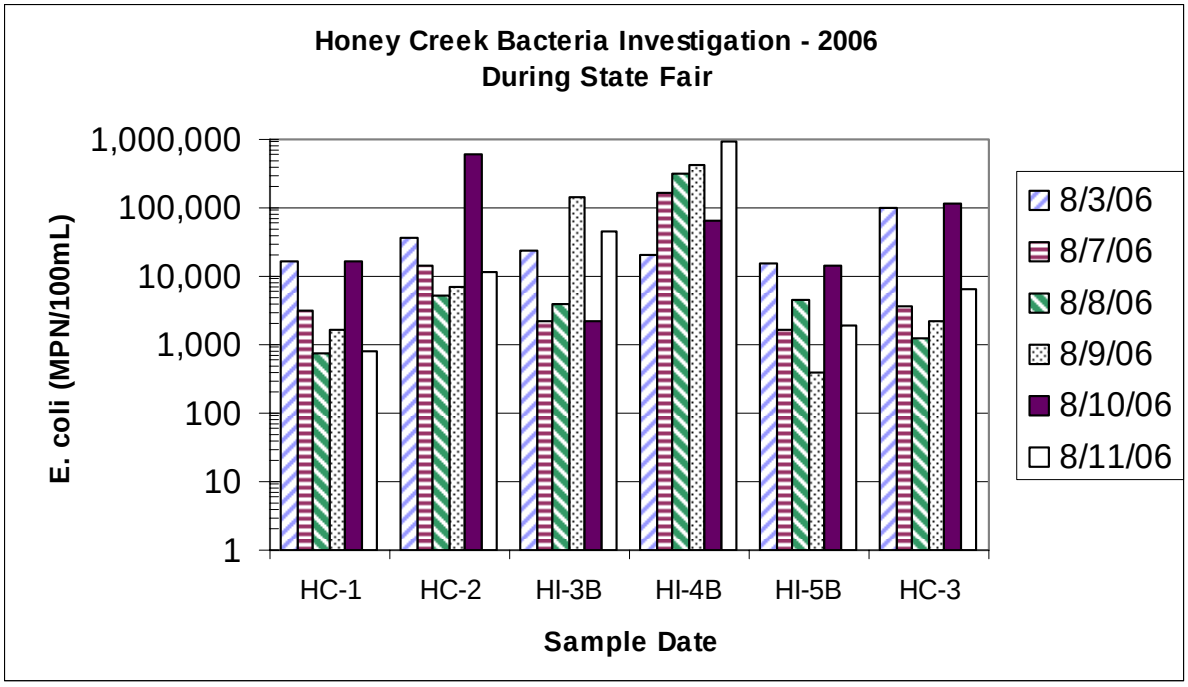

Figure 11. Honey Creek *E. coli* bacteria – During State Fair

Post-State Fair – *E. coli*

The three dates after the conclusion of the State Fair (August 14th -16th, 2006) continued to show very high *E. coli* bacteria counts levels as was seen with fecal coliform levels at all the three storm sewer locations (Figure 12).

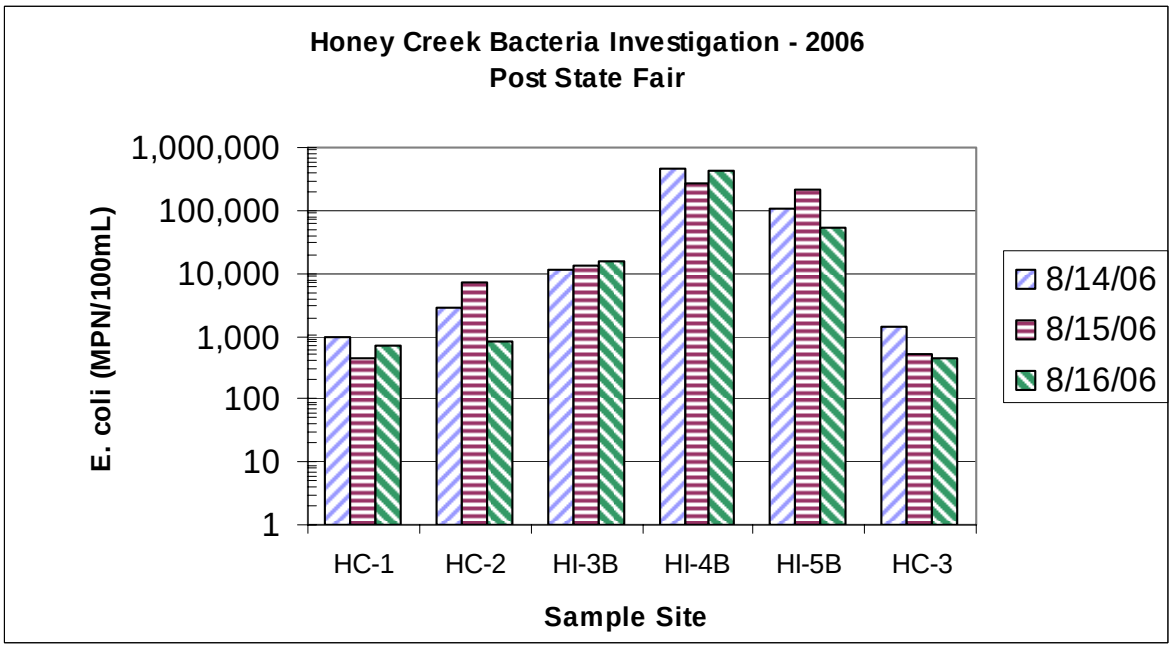

Figure 12. Honey Creek *E. coli* bacteria – Post-State Fair

The storm sewer outfall at 79th Street and Mount Vernon Avenue (HI-4B) exhibited the highest *E. coli* numbers on all three days. *E. coli* bacteria counts of 460,000 mpn/100 mL, 260,000 mpn/100 mL and 420,000 mpn/100 mL were measured on August 14th, 15th and 16th respectively. These *E. coli* bacteria concentrations are extremely high and are indicative of some type of sanitary waste contamination.

Precipitation and Stream Discharge

Precipitation and stream discharge are important factors affecting water quality. A few dates during the Honey Creek investigation period coincided with modest rainfall, including August 2nd, 3rd, 6th, 9th and 10th, 2006. Many days however during the sampling period had no precipitation at all. A breakdown precipitation (inches) and stream discharge (flow in cubic feet per second (cfs)) in July and August during the Honey Creek bacteria surveys is shown in Figure 13. The highest daily average stream flow in Honey Creek occurred on August 6th (34 cfs), which coincided with the highest recorded rainfall (0.53 inches) as would be expected. Other Honey Creek stream flow dates, August 3rd (8 cfs) and 10th (13.9 cfs), coincided with some high bacteria concentrations. An in-stream fecal coliform bacteria count of 430,000 cfu/100mL was recorded on August 3rd at 80th Street and Wisconsin Avenue (HC-3), and value of greater than 600,000 cfu/100mL was recorded on August 11th at 79th Street and Mount Vernon Avenue storm sewer outfall (HI-4B), the day after an approximately 0.07 inch rainfall.

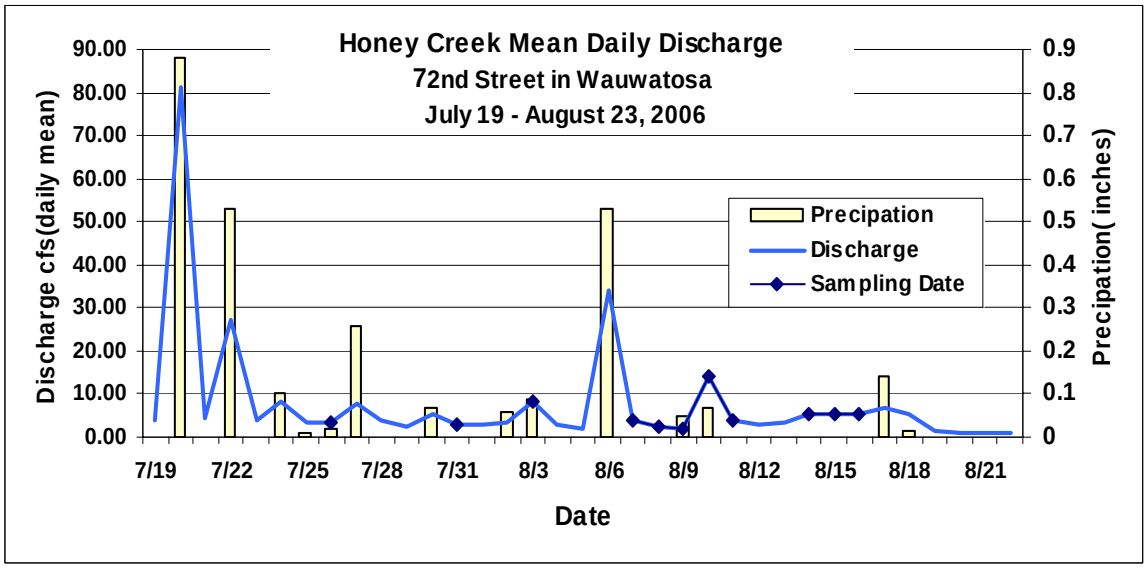

Figure 13. Honey Creek relationship of Discharge (cfs) and Average Daily Precipitation (in.)

As mentioned previously Honey Creek at 80th Street and Wisconsin Avenue (HC-3) had *E. coli* counts of 100,000 mpn/100mL and 110,000 cfu/100mL on August 3rd and August 10th respectively and both days had higher than average in-stream flows. Similarly, the storm sewer at 79th Street and Mount Vernon Avenue (HI-4B) had an extremely high *E. coli* number of 955,000 mpn/100mL on August 11th. The absence of precipitation however, does not automatically ensure lower bacteria levels. Elevated bacteria counts were present on many dry sampling days, having low in-stream flows.

Comparison of Bacteria Levels with All Sample Dates

While the fecal coliform values were high at all locations, there appears to be higher bacteria levels downstream of State Fair and a distinct rise in quantity of bacteria during, and shortly after the State Fair in Honey Creek (Figure 14). Without question, the highest bacteria amounts measured consistently originated from the storm sewer outfall located in the residential neighborhood at 79th Street and Mt. Vernon Avenue in the City of Milwaukee (HI-4B). While the discharge volume from this storm sewer outfall was generally quite low (a constant low flow discharge), its' bacterial concentration cannot be minimized. Consequently, this outfall appears to have a negative impact on the in-stream Honey Creek monitoring station just downstream at 80th Street and Wisconsin Avenue (HC-3).

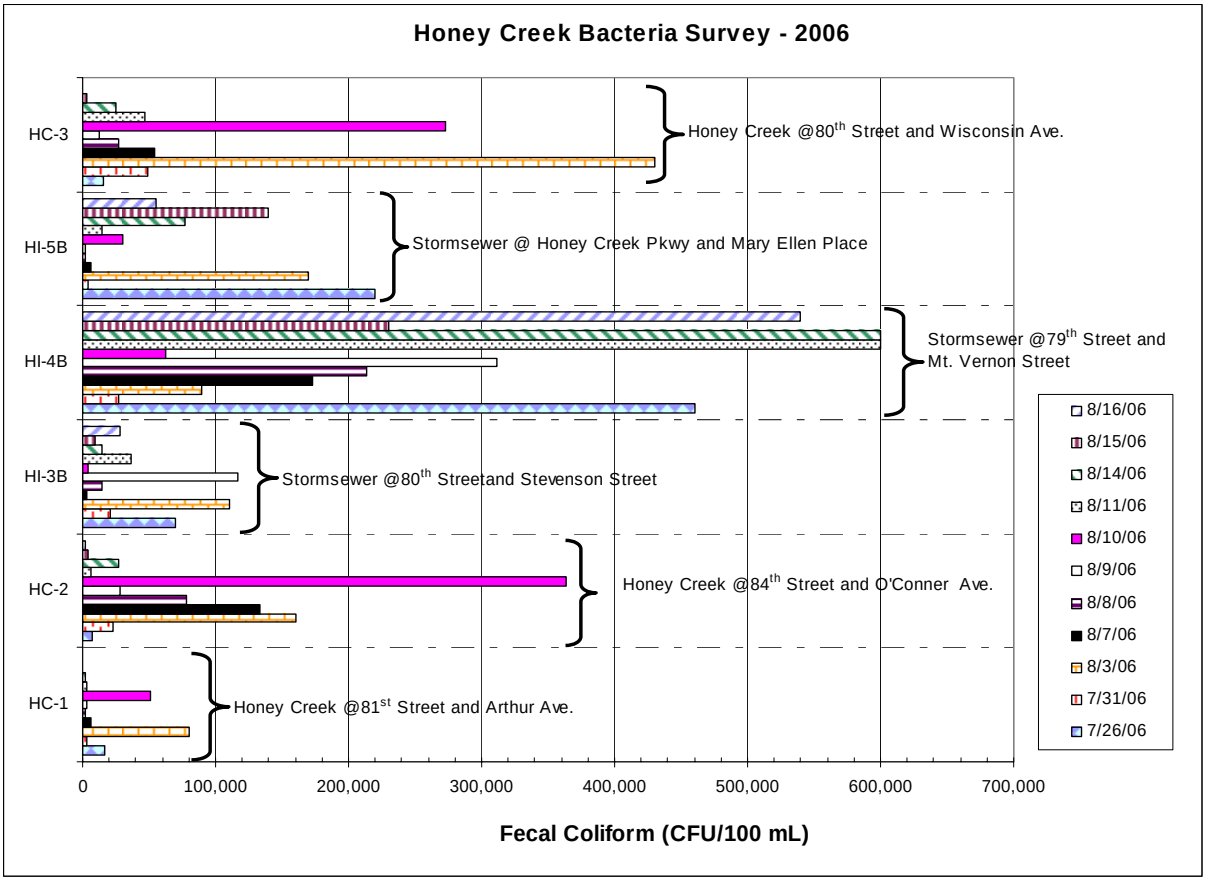

Figure 14. Honey Creek Fecal Coliform Bacteria - Location and Sampling Date

Comparison of Bacteria Levels with Time of Day

While the fecal coliform values were high at all locations at all times of the day, generally there appears to be higher bacteria levels in the storm sewer system during the morning hours between 7:00 a.m. and noon (Figure 15). Theoretically this increase would coincide with higher flow typically seen in the sanitary sewer system as daily activities increase. Samples were collected three times per day days during the week of August 7th - 10th and twice per day on August 11th.

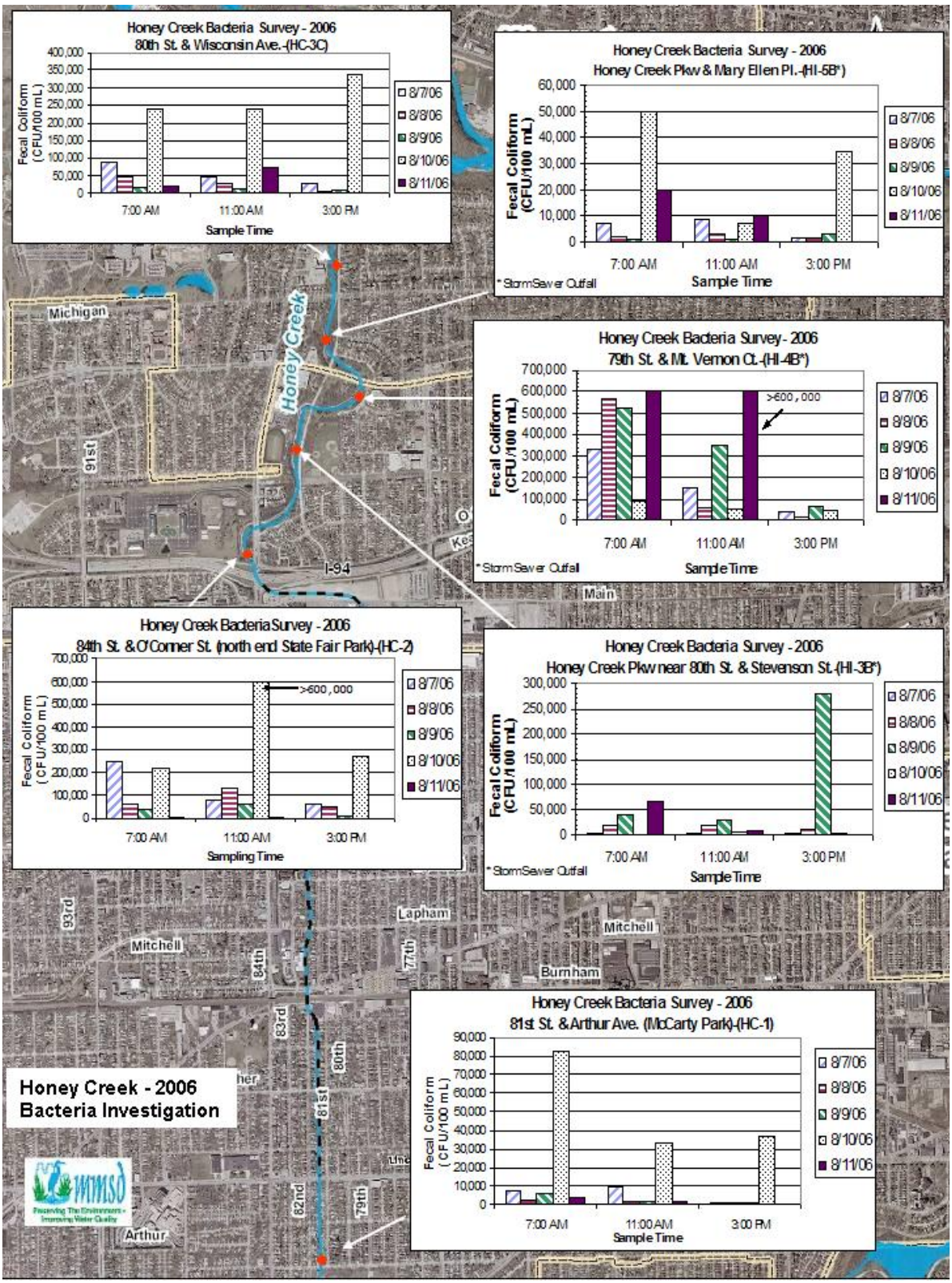

Figure 15. Time of Day and Location of Fecal Coliform Bacteria Counts

There were a few exceptions to this observation; most noteworthy was the afternoon (3:00 p.m.) sample collected 80th Street and Stevenson Street (HI-3B) on August

9th when the highest fecal coliform and *E. Coli* counts were measured at 280,000 cfu/100 ml and 410,000 mpn/100 mL respectively.

Comparison of Bacteria Levels to State Water Quality Standard

In order to gain a better overall picture, the fecal coliform bacteria data was compared to the State of Wisconsin water quality standard. Honey Creek has a water quality variance to the State Bacteriological Standards for Recreational Use (NR 102.02 (4)) for fecal coliforms. Under this variance, bacteria counts shall not exceed 1000/100 mL as a monthly geometric mean based upon not less than 5 samples per month nor exceed 2000/100 mL in more than 10% of all samples during any month. Measured bacteria values in Honey Creek during August, 2006 greatly exceed this water quality standard. For example, Honey Creek at HC-1 was four (4) times the standard, HC-2 was more than forty (40) times the standard and HC-3 was more than thirty (30) times the standard (Figure 16).

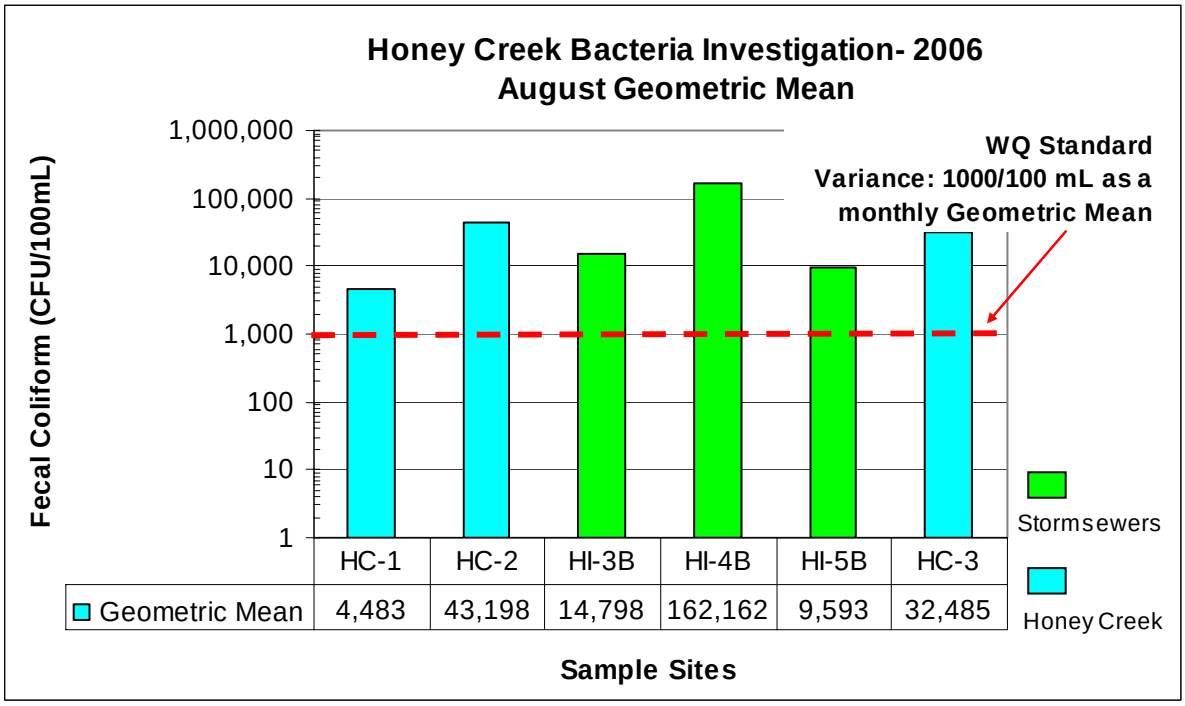

Figure 16. Honey Creek Fecal Coliform Bacteria - Geometric Mean Values for August 2006

Human Specific *Bacteroides Evaluation*

Water from stormwater runoff is discharged from outfalls that are located primarily along rivers of various watersheds. Stormwater discharge contains a mixture of contaminants that flow directly into surface waters during rain/snowmelt events. These discharges impact water quality in both the immediate river/creek and ultimately Milwaukee's Outer Harbor and Lake Michigan. Stormwater runoff, a form of non-point source pollution, has both aquatic ecosystem and public health implications because it has been linked to both acute and chronic toxicity and illnesses through exposure to contaminated waters.

The potential for unrecognized human sanitary inputs entering a stormwater system due to illicit cross connections and failing infrastructure within storm sewer systems is not widely known. However, data collected as part of another study conducted in Milwaukee; the Bacterial Source, Transport and Fate Study (McLellan and Jensen-Hollis, 2006), demonstrated that of 60 stormwater outfalls examined, over 30% tested positive for human-specific genetic markers of fecal pollution.

It is difficult for municipalities to develop and implement effective stormwater pollution reduction strategies without first knowing the sources of contamination. Therefore it is beneficial to identify stormwater outfalls within Honey Creek and other greater Milwaukee watersheds that are discharging elevated levels of bacteria and other potential human pathogens from the storm sewer system. If it can be determined that the origin of the pollution is from primarily human or non-human sources, it would provide valuable information to water resource managers/engineers who are responsible for the design, construction, operation and maintenance of these stormwater systems.

For this study samples were tested for *Bacteroides*, a type of bacteria that can be used to identify human-specific contamination (Kreader, 1995). Previous studies have indicated that *Bacteroides* spp. may be one of the most sensitive fecal indicator genetic markers since *Bacteroides* are present in fecal pollution at a much higher abundance (1000X) than fecal coliforms (Fiksdal, et. al., 1985). In addition, certain species of *Bacteroides* have been found to be exclusively harbored in humans, and not in other sources of fecal pollution such as other animals like cows or gulls (Bernhard and Field, 2000b). *Bacteroides* are obligate anaerobes and are not expected to survive for extended periods of time in the environment (Carrillo *et al*., 1985; Kreader, 1998; Resnick and Levin, 1981). However, research in the Milwaukee Harbor and Lake Michigan indicates that human specific *Bacteroides* (HF183F/708R) cells remain intact for similar amounts of time to that of culturable *E. coli* (McLellan, 2004). Because these results demonstrate that the human specific *Bacteroides* marker is a sensitive and specific marker for human sources of fecal contamination, samples collected from Honey Creek and attendant stormwater outfalls were analyzed for the *Bacteroides* human specific genetic marker by University of Wisconsin-Milwaukee's Great Lakes WATER Institute.

Urban stormwater runoff has been identified both nationally and locally as a major source of fecal coliform and *E. coli* bacteria and one of the leading causes of water quality impairment (Bannerman, et. al., 1993; USGS, 1996; USEPA, 1996). Tracking the sources of bacterial contamination in stormwater is therefore crucial. This study repeatedly sampled the three in-stream and three stormwater outfalls along Honey Creek for the *Bacteroides* human specific marker, for evidence of human sources of fecal pollution. Overall a total of 120 samples were analyzed for *Bacteroides* human specific marker (Table 2).

The *Bacteroides* human specific genetic marker was found (tested positive) at all Honey Creek locations. Storm sewer outfall at 79th and Mount Vernon Avenue (HI-4B) demonstrated the highest incidence of positive *Bacteroides* human specific marker with 19 of 20 samples testing positive (95%). Conversely, the storm sewer outfall at Honey Creek

Parkway and Mary Ellen Place (HI-5B) had the lowest incidence of positive results with 5 of 20 samples testing positive (25%).

Table 2. Honey Creek Sampling – Human Specific *Bacteroides* Percentages

Site ID	Location	Human Bacteroides	Percent
HC-1	81st St. & Arthur Ave. (Honey Creek downstream of McCarty Park)	16 samples of 20 positive for Human Bacteroides	80%
HC-2	84th St. & O'Conner St. (Honey Creek downstream of State Fair Park)	16 samples of 20 positive for Human Bacteroides	80%
HI-3	Honey Creek Pkwy near 80th & Stevenson Streets (Storm sewer outfall)	14 samples of 19 positive for Human Bacteroides	74%
HI-4	79th St. & Mt. Vernon Avenue (Storm sewer outfall)	19 samples of 20 positive for Human Bacteroides	95%
HI-5	Honey Creek Parkway & Mary Ellen Place (Storm sewer outfall)	5 samples of 20 positive for Human Bacteroides	25%
HC-3	80th St. & Wisconsin Ave. – Honey Creek	18 samples of 20 positive for Human Bacteroides	90%

The other four Honey Creek sites all had percentages of samples testing positive for *Bacteroides* greater than 70%. These results are strong evidence that sanitary sewage is present both in Honey Creek and in the attending storm sewer system. It is likely that sanitary waste is entering the storm sewer system either from failing or leaking pipes, allowing seepage of sanitary waste or some type of cross connections.

Sanitary Sewer Dyeing Efforts

Because the storm sewer located at 79th Street and Mount Vernon Avenue (HI-4B) had consistently the highest bacteria counts measured an effort was made to determine the cause of the high bacteria levels. Dye was introduced into the sanitary sewer system in three locations (79th Street and W. Stevenson Street; 80th Street and W. Fairview Avenue; and 78th Street and W. Fairview Avenue) to see if there was a flow exchange taking place from the sanitary sewers (shown in red) into the storm sewers (shown in blue) in this neighborhood (Figure 17).

The most downstream sanitary sewer located at 79th Street and Mount Vernon Court was viewed to determine when the dye made its way through the subject area. The 79th Street and Mount Vernon Avenue storm sewer outfall (HI-4B) was also viewed to determine if any of the dye transferred from any of the sanitary sewer system lines into the storm sewer lines and subsequent outfall.

The dye introduction and observation period spanned several hours but during that time no dye was observed entering in the storm sewer outfall. Though there was no dye evident in the storm sewer line, not all possible routes of sanitary sewage entry into the storm sewer system were examined. Direct private lateral connections to the storm sewer could be one possibility for the high bacteria counts, if only remotely, since there was no physical evidence of sanitary waste at this or any of the storm sewer outfalls examined in this investigation. A more likely scenario is failing lateral(s) that are allowing seepage of sanitary contamination to reach the storm sewer. Older residential areas could have

Figure 17. Dye introduction to sanitary sewers (in red) near 79th St. & W. Mount Vernon Ave.

exfiltration occurring from leaking sanitary lateral pipes or poor connections/seals due to subsidence. Infiltration of sanitary waste in to the storm sewers can occur though these leaking joints and poor connections or could enter the storm sewer more directly from foundation drains or sump pumps connected to the storm sewer. This transfer of contaminated seepage can be accelerated during wet weather or even when lawns are watered and conversely this also could be a source of significant clear water infiltration

entering the sanitary sewer system during wet weather thereby potentially contributing to sanitary sewer overflows.

MMSD Sanitary Sewer Evaluation

Throughout this investigation the MMSD's sewer system was routinely checked for any evidence of leakage or bypassing of sanitary waste into the local storm sewers serving Honey Creek. Systems monitoring personnel evaluated computer records of current and historical flow monitoring meters and field monitoring crews visually inspected specific metering locations along Honey Creek. No evidence of overflow bypassing or leakage was found from MMSD's sewer system during this investigation; results shown in Appendix C.

State Fair Grounds Storm Sewer Monitoring

Potential sources of fecal bacteria entering the storm sewer system on the State Fair grounds is from animal holding areas or transporting of animals to and from holding areas. The photographs shown below (Figures 18 and 19) were taken on August 15, 2006 (post-State Fair).

Figure 18. State Fair Storm Sewer Grate

Figure 19. Water and Animal Feces

The location of these pictures was along the west side of the swine barn, on the western border of the State Fair grounds. The flow pattern of water and accumulations of animal waste on the storm sewer grate are illustrated in the foreground of Figure 18. Standing water and animal feces are seen in Figure 19 and are also seen in the background of Figure 18. Intensive sampling was not conducted on the State Fair grounds during this bacterial investigation. However, the relationship between high concentrations of fecal coliform bacteria in State Fair storm sewers and high bacteria values found in Honey Creek

directly downstream of the State Fair grounds at 84th and O'Conner Streets (HC-2S) is significant. Data collected from HC-2 displayed the highest in-stream concentrations of fecal coliform contamination as a monthly geometric mean (43,198 cfu/100mL).

Bacteria sampling on the grounds of the State Fair occurred on August 9th during the State Fair and again on August 15th, after the State Fair had concluded. The results of the two monitoring dates are shown in Figures 20 and 21.

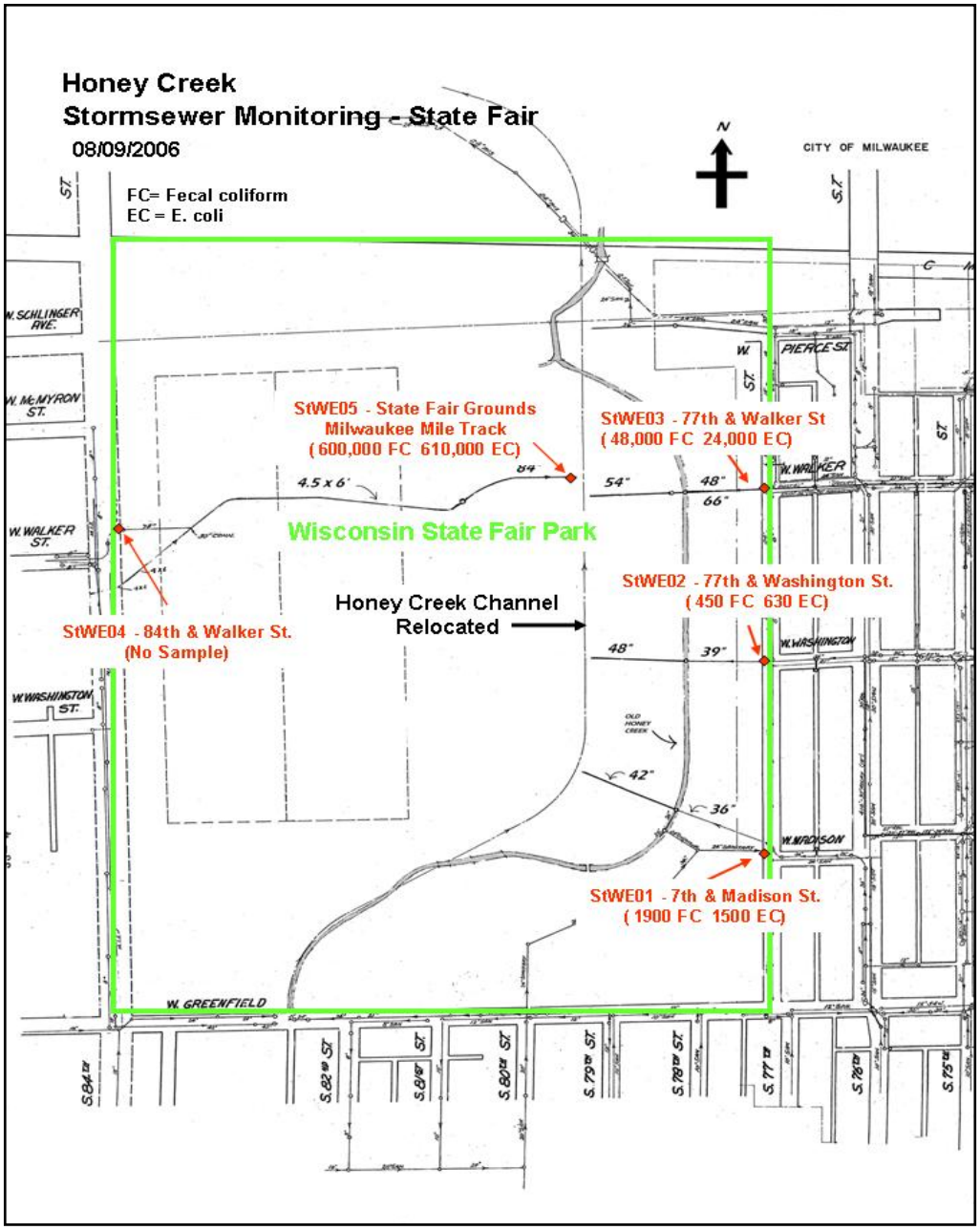

Figure 20. State Fair Grounds - Storm sewer Monitoring on August 9th, 2006

A large 84"diameter storm sewer that bisects the Stair Fair grounds, from west to east from 84th Street, had the highest levels of both fecal coliform and *E. coli* bacteria measured at the point of entry into Honey Creek. On August 9, 2006 (during State Fair) fecal coliform and *E. coli* bacteria levels were determined to be 600,000 cfu/100 mL and

610,000 cfu/100 mL, respectively. High bacteria levels were also observed in the 77th Street and Walker Street storm sewer on this date. Fecal coliform and *E. coli* levels were 48,000 and 24,000 CFU/100 mL respectively.

Bacteria monitoring results from the August 15th sampling date (post-State Fair) were lower than the August 9th results (during State Fair) but still very high (Figure 21).

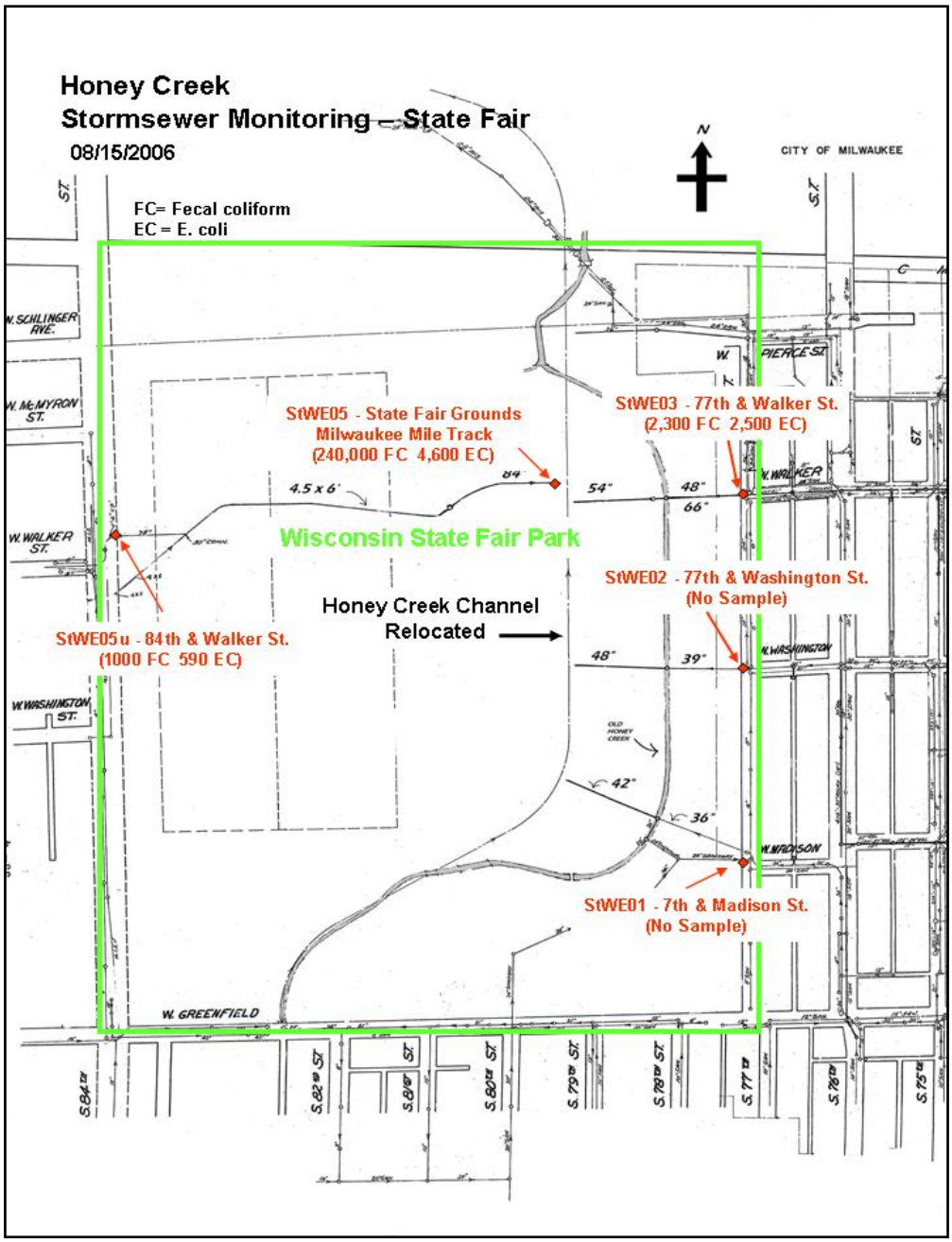

Figure 21. State Fair Grounds Storm Sewer Monitoring August 15, 2006

The 78"diamenter storm sewer that connects with the 84" diameter storm sewer that bisects the Fair grounds had fecal coliform bacteria counts of 1000 cfu/100 mL at the very most upstream (west) collection point near 84th Street and had a count 240,000 cfu/100mL at the downstream collection point just before entering Honey Creek. This

significant increase in bacteria numbers indicates that fecal material is entering the storm sewer system from the Wisconsin State Fair grounds from a variety of potential locations and sources and is being transported to Honey Creek in significant concentrations.

Summary

The results of this investigation strongly imply that storm sewer inputs of fecal coliform and *E.coli* bacteria are significant to Honey Creek and that evidence of sanitary sewage is present both in the tested storm sewer system and in Honey Creek even though there were no reported sanitary sewer overflows or bypasses during the entire monitoring period by any of the communities in the study area.

Key findings from this bacterial source investigation are listed below:

- Fecal coliform bacteria levels in Honey Creek (in-stream) greatly exceed the Wisconsin Recreational Water Quality Standard for Full Body Contact and even greatly exceed the fecal coliform variance established for Honey Creek (1000 counts/100mL as a monthly geometric mean).
- The highest bacteria counts generally occurred during the morning to noon sampling time periods as measured in the three monitored storm sewers (HI-3B, HI-4B, and HI-5B).
- The storm sewer outfall at 79th Street & Mt. Vernon Avenue (HI-4B) had the highest levels of both fecal coliforms and *E. coli* throughout the investigation period. Fecal coliform levels at this location exceeded 162,000 counts/100mL as a monthly geometric mean (August 2006).
- The storm sewer outfall at 79th Street & Mt. Vernon Avenue (HI-4B) also appears to have a negative impact on the in-stream Honey Creek monitoring site downstream at 80th and Wisconsin Avenue (HC-3).
- The human specific genetic bacteria marker (*Bacteroides*) test showed positive results at all Honey Creek in-stream locations (HC-1, HC-2, and HC-3) and storm sewer outfall locations (HI-3, HI-4, and HI-5), indicating sanitary sewage contamination.
- The storm sewer outfall at 79th Street & Mt. Vernon Avenue (HI-4B) had the highest incidence of positive human specific *Bacteroides* results; with 95% of the samples testing positive.
- Storm sewer outfalls located on the Wisconsin State Fair Park grounds also contain levels of fecal coliform and *E. coli* bacteria far in excess of the Wisconsin Recreational Water Quality Standard.
- There also appears to be higher bacteria levels in Honey Creek downstream of Wisconsin State Fair Park and a distinct increase during, and shortly after the run of the State Fair.

- It is very apparent that storm water runoff and storm sewer discharges are negatively affecting the water quality of Honey Creek and downstream reaches of the Menomonee River.

Monitoring of the human specific *Bacteroides* indicated that a chronic problem exists at 79th Street and Mount Vernon Avenue (Site HI-4B). It is likely that sanitary waste is entering the storm system through either failing leaking pipes or perhaps some type of cross connections in this area. It also appears that the Wisconsin State Fair negatively impacts the water quality on downstream portion of Honey Creek during its run in August.

Recommendations

Additional investigation and testing on some of the storm sewer outfalls in the study vicinity is warranted. It is recommended that the drainage area for the storm sewer outfalls that exhibited unacceptable and persistent levels of fecal bacteria be examined and potential entry routes evaluated. It must be kept in mind that both fecal colifom and *E. coli* are not considered pathogenic but rather act as indicator organisms indicating the potential presence for more serious human pathogens (viruses, protozoans). The pathogen source tracking study currently underway by MMSD should continue to determine how widespread this problem is and what are the associated health risks. Additionally, future monitoring, near the time that State Fair is operating (2007), should again be undertaken using these results to tailor a specific monitoring and remediation strategy.

The results of this evaluation should be shared and discussed with representatives from each of the communities in the study area, Wisconsin State Fair and the Wisconsin Department of Natural Resources.

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APPENDIX A

SUMMARY OF COLLECTED BACTERIA DATA

APPENDIX A
Honey Creek Bacteria Investigation – 2006
Table A-1 Fecal coliform, *E. Coli*, and *Bacteroides Data*

Survey # SP 38										
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
7/26/06	930	HC-01S	FURTHEST UPSTREAM	81st St. & Arthur Ave. (McCarty Park)	6016527	17,000	6,500	positive	Average 0.1" (7/24); 0.01" (7/26)	1867
7/26/06	944	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6016528	7,000	3,100	positive		1869
7/26/06	952	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6016532	70,000	27,000	positive		1868
7/26/06	1001	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6016530	460,000	4,600	strongly positve		1872
7/26/06	1010	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6016531	220,000	240,000	negative		1871
7/26/06	1015	HC-03S	FURTHEST DOWNSTREAM	80th St. & Wisconsin Ave.	6016529	16,000	2,300	positive		1870

Survey # SP 39										
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
7/31/06	908	HC-01S	FURTHEST UPSTREAM	81st St. & Arthur Ave. (McCarty Park)	6016473	3,600	2,000	weak	Average 0.26" (7/27); 0.07" (7/30)	1906
7/31/06	921	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6016474	23,000	20,000	positive		1905
7/31/06	930	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6016478	21,000	28,000	positive		1910
7/31/06	937	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6016476	27,000	1,400	positive		1909
7/31/06	944	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6016477	3,900	4,900	negative		1908
7/31/06	948	HC-03S	FURTHEST DOWNSTREAM	80th St. & Wisconsin Ave.	6016475	49,000	25,000	positive		1907

Survey # SP 40										
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/3/06	950	HC-01S	FURTHEST UPSTREAM	81st St. & Arthur Ave. (McCarty Park)	6016740	80,000	17,000	positive	Average 0.06" (8/2); 0.09" (8/3)	Recorded 0.15" rain on 8/3/06 at rain gauge closest to sites HC-2 and HC-3 prior to sampling. 1916
8/3/06	1005	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6016741	160,000	36,000	negative		1917
8/3/06	1015	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6016745	110,000	24,000	positive		1919
8/3/06	1025	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6016743	90,000	21,000	positive		1920
8/3/06	1035	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6016744	170,000	15,000	very weak		1921
8/3/06	1042	HC-03S	FURTHEST DOWNSTREAM	80th St. & Wisconsin Ave.	6016742	430,000	100,000	positive		1918

* Red Results = Indicates values greater or equal to a bacteria count of 20,000
** Precipitation is the average of 3 area rain gauges for 72 hours prior to sample collection
+ NS – Site not samples

APPENDIX A
Honey Creek Bacteria Investigation – 2006
Table A-1 Fecal coliform, *E. Coli*, and *Bacteroides Data*

Survey # SP 41										
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/7/06	750	HC-01S	FURTHEST UPSTREAM	81st St. & Arthur Ave. (McCarty Park)	6016752	7,000	7,300	positive	Average 0.53" (8/6)	1943
8/7/06	805	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6016753	250,000	20,000	positive		1944
8/7/06	810	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6016757	2,500	2,200	weak		1946
8/7/06	816	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6016755	330,000	250,000	positive		1947
8/7/06	823	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6016756	15,000	3,400	negative		1948
8/7/06	830	HC-03S	FURTHEST DOWNSTREAM	80th St. & Wisconsin Ave.	6016754	90,000	4,600	positive		1945
Survey # SP 42										
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/7/06	1150	HC-01S	FURTHEST UPSTREAM	81st St. & Arthur Ave. (McCarty Park)	6016764	9,000	2,000	positive	Average 0.53" (8/6)	1963
8/7/06	1202	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6016765	83,000	19,000	positive		1964
8/7/06	1208	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6016769	3,000	1,300	negative		1966
8/7/06	1213	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6016767	150,000	170,000	positive		1967
8/7/06	1222	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6016768	1,600	490	negative		1968
8/7/06	1226	HC-03S	FURTHEST DOWNSTREAM	80th St. & Wisconsin Ave.	6016766	45,000	5,500	positive		1965
Survey # SP 43										
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/7/06	1445	HC-01S	FURTHEST UPSTREAM	81st St. & Arthur Ave. (McCarty Park)	6016792	1,300	230	positive	Average 0.53" (8/6)	1969
8/7/06	1455	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6016793	67,000	4,600	positive		1970
8/7/06	1500	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6016797	3,000	3,100	negative		1972
8/7/06	1503	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6016795	40,000	65,000	positive		1973
8/7/06	1515	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6016796	2,300	980	negative		1974X
8/7/06	1520	HC-03S	FURTHEST DOWNSTREAM	80th St. & Wisconsin Ave.	6016794	28,000	580	positive		1971

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** Precipitation is the average of 3 area rain gauges for 72 hours prior to sample collection
+ NS – Site not samples

APPENDIX A
Honey Creek Bacteria Investigation – 2006
Table A-1 Fecal coliform, *E. Coli*, and *Bacteroides Data*

Survey # SP 44

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/8/06	720	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017018	2,500	1,400	positive	Average 0.53" (8/6)	1974
8/8/06	733	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017019	**57,000**	820	positive		1975
8/8/06	739	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017023	17,000	2,400	positive		1977
8/8/06	746	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017021	**570,000**	**920,000**	negative		1978
8/8/06	753	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017022	2,300	510	negative		1979
8/8/06	801	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017020	**45,000**	1,000	weak		1976

Survey # SP 45

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/8/06	1104	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017031	1,900	720	negative	Average 0.53" (8/6)	1983
8/8/06	1115	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017032	**130,000**	9,200	positive		1984
8/8/06	1120	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017036	18,000	7,700	weak		1986
8/8/06	1122	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017035	**55,000**	**50,000**	positive		1987
8/8/06	1133	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017022	3,000	710	positive		1988
8/8/06	1143	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017033	**29,000**	880	positive		1985

Survey # SP 46

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/8/06	1435	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017043	940	190	positive	Average 0.53" (8/6)	1989
8/8/06	1446	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017044	**48,000**	5,800	positive		1990
8/8/06	1452	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017048	8,600	1,900	very weak		1992
8/8/06	1500	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017046	16,000	290	positive		1993
8/8/06	1507	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017047	1,300	12,000	negative		1994
8/8/06	1513	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017045	5,900	1,900	negative		1991

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** Precipitation is the average of 3 area rain gauges for 72 hours prior to sample collection
+ NS – Site not samples

APPENDIX A
Honey Creek Bacteria Investigation – 2006
Table A-1 Fecal coliform, *E. Coli,* and *Bacteroides Data*

Survey # SP 47

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/9/06	700	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017055	6,100	3,700	positive	Average 0.53" (8/6)	1995
8/9/06	711	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017056	16,000	600	positive		1996
8/9/06	721	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017060	**40,000**	10,000	negative		1998
8/9/06	733	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017058	**520,000**	**770,000**	positive		1999
8/9/06	737	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017059	1,100	320	negative		2000
8/9/06	743	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017057	16,000	990	positive		1997

Survey # SP 48

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/9/06	1040	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017067	2,300	700	negative	Average 0.53" (8/6)	2001
8/9/06	1054	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017068	**59,000**	19,000	very weak		2002
8/9/06	1101	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017072	**30,000**	15,000	negative		2004
8/9/06	1110	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017070	**350,000**	**440,000**	positive		2005
8/9/06	1115	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017071	1,100	250	positive		2006
8/9/06	1121	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017069	13,000	4,400	very weak		2003

Survey # SP 49

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/9/06	1439	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017079	1,200	420	negative	Average 0.53" (8/6)	2007
8/9/06	1450	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017080	10,000	2,000	positive		2008
8/9/06	1455	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017084	**280,000**	**410,000**	very weak		2010
8/9/06	1502	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017082	**63,000**	**52,000**	positive		2011
8/9/06	1510	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017083	3,200	590	positive		2012
8/9/06	1517	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017081	8,000	1,300	very weak		2009

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** Precipitation is the average of 3 area rain gauges for 72 hours prior to sample collection
+ NS – Site not samples

APPENDIX A

Honey Creek Bacteria Investigation – 2006

Table A-1 Fecal coliform, *E. Coli,* and *Bacteroides Data*

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/10/2006	710	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017955	**83,000**	**21,000**	positive	Average 0.05" (8/9); 0.07" (8/10)	2013
8/10/2006	722	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017956	**220,000**	**84,000**	negative		2014
8/10/2006	NS	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	NS +	NS	NS	NS		No Sample
8/10/2006	734	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017958	**90,000**	**99,000**	weak		2016
8/10/2006	739	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017959	**50,000**	**24,000**	negative		2017
8/10/2006	747	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017960	**240,000**	**120,000**	positive		2015

Survey # SP 51

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/10/2006	1052	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017967	**33,000**	18,000	positive	Average 0.05" (8/9); 0.07" (8/10)	2019
8/10/2006	1102	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017968	**> 600,000**	**1,600,000**	negative		2020
8/10/2006	1107	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017969	5,500	2,500	positive		2022
8/10/2006	1114	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017970	**54,000**	**41,000**	positive		2023
8/10/2006	1120	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017971	7,000	5,500	negative		2024
8/10/2006	1129	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017972	**240,000**	**110,000**	positive		2021

Survey # SP 52

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/10/2006	1430	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017979	**37,000**	10,000	positive	Average 0.05" (8/9); 0.07" (8/10)	2025
8/10/2006	1441	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017980	**270,000**	**170,000**	positive		2026
8/10/2006	1450	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017981	3,200	1,800	positive		2028
8/10/2006	1457	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017982	**45,000**	**51,000**	positive		2029
8/10/2006	1505	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017983	**35,000**	13,000	negative		2030
8/10/2006	1511	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017984	**340,000**	**120,000**	positive		2027

* Red Results = Indicates values greater or equal to a bacteria count of 20,000

** Precipitation is the average of 3 area rain gauges for 72 hours prior to sample collection

+ NS – Site not samples

APPENDIX A
Honey Creek Bacteria Investigation – 2006
Table A-1 Fecal coliform, *E. Coli,* and *Bacteroides Data*

Survey # SP 53

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/11/06	654	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6017991	3,900	1,200	positive	Average 0.07" (8/10)	2031
8/11/06	705	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6017992	6,700	2,900	positive		2032
8/11/06	712	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6017993	**65,000**	**73,000**	positive		2034
8/11/06	720	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6017994	**>600,000**	**610,000**	positive		2035
8/11/06	726	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6017995	**20,000**	2,600	negative		2036
8/11/06	736	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6017996	**21,000**	3,400	positive		2033

Survey # SP 54

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/11/06	1149	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6018003	2,100	370	positive	Average 0.07" (8/10)	2037
8/11/06	1159	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6018004	5,300	**21,000**	negative		3038
8/11/06	1204	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6018005	8,000	**20,000**	weak		3040
8/11/06	1213	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6018006	**> 600,000**	**1,300,000**	weak		2041
8/11/06	1219	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6018007	10,000	1,200	negative		2042
8/11/06	1227	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6018008	**72,000**	9,200	weak		2039

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+ NS – Site not samples

APPENDIX A
Honey Creek Bacteria Investigation – 2006
Table A-1 Fecal coliform, *E. Coli*, and *Bacteroides Data*

Survey # SP 55

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/14/06	926	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6018133	2,200	930	weak	none	2043
8/14/06	940	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6018134	**27,000**	2,800	positive		2044
8/14/06	1011	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6018135	15,000	11,000	positive		2046
8/14/06	948	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6018136	**> 600,000**	**460,000**	positive		2047
8/14/06	956	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6018137	**77,000**	**110,000**	negative		2048
8/14/06	1003	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6018138	**25,000**	1,400	positive		2045

Survey # SP 56

DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/15/06	1001	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6018364	900	440	weak	none	2049
8/15/06	1017	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6018365	4,300	6,900	positive		2050
8/15/06	1032	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6018366	9,300	13,000	negative		2052
8/15/06	1040	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6018367	**230,000**	**260,000**	positive		2053
8/15/06	1109	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6018368	**140,000**	**210,000**	negative		2054
8/15/06	1118	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6018369	2,700	500	weak		2051

Survey # SP 57

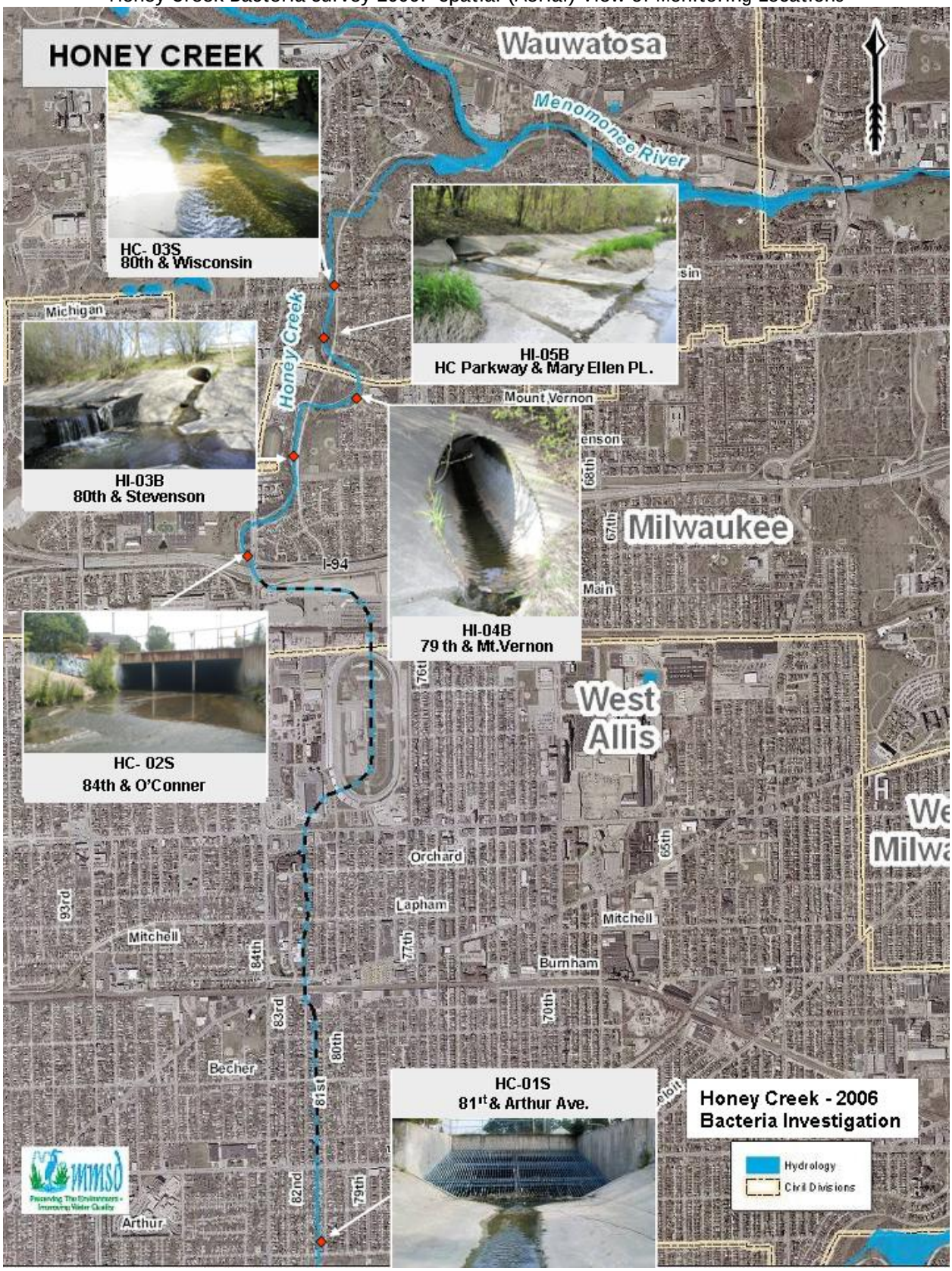
DATE	Time (hrs)	SITE CODE	RELATIVE STREAM LOCATION	APPROX. LOCATION	LIMS #	FECALS (CFU/100mL) *	E.COLI (MPN/100mL) *	Human Specific Bacteroides	PRECIPITATION **	COMMENTS
8/16/06	945	HC-01S	**FURTHEST UPSTREAM**	81st St. & Arthur Ave. (McCarty Park)	6018370	660	700	negative	none	2055
8/16/06	955	HC-02S		84th St. & O'Conner St. (downstream of State Fair Park)	6018371	2,500	810	positive		2056
8/16/06	1002	HI-03B		Honey Creek Parkway at "waterfall" (directly from oval concrete pipe near 80th & Stevenson Streets)	6018372	**28,000**	15,000	NS		2058
8/16/06	1012	HI-04B		79th St. & Mt. Vernon Ct. (directly from corrugated metal pipe)	6018373	**540,000**	**420,000**	positive		2059
8/16/06	1019	HI-05B		Honey Creek Parkway & Mary Ellen Pl. (directly from corrugated metal pipe)	6018374	**55,000**	**54,000**	weak		2060
8/16/06	1025	HC-03S	**FURTHEST DOWNSTREAM**	80th St. & Wisconsin Ave.	6018375	1,300	460	negative		2057

* Red Results = Indicates values greater or equal to a bacteria count of 20,000
** Precipitation is the average of 3 area rain gauges for 72 hours prior to sample collection
+ NS – Site not samples

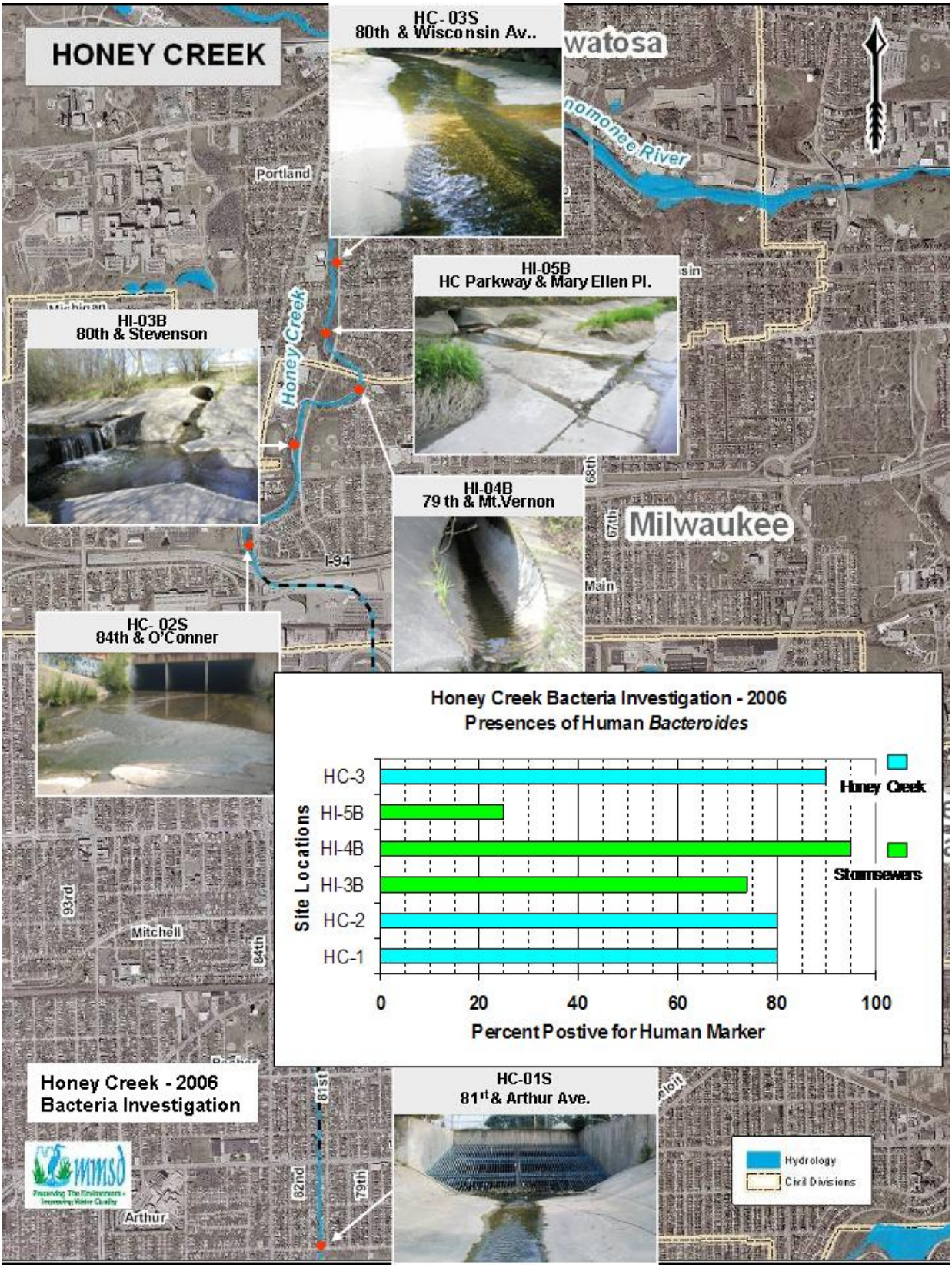
APPENDIX B

SUMMARY OF GRAPHICAL DATA

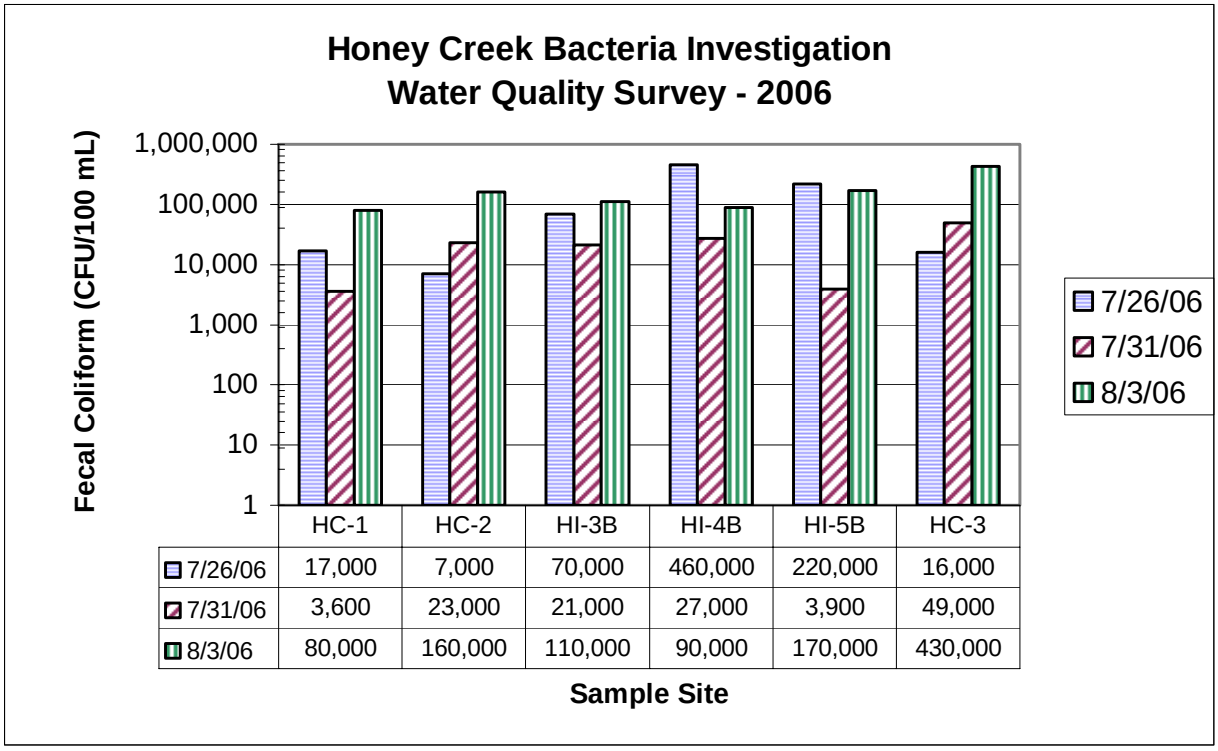
Honey Creek Bacteria Survey 2006: Spatial (Aerial) View of Monitoring Locations



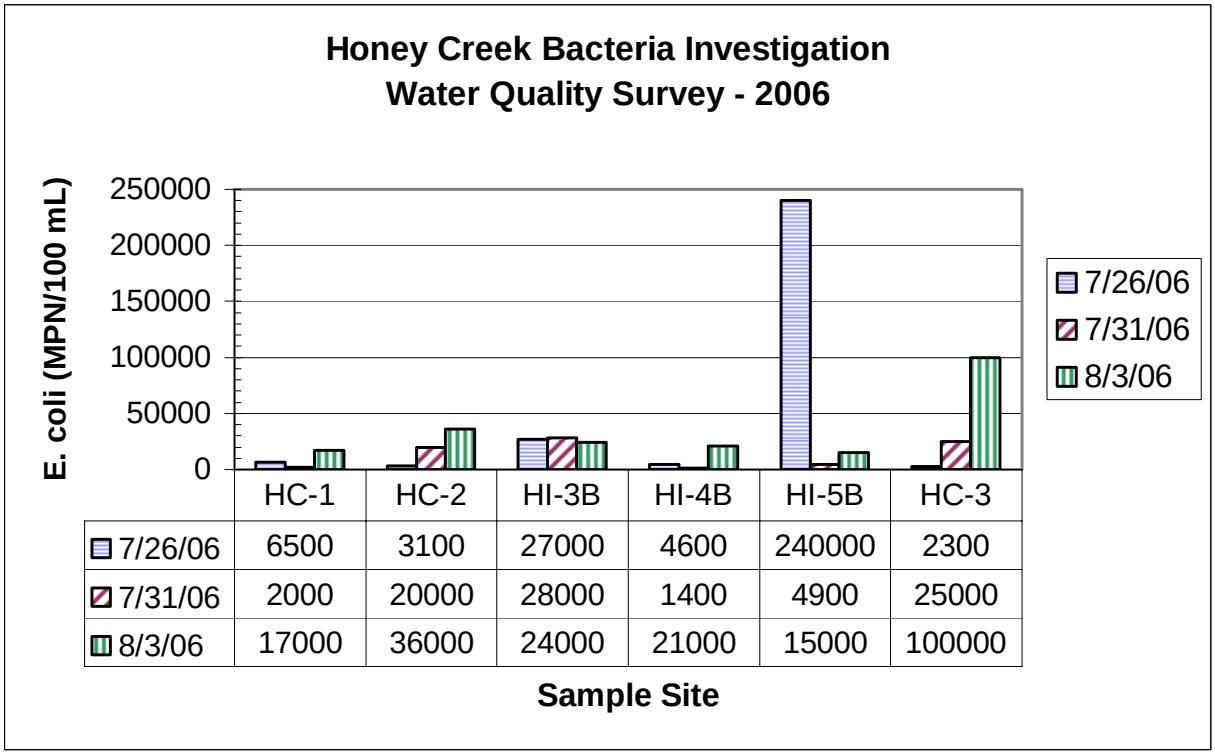
Honey Creek Bacteria Survey 2006: Human Specific *Bacteroides* Monitoring Results



Honey Creek Bacteria Survey – Daily Fecal Coliform and *E. Coli* Monitoring Data (July 26th , July 31st and August 3rd, 2006)

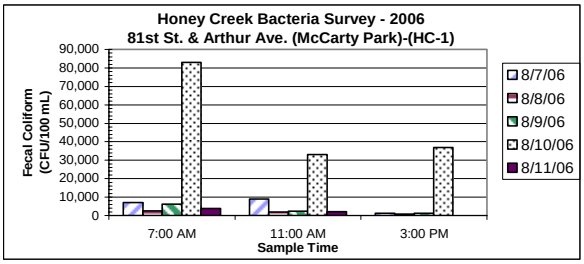


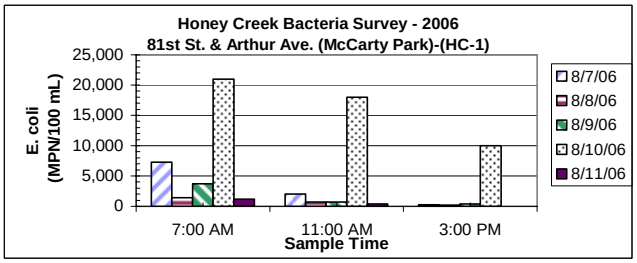
	HC-1	HC-2	HI-3B	HI-4B	HI-5B	HC-3
7/26/06	17,000	7,000	70,000	460,000	220,000	16,000
7/31/06	3,600	23,000	21,000	27,000	3,900	49,000
8/3/06	80,000	160,000	110,000	90,000	170,000	430,000

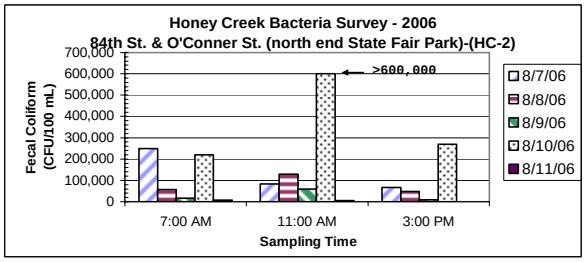


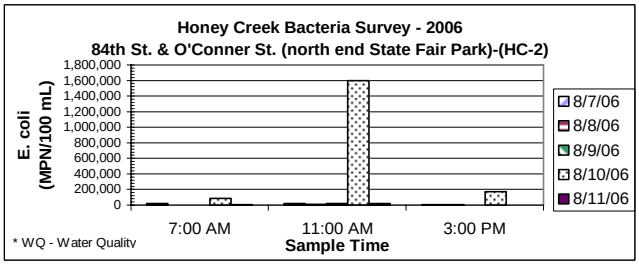
	HC-1	HC-2	HI-3B	HI-4B	HI-5B	HC-3
7/26/06	6500	3100	27000	4600	240000	2300
7/31/06	2000	20000	28000	1400	4900	25000
8/3/06	17000	36000	24000	21000	15000	100000

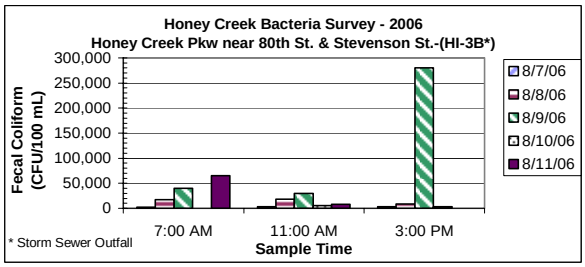
Honey Creek Bacteria Survey – Daily Fecal Coliform and *E. Coli* Monitoring Data (August 7th – 11th, 2006)

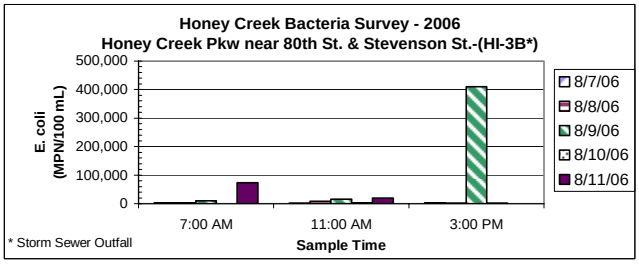


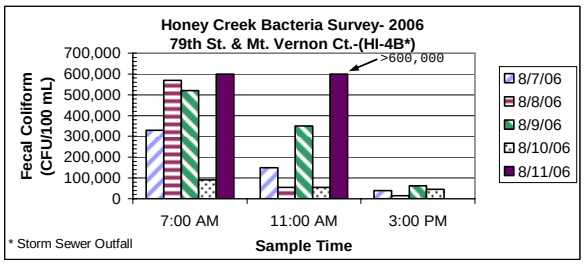


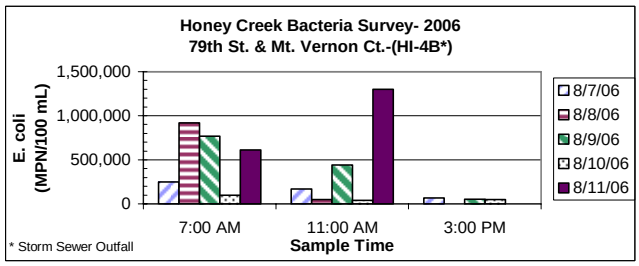


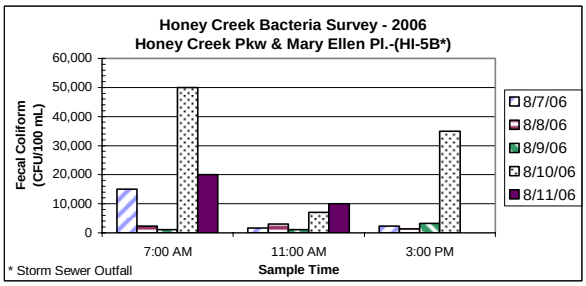


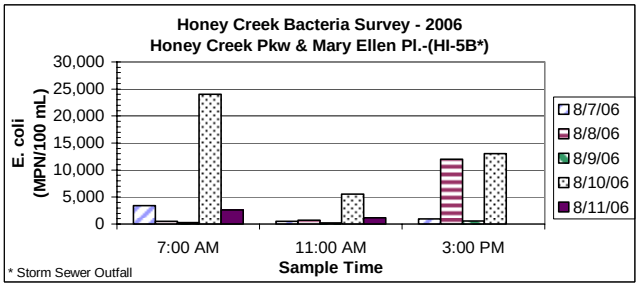


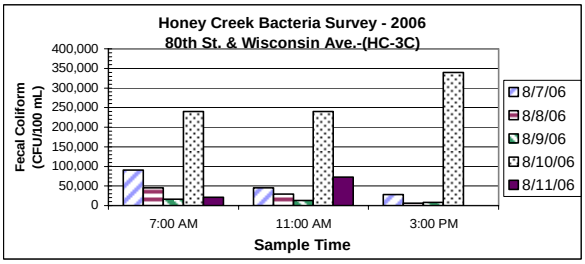


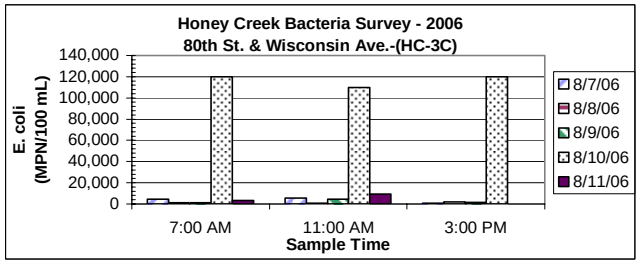




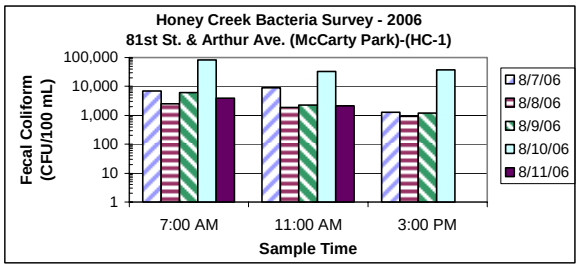


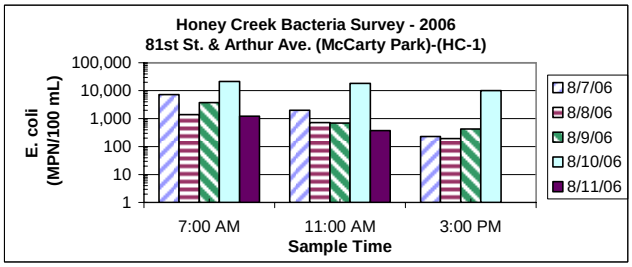


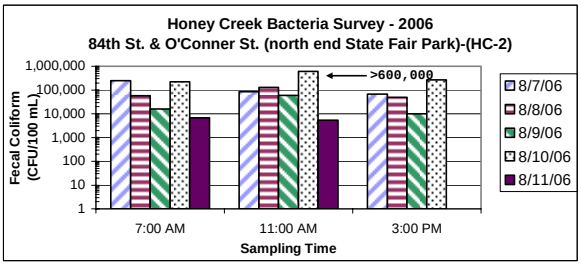


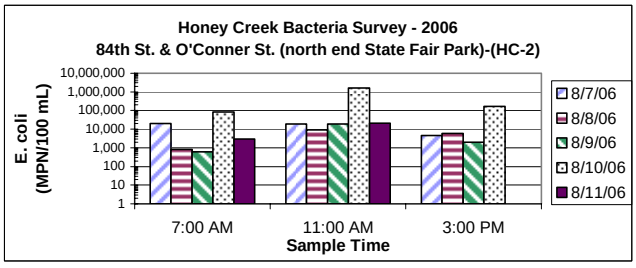


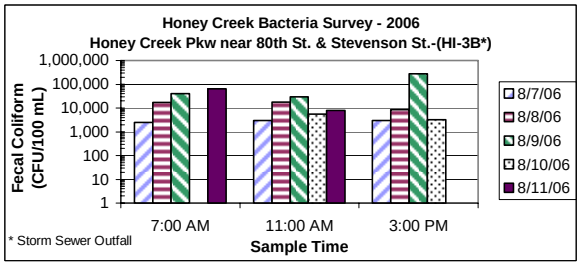
Honey Creek Bacteria Survey – Daily Fecal Coliform and *E. Coli* Monitoring Data - Log (August 7th – 11th, 2006)

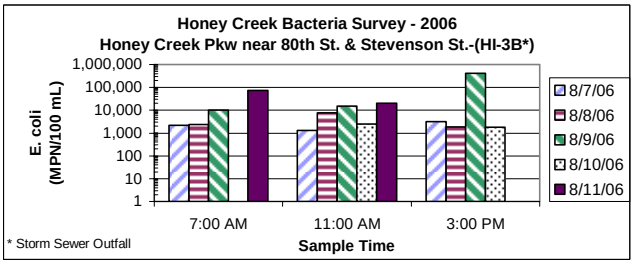


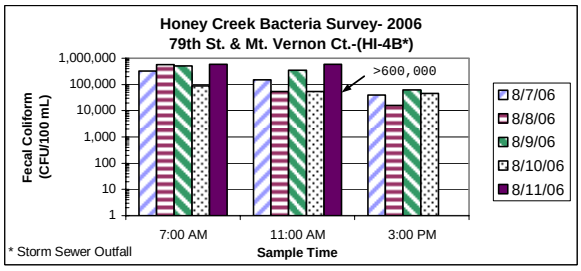


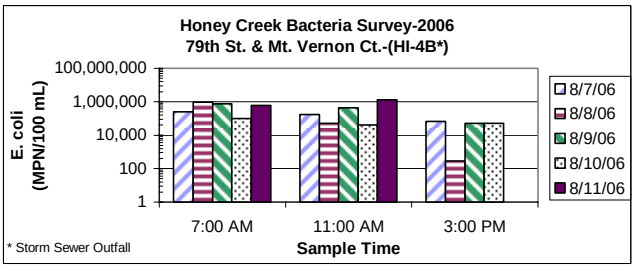


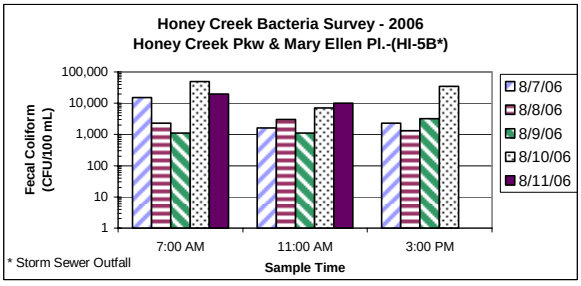


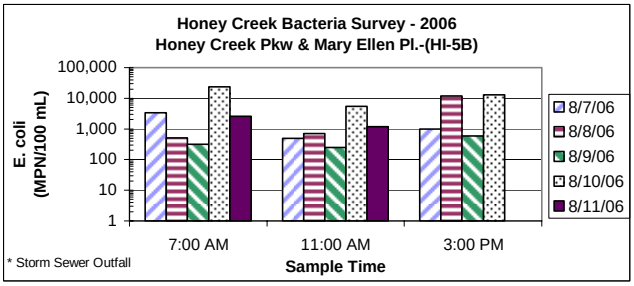


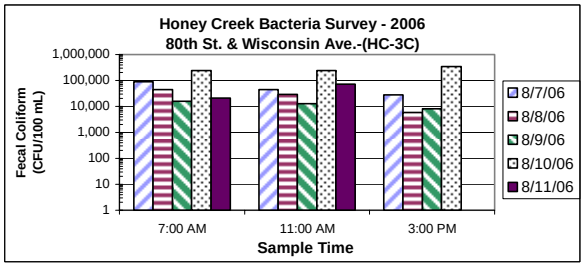


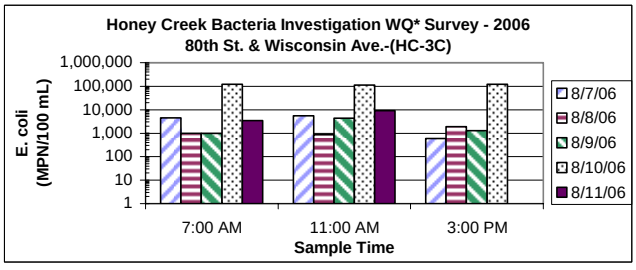






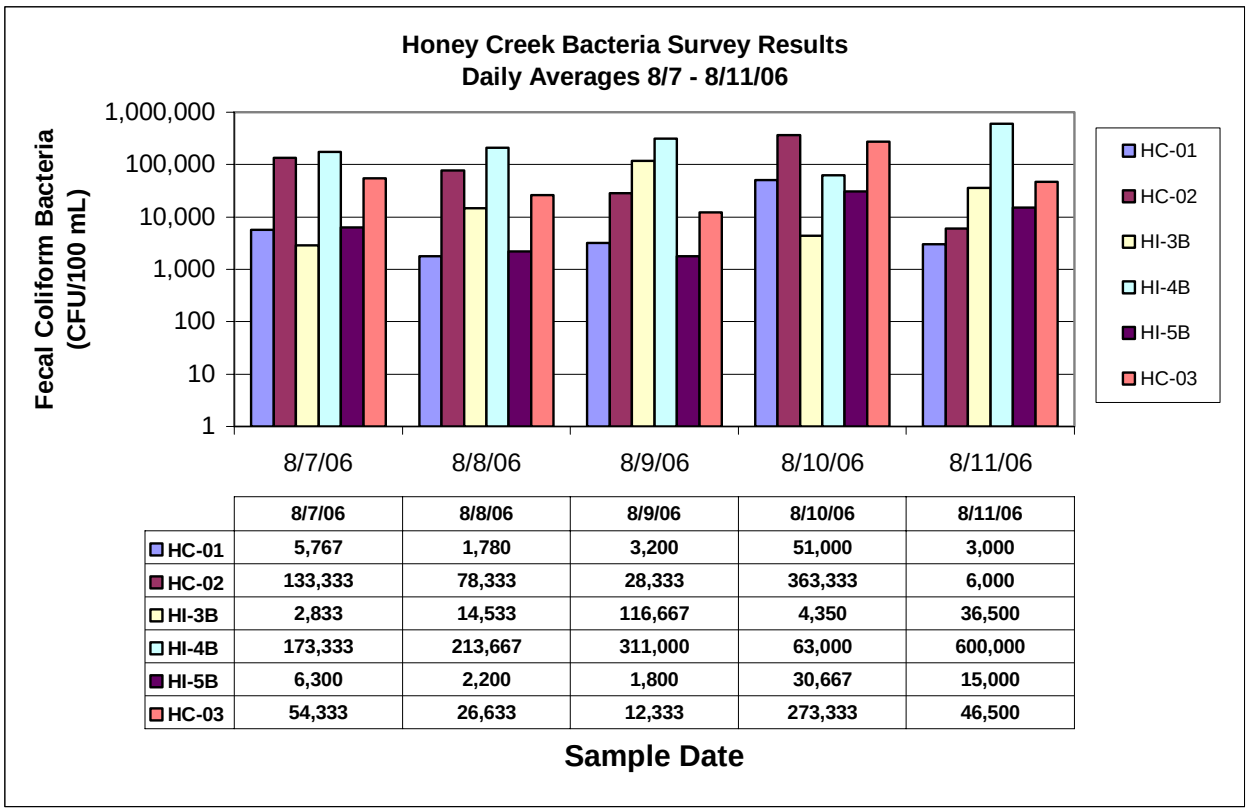




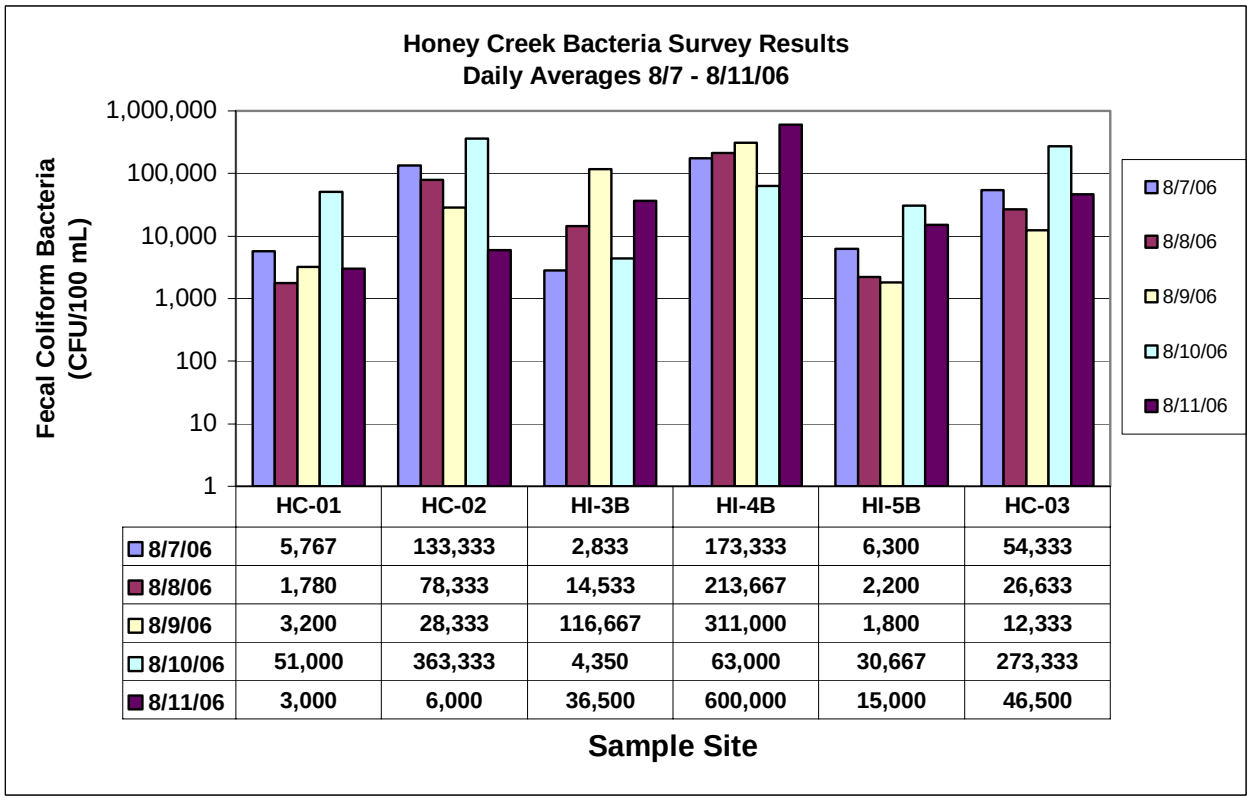


APPENDIX B

Honey Creek Bacteria Survey 2006: Fecal Coliform Daily Average Data By Date and By Location



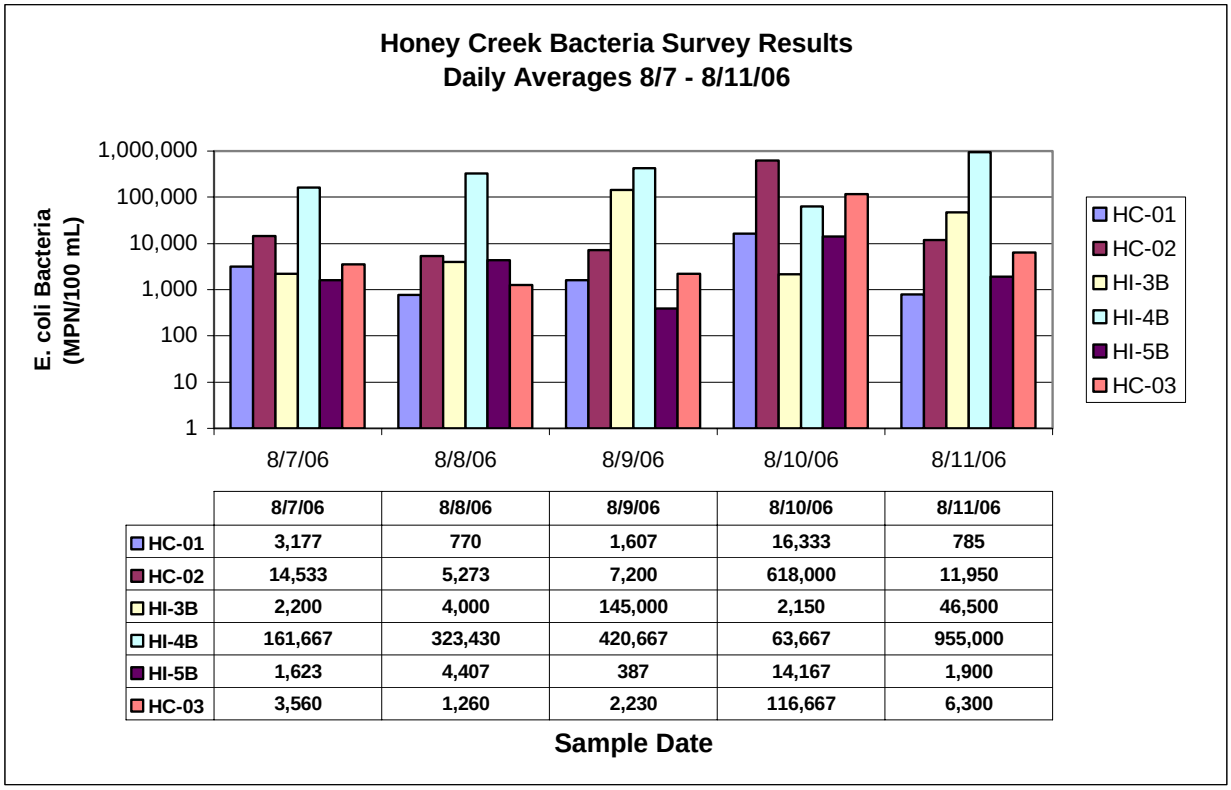
	8/7/06	8/8/06	8/9/06	8/10/06	8/11/06
HC-01	5,767	1,780	3,200	51,000	3,000
HC-02	133,333	78,333	28,333	363,333	6,000
HI-3B	2,833	14,533	116,667	4,350	36,500
HI-4B	173,333	213,667	311,000	63,000	600,000
HI-5B	6,300	2,200	1,800	30,667	15,000
HC-03	54,333	26,633	12,333	273,333	46,500



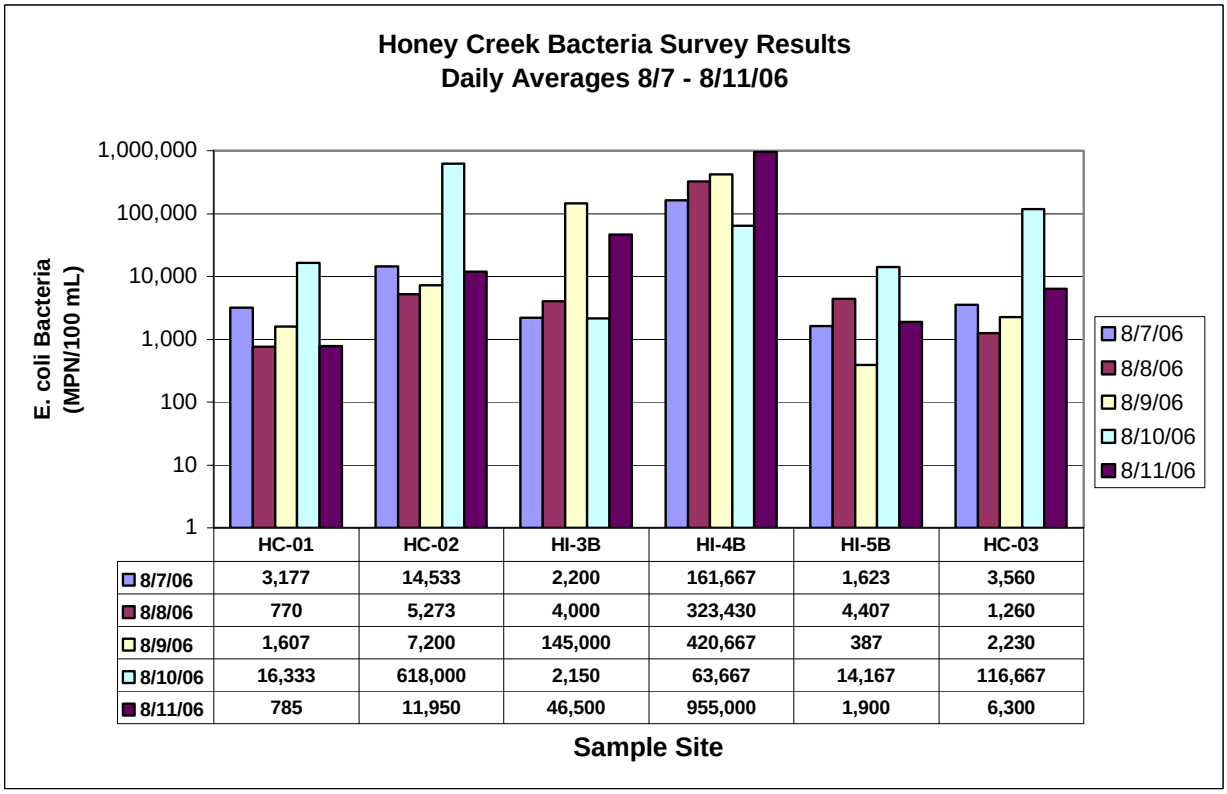
	HC-01	HC-02	HI-3B	HI-4B	HI-5B	HC-03
8/7/06	5,767	133,333	2,833	173,333	6,300	54,333
8/8/06	1,780	78,333	14,533	213,667	2,200	26,633
8/9/06	3,200	28,333	116,667	311,000	1,800	12,333
8/10/06	51,000	363,333	4,350	63,000	30,667	273,333
8/11/06	3,000	6,000	36,500	600,000	15,000	46,500

APPENDIX B

Honey Creek Bacteria Survey 2006: *E. Coli* Daily Average Data By Date and By Location



	8/7/06	8/8/06	8/9/06	8/10/06	8/11/06
HC-01	3,177	770	1,607	16,333	785
HC-02	14,533	5,273	7,200	618,000	11,950
HI-3B	2,200	4,000	145,000	2,150	46,500
HI-4B	161,667	323,430	420,667	63,667	955,000
HI-5B	1,623	4,407	387	14,167	1,900
HC-03	3,560	1,260	2,230	116,667	6,300



	HC-01	HC-02	HI-3B	HI-4B	HI-5B	HC-03
8/7/06	3,177	14,533	2,200	161,667	1,623	3,560
8/8/06	770	5,273	4,000	323,430	4,407	1,260
8/9/06	1,607	7,200	145,000	420,667	387	2,230
8/10/06	16,333	618,000	2,150	63,667	14,167	116,667
8/11/06	785	11,950	46,500	955,000	1,900	6,300

APPENDIX C

MMSD SANITARY SEWER SYSTEM METERING EVALUATION

APPENDIX C

Honey Creek Bacterial Investigation 2006

Key to site and map designations

BLUE	Flow routed to JI WWTP
GREEN	Flow routed to SSWWTP
SSO	Portable AV flow meter in separate sewer overflow from MIS
CK	Portable AV flow meter in MIS near SSO sites
MS	Permanent telemetered monitoring station in MIS
DC	Diversion chamber all dry and wet weather flow routed to SS WWTP
C80031	Portable AV flow meter in MIS near SSO sites
stWE	Storm sewer in west allis
bsWE	local bypass in West Allis
bsWA	local bypass in Wauwatosa

Key to locations and monitoring description

	MMSD ID #		Diameter pipe (inches)
AV meter at bypass	sso242 & sli 9020	S. 79th and Dickinson at STATE FAIR GROUNDS	24
MIS telem level	MS0321	460 S.84th Street	24
AV meter in MIS	ckbs41	Wisconsin and Honey Creek	39
MIS at SSO 235	BS41sl sso235	Wisconsin and Honey Creek	39
AV meter in MIS	c80031	Portland and Honey Creek	24
AV meter and SLI at bypass	SS0234	Portland and Honey Creek	24
AV meter in MIS	ckbs42	N.69th and Auburn	36
SLI at bypass	SSO237	N.68th and Menom R	36
	West Allis ID #		
local bypass	bsWE01	s.77th and Madison	24
storm sewers	stWE01	S.77th and Madison	36
↓	stWE02	S.77th and Washington	39
	stWE03	S.77TH and Walker	48
	stWE04	S.77th and Pierce	36
	stWE05	84 inch storm sewer in State Fair grounds	84
↓	stWE5U	Upstream State Fair grds	54
	Milwaukee ID #		
storm sewers	no site ID	N.79th and Mt Vernon area	
	Wauwatosa ID #		
local bypasses	bsWA01	Glenview and Hawthorne	8 ?
↓	bsWA02	N85th and Hill	10
	bsWA03	Ravenswood and N.88th	10
	bsWA04	Glenview and Currie	8


Appendix C - Map
Honey Creek Investigation
July - August 2006
Approx. Locations
SSO237
CKBS42
SSO234
BSWA04
C80031
SSO235
DC0303
Wisconsin Ave.
CKBS41
BSWA03
BSWA02
BSWA01
MS0321
SSO242
24" & 30" SY.
STWE5U
STWE04
STWE05
STWE03
STWE02
BSWE01
STWE01
Greenfield Ave.
N

APPENDIX C

Honey Creek Bacterial Investigation 2006

SITE ID (see Map)	MMSD SITES CHECKED LOCATIONS FROM UPSTREAM TO DOWNSTREAM	MIS PIPE SIZE (INCHES)	PORTABLE FLOW METER OR PUMPED FLOW AT sso	Surcharge level indicator SLI	**Peak Hour Level (Feet) FROM 8/1-8/8/06**	**Available Sewer Capacity Peak Level (Feet) 8/6/06**	OBSERVATIONS:	Date(s) checked:
SLI9020	SLI at SSO242 state Fair	at SSO	NA	0	**0**	**NA**	SLI indicates NO BYPASS	8/2,8/8,8/16
sso242	S. 79th and Dickinson STATE FAIR	24	0	0	**0**	**NA**	NO BYPASS	8/1-8/8/06
MS0321	460 S.84th Street	24	NA	0	**0.6**	**1.4**	**no sign of high flow or upstream bypass at sso242**	8/1-8/14/06
ckbs41	Wisconsin and Honey Creek	39	NA	NA	**0.4**	**1.6**	**no sign of high flow or bypass at sso 235**	8/1-8/10/06
			in MIS at BS0401					
BS0401 SSO235	Wisconsin and Honey Creek	39	no record of pumped flow in proficy or in alarm report	NA			**no sign of high flow or bypass at sso235**	7/26-8/16/06
c80031	Portland and Honey Creek	24	NA	NA	**0.5**	**1.5**	**no sign of high flow or bypass at sso234**	8/1-8/14/06
SS0234	Portland and Honey Creek	24	METER OUT TO 8/8/06	0	**NA**	**NA**	SLI indicates NO BYPASS	8/7,8/14
ckbs42	N.69th and Auburn	36	NA	NA	**1**	**2**	**no sign of high flow or downstream bypass**	8/1-8/8/06
SSO237	N.68th and Menomonee River	36	METER OUT No data	missing	**NA**	**NA**	Inspection indicates overflow cannot discharge to river	8/1-8/8/06

APPENDIX C

Honey Creek Bacterial Investigation 2006

Community Bypasses Checked for Bacteriological Contamination

	SITE ID (see map)	LOCATION (Upstream to Downstream	PIPE SIZE (INCHES)	**RESULTS:**	NOTES	Date checked:
Wauwatosa	bsWA01	Glenview and Hawthorne	8 ?	NO BYPASS	NO BYPASS ON SYSTEM PLAN	8/10/06
	bsWA02	N. 85th and Hill	10	SLI =0.8'	18" BYPASS	8/10/06
	bsWA03	Ravenswood and N.88th	10	NA	NOTED AS DIVERSION ON SYSTEM PLAN	8/10/06
	bsWA04	Glenview and Currie	8	NO BYPASS	10" BYPASS	8/10/06
West Allis	bsWE01	s.77th and Madison	24	NO BYPASS	BULKHEADED	8/9/06

Community Storm Sewers Checked for Bacteriological Contamination

	SITE ID (see map)	LOCATION (Upstream to Downstream	PIPE SIZE (INCHES)	Bacterial Analysis	8/9/06 RESULTS FC/EC:	8/15/06 RESULTS FC/EC:	Dates checked:
West Allis	stWE01	S.77th and Madison	36	fecal coliform/ E. Coli	1900/1500 counts	No Sample	8/9and 15/2006
	stWE02	S.77th and Washington	39	fecal coliform/ E. Coli	450/630 counts	No Sample	8/9and 15/2006
	stWE03	S.77TH and Walker	48	fecal coliform/ E. Coli	48,000/24,000 counts	2300/2500 counts	8/9and 15/2006
	stWE04	S.77th and Pierce	36		No Sample	No Sample	8/10/06
	stWE05	84 inch storm sewer in State Fair grounds	84	fecal coliform/ E. Coli	>600,000/610,000 counts	240,000/4600 counts	8/9and 15/2006
	stWE5u	storm sewer upstream of state fair at s.84th and walker	54	fecal coliform/ E. Coli	No Sample	1000/590 counts	
Milwaukee		N.79th and Mt Vernon area					