VIII. BASIN PERFORMANCE IN MEETING PHASE II GOALS

A. INTRODUCTION

The Rouge Remedial Action Plan (Rouge RAP) described a three-phased approach to address CSO control. Phase II requires each CSO facility to provide for the “elimination of raw sewage discharge and the protection of public health". Phase III requires the CSO facility to “eliminate or provide adequate treatment of combined sewage discharge to comply with Water Quality Standards at the time of discharge”. The overall purpose of the evaluation was to demonstrate whether a facility size smaller than the MDEQ presumptive approach would satisfy both Phase II and III treatment requirements. In August 1998, the MDEQ issued to the CSO Basin Communities a document entitled “Criteria for Success in CSO Treatment”. The document identifies procedures allowing the performance of each facility to be evaluated relative to the Phase II and Phase III criteria.

The following provides data and analysis following the procedures contained in the “Criteria for Success in CSO Treatment” document demonstrating the ability of the Dearborn Heights CSO Retention Basin to satisfy the Phase II criteria.

B. PROTECTION OF PUBLIC HEALTH

1. DESCRIPTION OF DISINFECTION SYSTEM

Historically, the discharge of untreated CSO contained high levels of fecal coliform bacteria (10^5 to 10^7 cfu/100 mL), contributing to the receiving stream violating full and/or partial body contact bacteriological standards during wet weather events. The Dearborn Heights CSO Retention Basin

provides treatment of CSO by adding aqueous sodium hypochloride, at an approximate 5% strength, to the CSO flow and allowing sufficient contact time to achieve disinfection. The facility was designed to provide 30 minutes of contact time for disinfection to the peak CSO flow resulting from the 10-year, 1-hour design storm event.

Sodium hypochlorite is stored on-site in two, 12,000-gallon fiberglass reinforced plastic (FRP) bulk storage tanks located in a basement level of the facility. The storage tanks were sized to be adequate for two consecutive one-year, 24-hour design storm events, a total treated CSO volume of about 18 million gallons. The chemical is delivered to the facility by bulk truck tanker at approximately 11 to 14% strength and then diluted (approximately 2:1 process water:concentrated hypochlorite) with sufficient non-portable water to achieve an approximate 5% strength. Sodium hypochlorite degrades or loses strength with time due to such factors as light, heat, and metals. The chemical is believed to have the longest half-life or retains its concentration the longest when stored at the 5% strength.

The facility was equipped with four hydraulic diaphragm style chemical metering pumps, manufactured by PulsaFeeder, to pump the aqueous hypochlorite from the bulk storage tank(s) to the application points. The chemical feed pumps were variable capacity; each rated to deliver a maximum capacity of 875 gallons per hour. The metering pumps were sized to provide a maximum dose of 10 mg/L chlorine to the CSO influent

flow rate resulting from the one-year, one-hour design storm, when using NaOCl at 5% strength.

In order to provide the operator variable control over hypochlorite dose rate, each pump has two different types of adjustment. Each chemical feed pump has a manual adjustment to adjust the stroke length (% of stroke). This adjustment was intended to allow the operator to alter the volume of hypochlorite delivered on each stroke of the pump, to account for the strength of hypochlorite in the bulk storage tank. Figure VIII-A taken from the Operation and Maintenance Manual shows the manual percent of stroke settings at various hypochlorite strengths. For example, the figure shows a percent of stroke adjustment from 40% to 75% would be required if the strength of the hypochlorite decreased from 5.5% to 3%, assuming a 5.0 mg/L hypochlorite dose.

In addition, each chemical feed pumps possess an automatic adjustment (based on a 4-20 mA control signal) to vary the stroke frequency or speed of each pump. The design of the facility allows a control signal to be sent to each pump based on the influent or effluent measured flow rate allowing flow-proportional hypochlorite dosing. The basin operating software allows the operator to input the desired chlorine dose and stock chlorine concentration. The software uses this information, along with the influent or effluent flow rate, to generate the 4-20 mA control signal.

Sodium hypochlorite can be applied to the CSO flow in several places in the process stream including: 1) wet well influent, 2) CSO pump

NaOCL Metering Pump Settings

% of Stroke vs. Feed Concentration

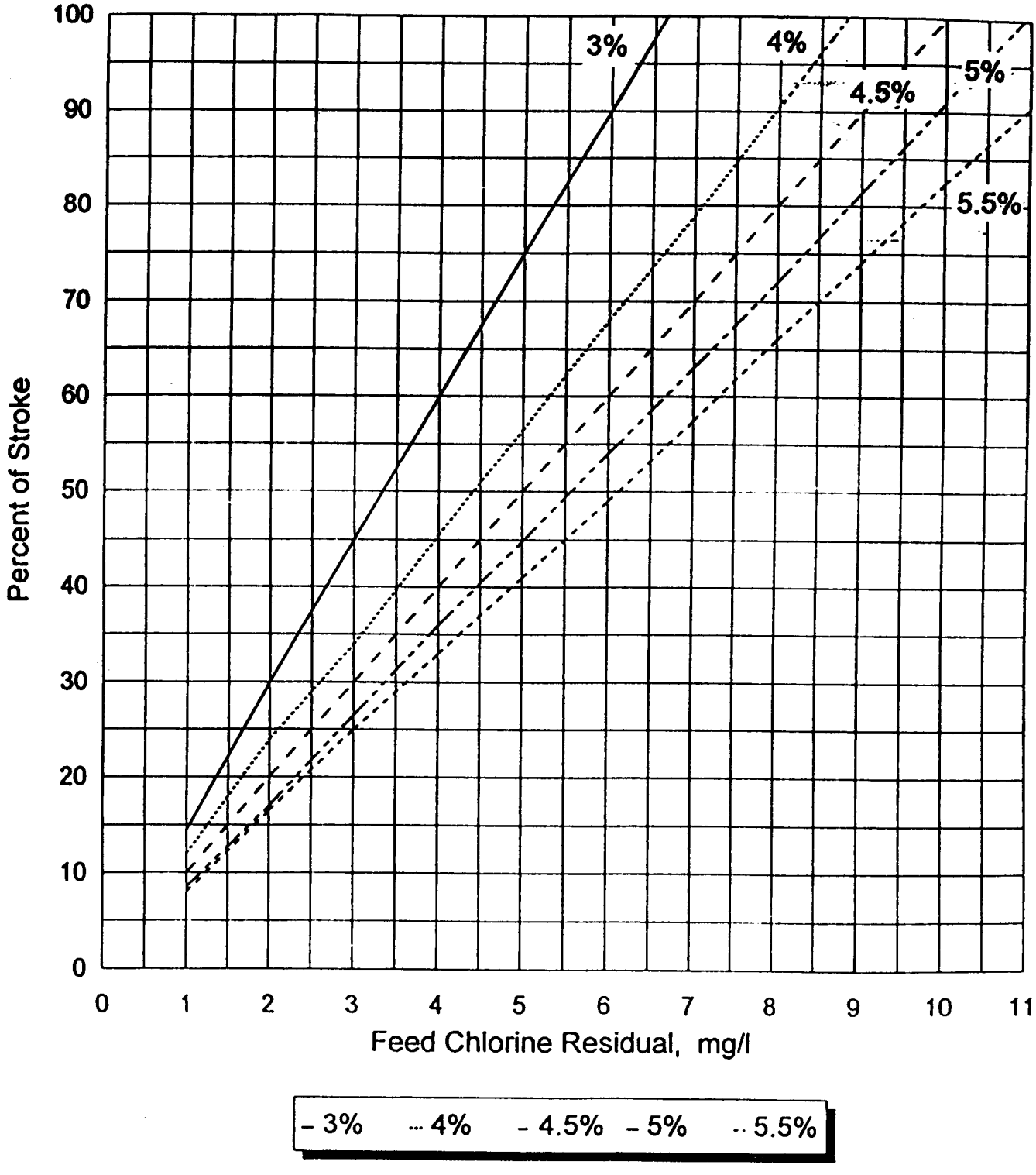

Figure VIII-A

discharge, and 3) basin effluent. During the majority of the evaluation period, the chemical was applied at the CSO pump discharge channel location and was flow-proportional dosed based on the CSO pump rate whenever the CSO pumps operated. The CSO pump discharge channel is the best location for disinfection because of the flow turbulence experienced within the channel for mixing of the hypochlorite.

2. DATA/ANALYSIS

Detailed treated effluent sample results for fecal coliform and TRC analysis from every sampled storm event can be found in Appendix H as part of the Event Summary data. The figures in the Event Summary data include the calculated hypochlorite dose. The volume of hypochlorite applied to the CSO during each pump cycle was determined by the change in hypochlorite storage tank level. The hypochlorite dose was calculated by assuming the volume of hypochlorite applied to the CSO was at 5 percent hypochlorite strength (0.53 lbs chlorine/gal).

a. Event Geometric Mean

The ability of the Dearborn Heights CSO Retention Basin to protect public health can be determined by the disinfection performance of the facility. The procedure described in the "Criteria for Success" document and the NPDES permit involves calculating the event geometric mean concentration of fecal coliform bacteria contained in the treated effluent. Sufficient disinfection to protect public health is provided by the facility when the event geometric mean concentration of fecal coliform bacteria

is less than 400 cfu/100 mL, using the results from a minimum of three discrete treated effluent samples. In fact, the current NPDES discharge permit contains a daily limit of 400 cfu/100 mL and a monthly limit of 200 cfu/100 mL for fecal coliform bacteria. The facility may be capable of meeting Phase II treatment criteria even if there were events that exceeded the limit during the demonstration period. Therefore, the evaluation report includes detailed explanations describing the event specific operating conditions that contributed to the unsatisfactory disinfection performance.

However, an additional objective of the evaluation was to demonstrate the ability of the facility to achieve satisfactory disinfection while minimizing the applied chlorine dose to maintain an event average total residual chlorine (TRC) concentration below 1.0 mg/L. Disinfection is much easier to obtain if excess hypochlorite is applied to the CSO, but this practice results in a higher than acceptable TRC concentration being released into the receiving stream. The 1.0 mg/L TRC event average concentration was considered a goal for the demonstration facilities, but could be reduced to 0.038 mg/L as a limit to meet Phase III treatment criteria. Reducing the TRC limit minimizes the acute toxic exposure of chlorine to the biological community contained within the receiving stream.

Table VIII-1 presents a summary of the event specific disinfection results obtained at the Dearborn Heights CSO Retention Basin during the evaluation. The number of discrete sample results used to calculate the event geometric mean for fecal coliform and the event mean concentration for TRC have been provided. The same information in graphical form is presented in Figure VIII-B and VIII-C.

It should be note that when a fecal coliform discrete sample result was reported as “less than” (<) a particular valve, the “less than” value was used to determine the event geometric mean. For example, if a result was reported as “< 10”, the number “10” was used as the discrete sample result in the calculation of the event geometric mean. Similarly, sample reported as “greater than” (>) a particular number, the “greater than” value was used to calculate the event geometric mean.

The event average TRC concentration was calculated as the arithmetic mean of the discrete treated effluent TRC sample results. The Wayne County DPW staff used a test kit (HACH, Colorimeter/DPD Chemistry) to perform the on-site analysis for TRC. This test kit has a maximum reportable concentration of 2.2 mg/L without performing a dilution. In cases where the reported value was “greater than” (>) 2.2, a value of 2.2 was used as the discrete sample result to calculate the event arithmetic mean concentration.

Table VIII-1
Dearborn Heights - Disinfection Results Summary

		Total Volume (MG)		Effluent *F. Coli*		Effluent TRC		Minimum Detention Time (min)
Date	Rainfall (in)	Influent	Effluent	# of Samples	Event Geomean (#/100 ML)	# of Samples	Event Mean (mg/L)	
8-Jan-98	0.23	7.47	3.84	4	524286	0		510
17/20-Feb-98	2.66	33.61	30.21	12	80441	12	0	185
9/10-Mar-98	1.11	10.63	7.05	3	2520	2	0.63	365
9/10-Apr-98	1.41	5.04	1.57	0		0		593
6/7-Aug-98	2.20	12.00	7.00	16	238	15	1.37	460
22/25-Apr-99	1.33	17.53	4.70	6	10	6	1.67	483
12/13-Jun-99	2.98	7.67	3.93	4	36	4	0.09	150
20/29-Jun-99	2.75	12.14	9.84	9	12	9	1.24	85
23/24-Jul-99	1.93	5.79	1.80	0		0		

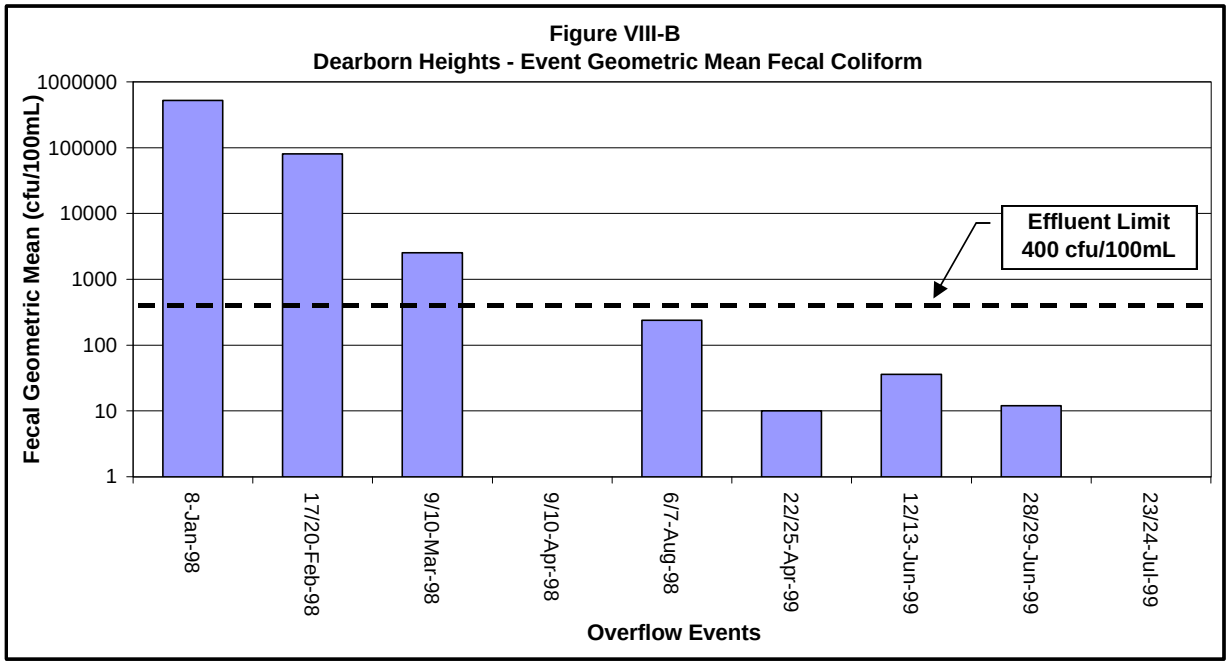
Figure VIII-B
Dearborn Heights - Event Geometric Mean Fecal Coliform
Fecal Geometric Mean (cfu/100mL)
1000000
100000
10000
1000
100
10
1
Effluent Limit
400 cfu/100mL
8-Jan-98
17/20-Feb-98
9/10-Mar-98
9/10-Apr-98
6/7-Aug-98
22/25-Apr-99
12/13-Jun-99
28/29-Jun-99
23/24-Jul-99
Overflow Events

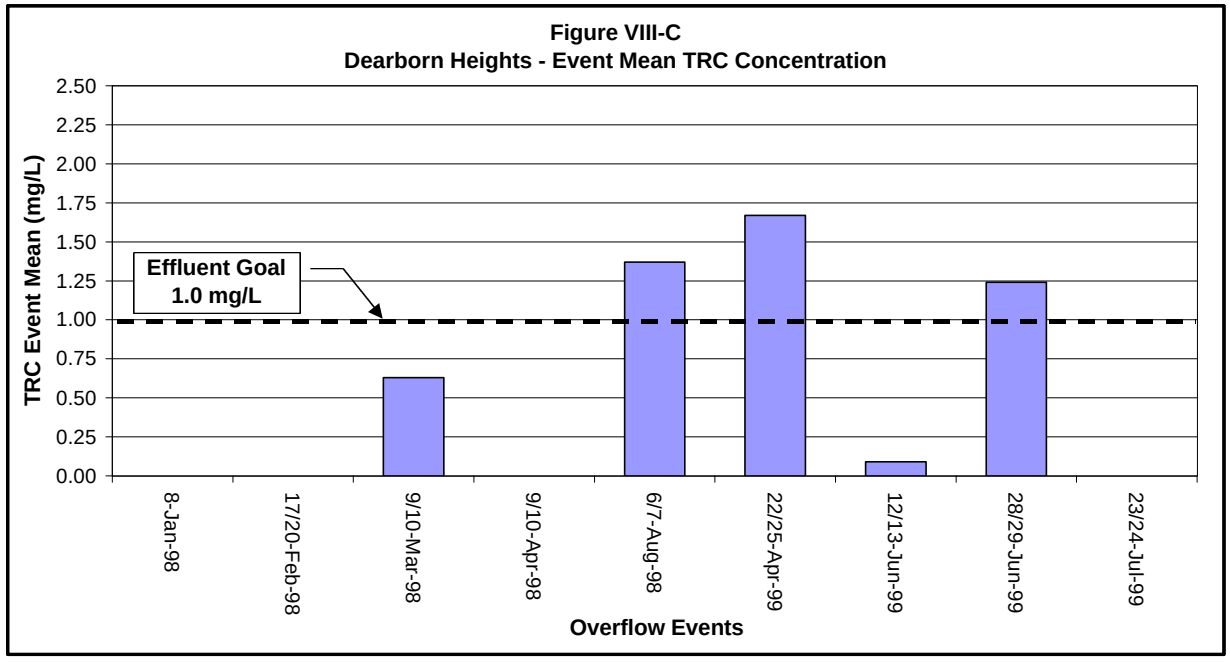
Figure VIII-C
Dearborn Heights - Event Mean TRC Concentration
TRC Event Mean (mg/L)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Effluent Goal
1.0 mg/L
8-Jan-98
17/20-Feb-98
9/10-Mar-98
9/10-Apr-98
6/7-Aug-98
22/25-Apr-99
12/13-Jun-99
28/29-Jun-99
23/24-Jul-99
Overflow Events

Table VIII-1 contains the minimum detention time for each event. The minimum detention time was defined as “the shortest time period during which the volume passing through the flow-through compartments in operation is equal its total volume”. For example, the minimum detention time would be 40 minutes if it took 40 minutes to pump 2.7 MG through the three parallel flow-through compartments at the Dearborn Heights CSO Retention Facility.

b. Monthly Geometric Mean

The existing NPDES permit for the facility contains a fecal coliform effluent limit computed as a monthly geometric mean using a minimum of five discrete treated effluent samples during a calendar month. Table VIII-2 presents a summary of the monthly geometric mean disinfection results.

Table VIII-2
Dearborn Heights - Monthly Disinfection Results Summary

		Effluent Fecal Coliform	
Month	No. of Overflow Events	No. of Effluent Discrete Samples	Monthly Geomean (cfu/100 mL)
Sep-97	0		
Oct-97	0		
Nov-97	0		
Dec-97	0		
Jan-98	1	4	524286
Feb-98	1	12	80441
Mar-98	1	3	2520
Apr-98	1	0	
May-98	0		
Jun-98	0		
Jul-98	0		
Aug-98	1	16	238
Sep-98	0		
Oct-98	0		
Nov-98	0		
Dec-98	0		
Jan-99	0		
Feb-99	0		
Mar-99	0		
Apr-99	1	6	10
May-99	0		
Jun-99	2	13	17
Jul-99	1	0	
Aug-99	0		
Sep-99	0		
Oct-99	0		
Nov-99	0		
Dec-99	0		

3. OBSERVATIONS

The disinfection summary results show the event geometric mean for fecal coliform counts exceed 400 cfu/100 mL geometric mean criteria three times during the evaluation period. Each occurrence would be considered a violation of the NPDES permit limit because three or more

discrete effluent samples was used to perform the calculation. The monthly disinfection summary results show that the NPDES permit limit was not exceeded when sufficient samples were collected, except for February 1998.

The evaluation program generally shows that the fecal coliform limit can be met with current operational protocol, as long as the total residual chlorine (TRC) concentration is greater than 1.0 mg/L. When the TRC was substantially less than 1 mg/L, the fecal coliform counts exceeded 400 cfu/100 mg/L.

4. EVENT EXPLANATION

The "Criteria for Success in CSO Treatment" document allows the facility to be deemed to meet the Phase II criteria even if there were events which exceeded the fecal coliform limits provided a satisfactory event specific explanation is provided. The following explanation is provided for those events where the fecal coliform limit was not met.

a. 08-Jan-98 Storm Event

The fecal coliform event geometric mean for the storm event on 08-Jan-98 was 524,286 cfu/100 mL calculated using four treated effluent discrete samples. The event geometric mean exceeded the Phase II disinfection performance criteria for this event. The unsatisfactory disinfection performance for this event can be explained by degradation (loss) of hypochlorite strength from the bulk solution due to extended storage and aeration of storage

tank contents. During the event, the facility operator(s) was not aware the degradation of the hypochlorite in the bulk storage tanks had occurred and did not adjust the hypochlorite feed rate to account for lower hypochlorite strength.

All three CSO facilities operated by Wayne County experienced similar problems meeting disinfection treatment performance during the winter and early spring of 1998. A possible contributing factor was identified as the age of the bulk hypochlorite in the storage tanks at the time of the event. Table VIII-3 is a report of the hypochlorite deliveries to the three CSO basins. It is not known how long the hypochlorite was in storage at the Dearborn Heights CSO Retention Basin prior to the storm event on 08-Jan-98.

During the preceding time period after facility start-up, an operational practice at the facilities contributed to the loss of hypochlorite strength during storage. Each of the three Wayne County CSO basins was designed with the ability to mix the contents of the hypochlorite storage tanks through aeration. Mixing was thought to be important during the dilution process of the concentrated hypochlorite with process water to arrive at the 5% working strength. A 1-inch PVC compressed air line at 80 psi provides a supply of compressed air into each storage tank. The common practice (since discontinued) was for the operating staff to aerate the contents of the hypochlorite storage tanks

Table VIII-3 **Wayne County Department of Environment**
Division of Public Works
Henry Ruff Field Office

Sodium Hypochlorite Report

Delivery Date	Gallons Delivered	Delivered To
February 7, 1997	4,752 Gallons	Inkster Basin
February 22, 1997	4,800 Gallons	Inkster Basin
May 6, 1997	3,626 Gallons	Inkster Basin
June 17, 1997	2,022 Gallons	Redford Basin
June 19, 1997	4,000 Gallons	Inkster Basin
June 20, 1997	4,000 Gallons	Redford Basin
July 9, 1997	4,101 Gallons	Inkster Basin
July 10, 1997	4,101 Gallons	Redford Basin
February 19, 1998	4,800 Gallons	Dbn. Hgts. Basin
February 19. 1998	4,800 Gallons	Inkster Basin
April 16, 1998	4,800 Gallons	Redford Basin
May 7, 1998	4,750 Gallons	Inkster Basin

dab/07/17/98

approximately once per month for 15 to 30 minutes as part of the regular preventative maintenance work assignments. During mixing, the hypochlorite was being lost from solution to the atmosphere through volatilization, which decreased the working strength of the solution. As a result, the actual applied chlorine dose was significantly less than what would be expected if the hypochlorite was at 5% strength. If the control system was programmed to deliver a flow-proportional chlorine dose of 25 mg/L when the hypochlorite strength was at 5%, the actual chlorine dose would have been 5 to 10 mg/L with an approximate 1 to 2% hypochlorite strength. The actual applied chlorine dose was not sufficient to satisfy the chlorine demand, and therefore a chlorine residual was not established to provide disinfection.

In addition, another contributing factor to the unsatisfactory disinfection performance was facility start-up problems associated with the chemical feed system. The Event Summary sheets contained in Appendix H for this event shows the calculated hypochlorite dose rate. The observed volume of hypochlorite applied to the CSO flow was approximately half the volume necessary to obtain the desired hypochlorite dose of 20 mg/L.

b. 17/20-Feb-98 Storm Event

The fecal coliform event geometric mean for the storm event on 17/20-Feb-98 was 80,441 cfu/100 mL calculated using 12 treated

effluent discrete samples. The geometric mean exceeded the Phase II disinfection performance criteria and the NDEPS permit limit for this event. The unsatisfactory disinfection performance for this event can be explained by the following contributing factors including: (1) low hypochlorite strength, (2) late start of hypochlorite chemical feed, and (3) low hypochlorite volume delivery.

The combined effects of extended hypochlorite storage and aeration was believed to caused the strength of the hypochlorite of below 5 percent. The facility operator(s) were not aware the strength of the hypochlorite in the bulk storage tanks was low and did not adjust the hypochlorite feed rate to account for low hypochlorite strength.

The hypochlorite dose rate data, shown on the Event Summary sheets in Appendix H for this event, indicates the hypochlorite chemical feed was started approximately five hours after the start of the event. The facility began receiving CSO influent flow at approximately 13:30 on 17-Feb-98, but the hypochlorite chemical feed was started at approximately 19:30. It is not known what caused the delay in starting the hypochlorite application to the CSO flow.

The hypochlorite dose rate data, shown on the Event Summary sheets in Appendix H for this event, indicates the observed

volume of hypochlorite applied to the CSO flow was approximately half the volume necessary to obtain the desired hypochlorite dose of 20 mg/L.

c. 09/10-Mar-98 Storm Event

The fecal coliform event geometric mean for the storm event on 09/10-Mar-98 was 2520 cfu/100 mL calculated using three treated effluent discrete samples. The geometric mean exceeded the Phase II disinfection performance criteria and the NPDES permit limit for this event. The unsatisfactory disinfection performance for this event can be explained by the following contributing factors including: (1) late start of hypochlorite chemical feed, and (2) low hypochlorite volume delivery. Low strength hypochlorite is not an issue for this event because a fresh load of concentrated hypochlorite was delivered to the facility on February 19, 1998, only three weeks previous to the event on 09/10-Mar-98.

The hypochlorite dose rate data, shown on the Event Summary sheets in Appendix H for this event, indicates the hypochlorite chemical feed was started approximately five hours after the start of the event. The facility began receiving CSO influent flow at approximately 7:00 on 9-Mar-98, but the hypochlorite chemical feed was started at approximately 13:00. It is not known what caused the delay in starting the hypochlorite application to the CSO flow.

The hypochlorite dose rate data, shown on the Event Summary sheets in Appendix H for this event, indicates the observed volume of hypochlorite applied to the CSO flow was approximately half the volume necessary to obtain the desired hypochlorite dose of 20 mg/L. The volume of hypochlorite applied to the CSO was sufficinet to obtain a TRC concentration of approximately 0.5 mg/L. If the hypochlorite dosing volume was correct, a higher TRC concentration may have been obtained and satisfactory disinfection achieved.

B. ELIMINATION OF RAW SEWAGE

Historically, the discharge of untreated CSO has contained the presence of sanitary trash (i.e. condoms, tampons, etc) and other solids associated with raw sewage. The discharge of this material causes an aesthetic concern within the receiving stream and may contribute to violations of the physical characteristic (Rule 50) of the water quality standard. The Dearborn Heights CSO Retention Basin provides treatment of CSO, eliminating raw sewage character of the CSO, by providing screening, skimming, and settling.

Debris larger than 1-½ inches is removed from the incoming CSO by passing the flow through a mechanically cleaned catenary-type bar screens. The effluent weir was designed with an underflow baffle arrangement to retain floatables and surface oil/scum behind the baffle. The geometry of the flow-through compartments was arranged to maximize settling.

The “Criteria of Success” document provides the basis to demonstrate the ability of the facility to provide treatment sufficient to eliminate the discharge of raw sewage. The discharge from a CSO treatment facility can “only be considered treated (and no longer raw) if it does not have the visual appearance of raw sewage as determined by (1) visual observation of the discharge for the presence of sanitary trash and identifiable sanitary solids and (2) measured removal efficiency for material > 4 mm for a range of storms”.

1. VISUAL OBSERVATION OF OUTFALL

The Wayne County DPW field crews made observations of the effluent discharge outfall and Middle Rouge River adjacent to the Dearborn Heights CSO Retention Basin periodically during overflow events. Observations were made only during daylight conditions. No “floatables” were observed during discharge from the facility after many minutes of observation. Also, no evidence of trash, sanitary or organic waste material were observed on the outfall grating, stream bank, or the area surrounding the outfall after overflow events. No pictures were taken to document the visual observations. Notations of the visual observations were written in the facility logbook for each overflow event. Visual observations are also contained on the Event Summary sheets contained in Appendix H for each event.

2. EFFLUENT NETS

The RPO has installed mesh bags (with a maximum opening size of ¼-inch) on the overflow conduit at five of the demonstration facilities to make a qualitative assessment of the presence of sanitary trash or

identifiable sanitary solids during discharge of treated effluent from the facilities. The mesh bag was installed at the Dearborn Heights CSO Retention Facility in May 1999 and was in place for the overflow events occurring on 12/13-Jun-99, 13/14-Jun-99, 24/25-Jun-99, 27/30-Jun-99, and 23/24-Jul-99. No evidence of sanitary debris has been reported for the Dearborn Heights CSO Retention Basin after visual inspection of the mesh bags following these overflow events. In addition, sanitary trash has only been reported for one of the twelve events monitored, considering all facilities, since the installation of the mesh bags.

Appendix K contains the CSO Basin Floatables Evaluation Update prepared by the RPO in July 1999.

C. CONCLUSIONS

Based upon the data and analysis supporting the Phase II determination, the following conclusions can be made:

1. The disinfection and floatable removal performance of the Dearborn Heights CSO Detention Basin over the range of storm events during the evaluation demonstrates the Dearborn Heights CSO Detention Basin meets Phase II treatment performance criteria. The facility has succeeded to “protect public health” by providing disinfection and to “eliminate raw sewage discharge” by providing sufficient screening, skimming, and settling.

2. It is difficult to meet fecal coliform event geometric mean limit of 400 cfu/100 mL unless the total residual chlorine (TRC) concentration is 1.0 to

1.5 mg/L. The goal was to limit the event mean TRC concentration to less than 1.0 mg/L. From the available data, raising the goal to 1.5 mg/l would assure that the fecal coliform limits are met. A TRC study will provide information on whether this is adequate to protect the river from infrequent discharges. If not, dechlorination facilities will need to be considered.

3. The detention times encountered during the evaluation have been higher than the design detention times. It appears that at the observed detention times (even at 17 minutes), the fecal coliform event geometric mean limits can be met. A study is currently being done to verify that the event geometric mean can be met at shorter detention times.

4. The event geometric mean limit is more difficult to satisfy rather than the monthly geometric mean limit.