Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Evaluation of the GDRSS System Model for Wastewater Master Planning

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Evaluation of the GDRSS Systems Model for Wastewater Master Planning

1. Introduction

This technical memorandum provides an evaluation of the Greater Detroit Regional Sewer System (GDRSS) model for use in the wastewater master plan (WWMP) project. The WWMP project is intended to project over the next 50 years the long term needs in the area and to recommend the most cost effective sewer facilities that would meet these needs. The evaluation of the GDRSS model includes review of the model's capabilities, objectives, and limitations relative to the intended uses for the WWMP. The model will also be used to review regional approaches to dealing with sanitary sewer overflow problems within the system. Recommendations for extending the model to meet the needs of the WWMP project and other DWSD efforts are given.

2. GDRSS Model Background

2.1 Model Development

The Greater Detroit Regional Sewer System (GDRSS) model is a mathematical computer model used to predict wet weather response within the collection system that is served by the DWSD WWTP. The GDRSS Model is based on U.S. EPA's Storm Water Management Model (SWMM). The SWMM program is a public domain model that can perform calculations of runoff and I/I from design storms or a long-term rainfall record as well as dynamic flow routing through the storage and conveyance system within a sewershed.

The GDRSS Model has been under development since 1988. Over the course of the model development, the model has evolved through three phases. The GDRSS Model was initially prepared by DWSD to help determine if operational changes to the collection and treatment system could help reduce CSOs. This first phase of the model development consisted of a skeletal model of the interceptor system tributary to the WWTP.

The model was later expanded under the auspices of the Federal Court to include the surrounding suburban sanitary districts and tributary communities. This second phase of model development included collecting data for model calibration and making system-wide estimates of annual combined sewer overflow. The analysis was used to develop system-wide CSO control options, evaluate their performance, and place costs on the alternatives for CSO control.

The most recent phase of model development (Phase III) involved using additional flow data collected at a number of detailed study areas for refinement of the hydrologic parameters and performing additional system-wide calibration using data collected throughout the DWSD collection system.

This third phase of the model development was established to further develop and refine a technical tool for evaluation and analysis of system-wide CSO controls, including planning and design work. This model was used as the basic analysis tool for preparing Detroit's Long Term CSO Control Plan.

2.2 GDRSS Technical Committee

The development of the GDRSS Model included the oversight of a technical committee that included representation from DWSD, Wayne County, Oakland County, Macomb County, City of Dearborn, MDEQ, and the Federal Court. The GDRSS Technical Committee was created in 1992 as an outgrowth of a permit dispute between the Detroit Water and Sewerage Department (DWSD) and the Michigan Department of Environmental Quality (MDEQ, formerly known as the Michigan Department of Natural Resources [MDNR]). The Federal Court became involved in the dispute and by order dated December 21, 1989, appointed Dr. Jonathan W. Bulkley to conduct settlement negotiations. These negotiations eventually led to the formation of the Technical Committee, chaired by Dr. Bulkley.

The committee has monitored progress and provided oversight to the modeling work, including formulation of alternatives to be reviewed. This oversight by customer communities has led to widespread acceptance of the model and its results. As a result, the GDRSS model has been and is being used for many projects throughout the collection system area. Some projects use the model directly, and others rely on it as the foundation for more detailed analysis. For some of these projects, a portion of the GDRSS Model was enhanced through refinements made to address a given project's needs. The use of a regional model ensures that collection system response and wastewater conveyance is handled uniformly throughout the DWSD service area.

2.3 Model Objectives

The objective of the GDRSS Model has been to predict the hydraulic response of the collection system to wet weather. In particular, one of the purposes of the model has been to make estimates of combined sewer overflow volumes throughout the system. The model was developed as a tool to support the evaluation and analysis of system-wide CSO control, including planning and design of CSO control facilities.

Another objective of the model has been to provide the framework for a more consistent representation of the sewer collection system tributary to the Detroit WWTP during wet weather conditions. Having a system-wide model provided the ability to understand the interplay between the different regions of the collection system.

This capability was invaluable in evaluating future changes to the system and understanding the impacts on different system components.

The use of common hydrologic parameters and methodologies that are built on consensus has also allowed results to be prepared without having to discuss the basic assumptions used in the evaluation as would be needed if models and analysis were prepared for each project.

2.4 Model Maintenance

Since many other projects use the GDRSS model foundation as a starting point, extensions are often made to address project-specific issues. Many of these enhancements would benefit the GDRSS model. To make this happen, the GDRSS project includes a user's group that meets periodically to understand the nature of the enhancements and extensions. These changes are then compiled for potential inclusion in the model should they be needed in the future.

Attendees of the model user's group have included representatives from DWSD, Wayne County, Oakland County, and Macomb County (See Appendix A for complete list). The operation of the model user's group and subsequent effort needed to incorporate these enhancements is funded by DWSD and its customers (common to all). DWSD plans to provide continuing support of this model users group as long as the model is a valid tool for system-wide use. It is anticipated that the WWMP modeling team will also participate in this endeavor as improvements and updates to the GDRSS Model are made. It should be noted that if/when any changes are made to the GDRSS Model for the WWMP project, the model will be called the WWMP Model to avoid confusing it with the official GDRSS Model.

2.5 Model Documentation

All the information and data used to develop the GDRSS Model are contained in the project files. The Phase II Report and Technical Memoranda (1 through 30) and the Phase III Report and Technical Memoranda (31 through 47) document the model development and applications. The Phase II documentation was published on June 30, 1994. The documentation for the Phase III work was published in March of 2001, and is available electronically on a computer CD.

3. Evaluation of the GDRSS Model

This evaluation of the GDRSS Model was performed based on expected uses of the model for the WWMP project. For the GDRSS project, the focus of the model use was on CSO related issues. While these issues will remain important, the modeling efforts for the WWMP project will include a greater emphasis on transport capacity-related issues for customers of the DWSD collection system over the next 50 years. Evaluation of future needs and various alternatives to meet these needs will be an important component of modeling for the WWMP project.

The current GDRSS Model was developed under DWSD contract CS-1249.

An official release of the GDRSS Model was made on September 9, 1999, by the CS-1249 project team. This release of the model is the version used for evaluation in this memo. The model as released was configured for baseline (1998) and future conditions. The future condition model included planned facilities and changes to the system known at the time of the model development, and it uses dry weather flows and populations as projected for the year 2020.

3.1 Service Area

The Detroit Water and Sewerage Department's (DWSD) single wastewater treatment plant (WWTP) collects flows from approximately three million persons in more than an 904-square-mile service area consisting of 77 communities, including Detroit, as shown in Figure 1. Table 1 lists area, population and baseflow statistics by sanitary district as included in the GDRSS Model.

This service area as used in the GDRSS Model represents conditions as determined for the year 1998. The service area was identified from sewerage system maps obtained from local communities or county Drain Commissioners. How non-tributary areas were handled depended on how the information was provided by the communities during the model's development. For instance, some communities included portions of river reaches as part of their tributary area while other communities did not. In addition, the defined tributary area may include open spaces that currently are not developed or sewered.

As mentioned, the Phase III Model was developed for both baseline (1998) and future (year not specified, but with 2020 dry weather flows and populations) conditions. For the future conditions of the model, the service area boundary was not allowed to change. It was assumed that the population served by sewers might change due to expansion of the sewer system within the defined tributary area (septic users, for instance), but the possible expansion of the service area was not considered in Phase III. Obviously as part of the WWMP project, the service area will need to be reviewed and expanded as needed to match projected growth of the sewer system.

Baseflows were determined from flow data measured in 1992 to 1993 and projected to 1998 and 2020 based on population growth projections using 120 gallons per capita per day (gpcd) for residential population and 20 gallons per employed per day. Further details on the projection and distribution of the dry weather flows in the model are documented in Technical Memorandum 43 of the GDRSS Phase III Report.

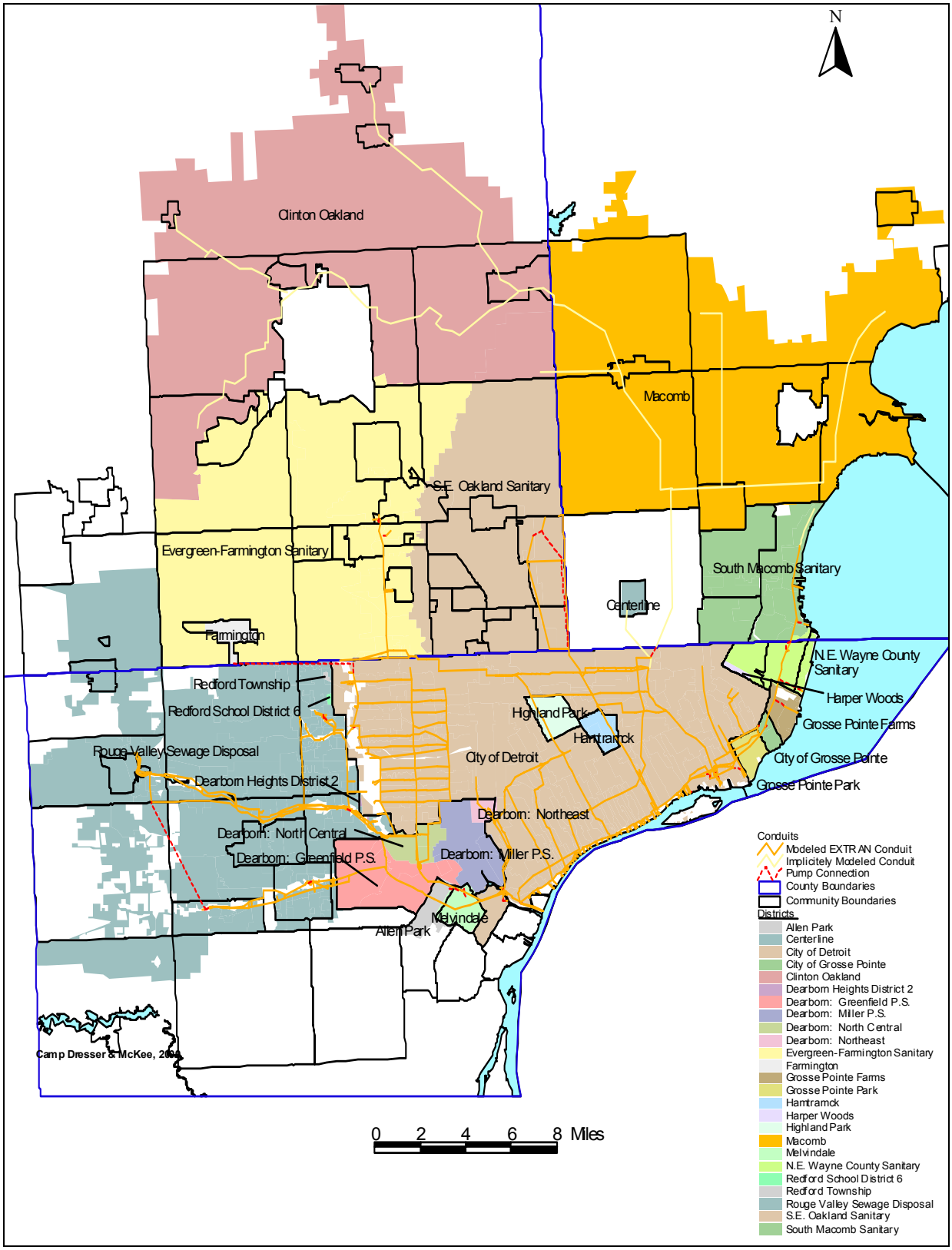

Figure 1. Tributary Wastewater Districts and Contracted Communities

Table 1. Sanitary District Characteristics

	Total Area (acres)				
District	Combined	Separate	Total	Population (1998)	Base Flow [1] (MGD)
Allen Park		1,590	1,590	4,000	1.3
Centerline		1,060	1,060	8,529	1.3
Clinton Oakland		119,813	119,813	205,031	31
Dearborn	9,896	5,719	15,615	95,764	25
Detroit[2]	87,457		87,457	1,060,716	330
Evergreen-Farmington	4,498	78,592	83,090	249,068	40
Farmington		1,424	1,424	8,021	2.0
Grosse Pointe	275	416	691	5,788	0.6
Grosse Pointe Farms	1,380	49	1,429	9,916	1.2
Grosse Pointe Park		1,300	1,300	12,685	1.5
Macomb		103,765	103,765	346,651	42
Melvindale		1,850	1,850	12,511	3.0
N.E. Wayne [3]	8,340	12,678	21,018	193,985	26.1
S.E. Oakland	24,222	21,305	45,527	303,673	55
Western Wayne [4]	5,912	90,855	96,767	498,925	80
Total	141,980	440,416	582,396	3,015,264	640

[1]Base flow is the annual average dry weather flow from residential, commercial, and industrial sources and includes dry weather infiltration. The base flow provided is the projected dry weather flow for the year 1998.
[2]Includes Highland Park, Hamtramck, and portions of Harper Woods, Redford Township, Dearborn Heights and Dearborn.
[3]Northeast Wayne District includes South Macomb Sanitary District, Grosse Pointe Shores and Milk River (Northeast Wayne County).
[4]Represents North Huron Valley-Rouge Valley wastewater control system.

3.2 Model Formulation

The DWSD and suburban collection system is a very large and complex system. To model this system, the GDRSS Model uses the U.S. EPA's Storm Water Management Model (SWMM) program, which consists of a series of mathematical computer modules (referred to as blocks in the program documentation) with related functions to predict wet weather response within the collection system. These modules are summarized in Table 2. This table includes descriptions of model function and simulation types (i.e. single event or continuous).

Table 2. EPA SWMM Computer Modules

Module	Function	Simulation Type
RUNOFF (hydrology)	Hydrologic model that estimates surface runoff and overland flow routing for combined sanitary service areas and rain dependent inflow/infiltration for sanitary service areas. These responses are generated from rainfall data for a single storm event or for a continuous rainfall record for an extended period of time.	Single Event or Continuous, depending on rainfall data used
EXTRAN ("event" hydraulics)	Hydraulic model that receives flows from the RUNOFF model and routes flows through the sewer system. Detailed hydraulic calculations are performed, and surcharging and backwater are properly represented.	Single Event
TRANSPORT ("continuous" hydraulics)	Hydraulic model that receives flow from the RUNOFF model and routes the flow through the sewer system using simplified hydraulic calculations that do not accurately account for surcharging and backwater.	Continuous (3 years)

In general, the RUNOFF and EXTRAN data files comprise what is commonly referred to as the GDRSS **Event Model**, while the RUNOFF and TRANSPORT data files comprise what is called the GDRSS **Continuous Model**. In addition to these modules of the SWMM program listed in the table, other components that have been used either directly or in support of the GDRSS Model include the RAIN module and the STATS module. The RAIN module is designed to read long-term precipitation records and from these records generates a file for input into the continuous RUNOFF. The STATS module is used to calculate statistics of annual frequency of overflow events, annual discharge volumes and duration from the continuous model output.

3.2.1 GDRSS Hydrology Model—SWMM RUNOFF

The SWMM RUNOFF module uses rainfall data to estimate surface runoff for combined sewer areas and to estimate rainfall dependent infiltration/inflow (RDI/I) for suburban areas served by sanitary sewers. The required input for the RUNOFF module describes tributary areas in terms of basic characteristics that affect wet weather response.

To characterize the GDRSS tributary service area for RUNOFF, the area was divided into subareas (subbasins), which are sub-divisions or portions of the drainage area that have similar hydrological characteristics and drain to a particular point. This delineation included distinguishing between combined sewer service areas and separate sewer service areas. A total of 145 separate sanitary subareas and 209 combined sewer service subareas were defined for the GDRSS Model as shown in Figure 2.

The subareas provide the basis of the various statistics of the model, including dry weather base flows, populations, and land uses. One of the outcomes from the use of the model has been to assess these and other parameters by municipality. This capability will be important for purposes of the WWMP; therefore, additional delineations may be needed to avoid any subarea spanning municipality boundaries.

3.2.1.1 Combined Sewer Service Areas

One of the key hydrologic parameters for combined sewer service areas is the directly connected impervious area (DCIA) parameter.

A number of detailed study site analyses as well as other field investigations and other analyses were used in the determination of the DCIA values. The tributary area was divided into 11 regions of similar characteristics based on land use, DCIA trends, and knowledge of the region's development history and unique characteristics, as shown in Figure 3. The data collected was then correlated to ten different land uses within each region

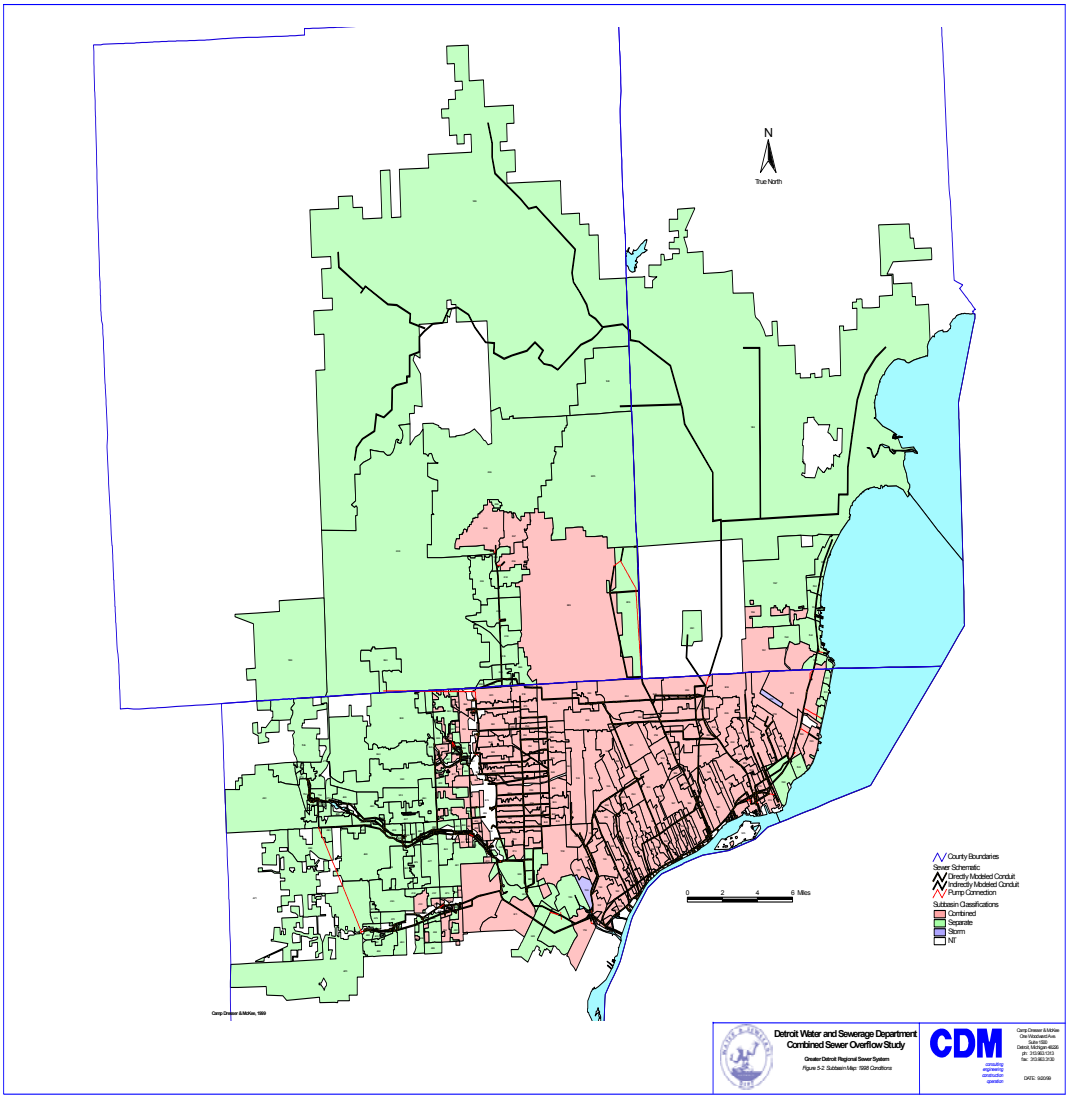

Figure 2. GDRSS Subareas Classification

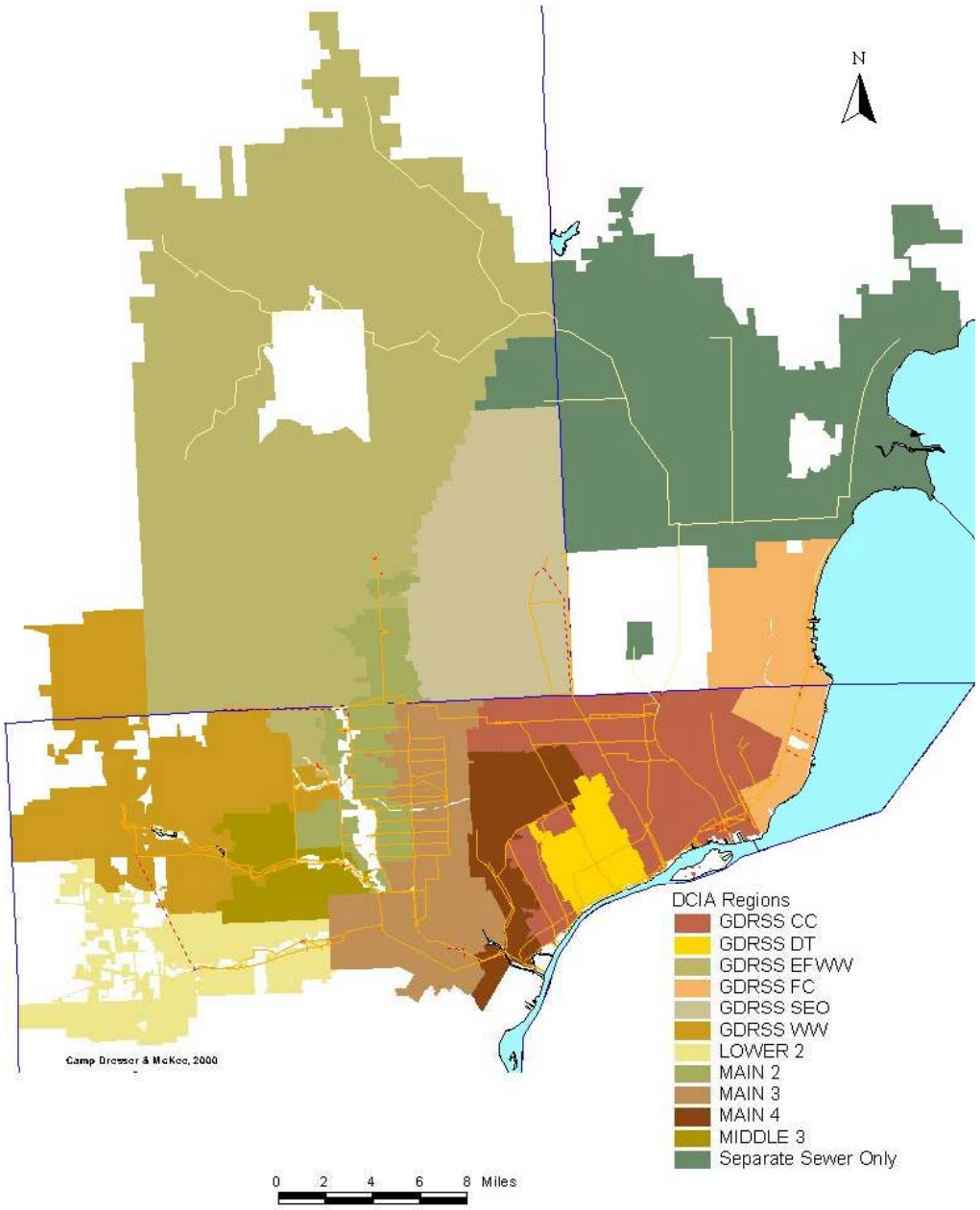

Figure 3. DCIA Regions as defined in GDRSS

Field determined values always were used if available versus the correlations. As additional data becomes available, these can continue to be improved, but in general, these values are considered to be good and reasonable estimates.

After the generation of storm runoff, the model routes the runoff volume through a "routing channel" that simulates the natural and man made drainage pathways. This channel is used to represent the storage and attenuation that is caused by the local collection and conveyance systems that is not included in the hydraulic portion of the GDRSS Model. A comprehensive runoff flow data set was used in the GDRSS Phase III project to establish relationships between the routing channels and population density, directly connected impervious area (DCIA) value, and the size of each subarea. As a result, the hydrographs generated by the RUNOFF model more closely resemble flow hydrographs observed in the collection system for a range of storm event sizes. It is anticipated that these will not need to be refined or updated for the WWMP project.

3.2.1.2 Separate Sanitary Sewer Service Areas

Separate sewer systems by design do not include storm runoff; however, they are a source of wet weather flows caused by rain dependent inflow and infiltration (RDII). The RDII in these systems is the result of stormwater leaking into the sanitary sewer systems through defects in the piping system, manhole defects, improperly connected drains, and basement foundation drains. This flow is an important component of the sanitary flow because all of it must be conveyed to the WWTP for treatment. It is a significant source of flow in the regional collection system because of the size of the sanitary areas that are tributary to the DWSD WWTP. The RDII flows can impact the amount of WWTP capacity that is available for handling wet weather flows from the combined areas.

The amount of RDII response to a rainfall event is calculated in RUNOFF as follows:
RDII Volume = C (P – Ia) A

Where C is the RDII factor, P is the rainfall, Ia is the initial abstraction or amount of rainfall below which a response is typically not seen and A is the tributary area. The RDII parameters were determined using data collected from a total of 70 areas that ranged from 25 to 12,000 acres in size. Correlations between RDII Cs and median building age were established to estimate the RDII values in areas where data were not available. The median building age was used as a surrogate for sewer system age and was obtained from the 1990 U.S. Census GIS coverage statistic. If an area did not have specific values determined from data collected from the area, the correlation was used.

Two distinct "seasons" were identified in the analysis of all the data collected for this project: dormant (November to April) and growing (June to September). Each of these seasons exhibits different RDI/I behavior that has been incorporated into the correlations. With this approach, May and October were classified as transition months.

As part of the metering program (CS-1249, Phase IV), additional data is being collected within Macomb County from the billing meters. This data can be used to refine the RDII values for these regions. The data along with updated census data can be reviewed for whether the correlations should be updated before being used in the WWMP projections to 2050.

3.2.2 GDRSS Event Hydraulics Model—SWMM EXTRAN

The GDRSS event hydraulic model routes wet weather flows generated by the hydrology model, along with base-wastewater flows, through the sewer collection system in response to both actual and design storm events. As mentioned previously, the event hydraulic model uses the SWMM EXTRAN program for these analyses. EXTRAN is a fully dynamic hydraulic engine that is able to accept flows generated by RUNOFF and represent the flow in complex sewer systems such as the DWSD and suburban collection systems.

Routing flows within the wastewater collection system requires characterization of the hydraulics of the system. Plan/profile design drawings, basis of design drawings and other information were used to develop the hydraulic components of the GDRSS model, including sewer sizes, in-system storage, pump station pumping capacities and operations, weirs, regulators, etc. Model input data were field checked at many locations to ensure the accuracy of the model input for hydraulic conveyance components.

EXTRAN has certain limitations in what system configurations it can handle. Weirs and short conduits can cause stability problems in an EXTRAN simulation. These problems are often addressed through the use of an equivalent conduit. An equivalent conduit is a conduit that has equivalent losses to the system configuration being replaced. An equivalent conduit can be used to obtain a configuration that can be handled by EXTRAN without the problem of instabilities or large continuity errors. The basis for the use of equivalent pipes and their calculations are presented in the SWMM User's Manual.

Generally all weirs, orifices (portholes), regulators, outfalls, and short pipes are modeled with equivalent conduits in the GDRSS model. In some cases, siphons also are modeled using an equivalent conduit to avoid instabilities that sometimes occur where the system has a transition from open to surcharge conditions. As the EXTRAN data set does not require a conduit to be identified as an actual or equivalent conduit, identification of equivalent conduits in the model is typically via comments that are contained within the data file.

A system-wide validation of the GDRSS Phase III Model was performed to substantiate the model's predictive capability and verify a number of updates made to the model.

DWSD's evaluation of the WWTP at near full capacity data (CS-1158 project) and other data were used to check flows throughout the system, including flows from the

various suburban areas. The calibration and validation of the model is described in the GDRSS Phase III Modeling Report.

3.2.3 GDRSS Continuous Hydraulics Model—SWMM TRANSPORT

The GDRSS continuous hydraulic model simulates the response of the sewer system to long-term rainfall records to produce statistics of expected annual overflow volumes and frequencies. The continuous hydraulic model uses the SWMM TRANSPORT program for these overflow volume and frequency analyses.

TRANSPORT is similar, but simpler, in function to the EXTRAN program, which allows the model to be used for longer simulation simulations. The foremost simplification is that the TRANSPORT model does not consider backwater conditions in its calculations. This simplification limits the accuracy of the model in some cases, but at the same time it dramatically reduces the number of calculations that must be performed. Because of this simplification, the model can be used, along with the continuous RUNOFF model, to perform continuous modeling of the collection system.

When the TRANSPORT model was originally developed, it used a computational time of 1 hour, which matched the RUNOFF timestep and rainfall interval used. With this timestep, the model was able to analyze a rainfall record of 10 years in a reasonable timeframe. During the Phase III project, the RUNOFF and rainfall timesteps were changed to 15-minutes to improve the numerical computation of the peak flows with the revised routing channels.

Because these changes in time step significantly increased the run-time of continuous simulations, the total continuous simulation time period was reduced from 10-years to 3-years. A 3-year rainfall period (1984, 1985 and 1986) was selected that produced the equivalent annual overflow of the 10-year simulation (1982 to 1991) used previously.

Because of the increase in computational power available today, this restriction on time period is not as critical. In fact, the issue is usually the availability of 15-minute rainfall record. In developing potential applications for the WWMP project, if continuous simulations are used, a longer time period may be warranted.

3.2.4 Model Assumptions

The following list provides the general assumptions that are applied in the GDRSS Model development and analyses. These assumptions are listed here, as they may need to be addressed in using the model for the WWMP purposes. Ones that are known now that will need to be addressed are shown with an asterisk (*).

Rainfall

- Rainfall is applied uniformly across the tributary area (no spatial variation).

- No rainfall area reduction factor for point rainfall is applied to the rainfall events (design or continuous).

Dry Weather Flow (DWF)

- District vs. WWTP flow regressions were used to estimate area-specific DWF.
- Monthly flow factors were calculated by district.
- *DWFs were projected for the years 1998 and 2020.
- DWF values are as used in the City of Detroit's Long-Term CSO Control Plan.
- Spring (April) dry weather flows, which represent the highest baseflows in the year, were used for the Event Model results.
- DWF Factors (DWFFs) were calculated by district and are the same for the years 1998 and 2020.

Outlet (Tailwater) Water Levels

- Detroit River level was set at 95 feet (City of Detroit elevation, applies to Event Model only).
- Rouge River levels were set at normal river levels. Normal river levels generally results in free discharge for outfalls along the Rouge River.

Hydrology

- *The GDRSS tributary area was divided into a number of subbasins consistent with the level of detail used in the modeling of the sewer network.
- Runoff from subbasins are determined using EPA SWMM RUNOFF.
- For combined sewer areas, the program uses factors of directly connected impervious areas and infiltration parameters to generate runoff response. Overland flow during which infiltration is possible in the pervious areas is limited to 100 feet.

  Routing and attenuation effects afforded by storage within the subbasin (secondary collection system, surface ponding, etc.) are accomplished through routing channels (fictitious hydraulic channels sized based on empirical relationships developed for this project—see Technical Memorandum 42).

- For separate sewer areas, the program uses rain dependent inflow/infiltration factors to generate runoff response. Routing of these flows within the subbasin is accomplished via triangular hydrographs.

- Wet antecedent conditions are assumed for design events with 1-hour durations; average antecedent conditions are used for 24-hour duration events.

Hydraulics

- Sewers are generally assumed to be in "clean" condition (no sedimentation).

- Real time control of gates, regulators, or pump stations is not incorporated into the current model framework.

- Gates are set at open state except for the following cases: only one of two gates at the Baby Creek regulator is open and only one of three gates at the Conner Creek forebay is set open in the model.

- Inflatable dams and operable gates (Hubbell Southfield outfall, in-system storage dams of the preferred plan, the Task 1 gates along the Northwest Interceptor outfalls, etc.) are generally modeled as a very wide weir with the top of the weir set at the elevation desired to be maintained by the operable device.

- Regulators are modeled in an open condition. A maximum flow rate is set for the Wayne County CSO mechanical regulators.

- Pumping capacities of pumps included in the model are set at firm capacity. A WWTP capacity of 1,520 MGD is used for 1998 conditions and 1700 MGD is used for future conditions.

- Storage volumes are included in both the Event Model and the Continuous Model. These storage facilities are defined as area versus depth in the model. In-system storage is calculated in EXTRAN directly if the pipes are included in the model.

  In some cases, if the upstream pipes are not included, storage is added to account for those pipes.

  Because the Continuous Model (TRANSPORT) does not account for in-system storage volume of pipes directly, storage for the Continuous Model includes volume for in-system storage where needed.

Decanting

Event (EXTRAN) Model

- Decanting is simulated in Event Model by reduction of basin volume to 1/3 of actual basin volume—timing and rate are not considered, as EXTRAN has no provision for representing those aspects of decanting. *Continuous (TRANSPORT) Model*

- Decanting of 2/3rds of the basin volume is assumed for those facilities capable of that function.

- Decanting begins 2 hours after inflows are less than the dewatering rate.

- Upper two thirds of basin is decanted.

- Rate is set to decant over 24-hour period.

Dewatering

Event (EXTRAN) Model

- Basins dewater as capacity becomes available in receiving sewer. *Continuous (TRANSPORT) Model*

- Basins are set to dewater over 48 hours along the NWI (to eliminate overflows).

- Basins set to dewater if WWTP capacity available along DRI (to reduce storage).

- Definitions of adequate treatment are reviewed at 10 minute, 30 minute and 1 hour.

3.3 Submodels

Due to the size of the DWSD and suburban collection systems, the GDRSS model consists of a number of submodels used to manage and model this complex system more effectively. Use of submodels enabled a more detailed evaluation of the important parameters within smaller areas of the collection system during the calibration process. The computational power available at the time was also a reason for using submodels. Generally, the collection system was divided into submodels where hydraulic controls exist.

Table 3 presents a list that describes the submodels comprising the GDRSS model. Figure 4 shows the locations of the submodels within the tributary area of the system.

Table 3. Submodel Descriptions

Submodel	Description
Lower & Middle Rouge (Western Wayne County)	Combined and sanitary sewer areas adjacent to the Lower and Middle Rouge Rivers. Interceptor sewers paralleling these river reaches discharge to the Central City submodel.
Evergreen Farmington	Primarily sanitary sewer district entirely in Oakland County. Some combined sewer areas with regulated discharges. Sanitary sewer flows dominate. Discharges to the Central City submodel.
Southeast Oakland	Sanitary sewers serve approximately half of area, the other half by combined sewers. A large combined sewer area with overflows through the Twelve Towns Drain Retention Treatment Basin (RTB). Discharges to the Central City submodel.
Fox Creek	Combined and sanitary sewer areas adjacent to Lake St. Clair. The Fox Creek area includes a number of pumping stations and three RTBs. Discharges to the East Side.
East Side East Side	Combined sewer area entirely in the City of Detroit. Extensively cross-connected system with all flows discharging to the Central City submodel through a single pump station. Overflows to the Detroit River by storm pumping stations.
West Side (Hubbell-Southfield)	Combined sewer area in the City of Detroit with input from Farmington. Extensively cross-connected system, which overflows to the Rouge River. Discharges to the Central City submodel.
Central City	Combined sewer areas, in the City of Detroit, Highland Park and Hamtramck, receives inflow from all of the above submodels, Centerline, Grosse Pointe Park, Dearborn, Allen Park, Melvindale, and the Clinton-Oakland and Macomb Sanitary Districts. This submodel contains the DWSD WWTP.

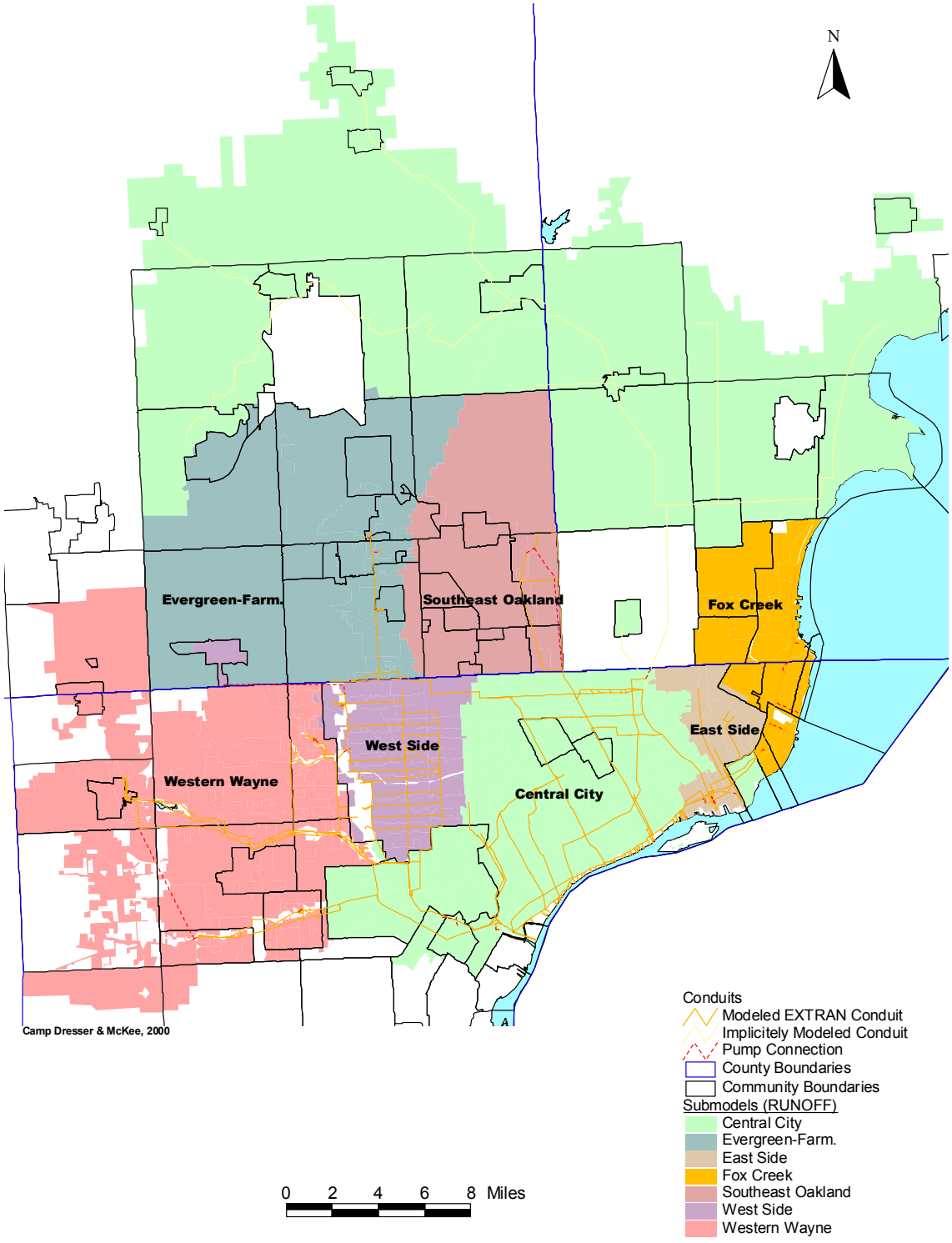

Figure 4. GDRSS Submodels

For the hydraulic model, some of the submodels have been combined to improve the representation within the City of Detroit. Figure 5 shows the framework of the Event Model. As shown, the Event Model consists of 6 RUNOFF submodels and 4 EXTRAN submodels.

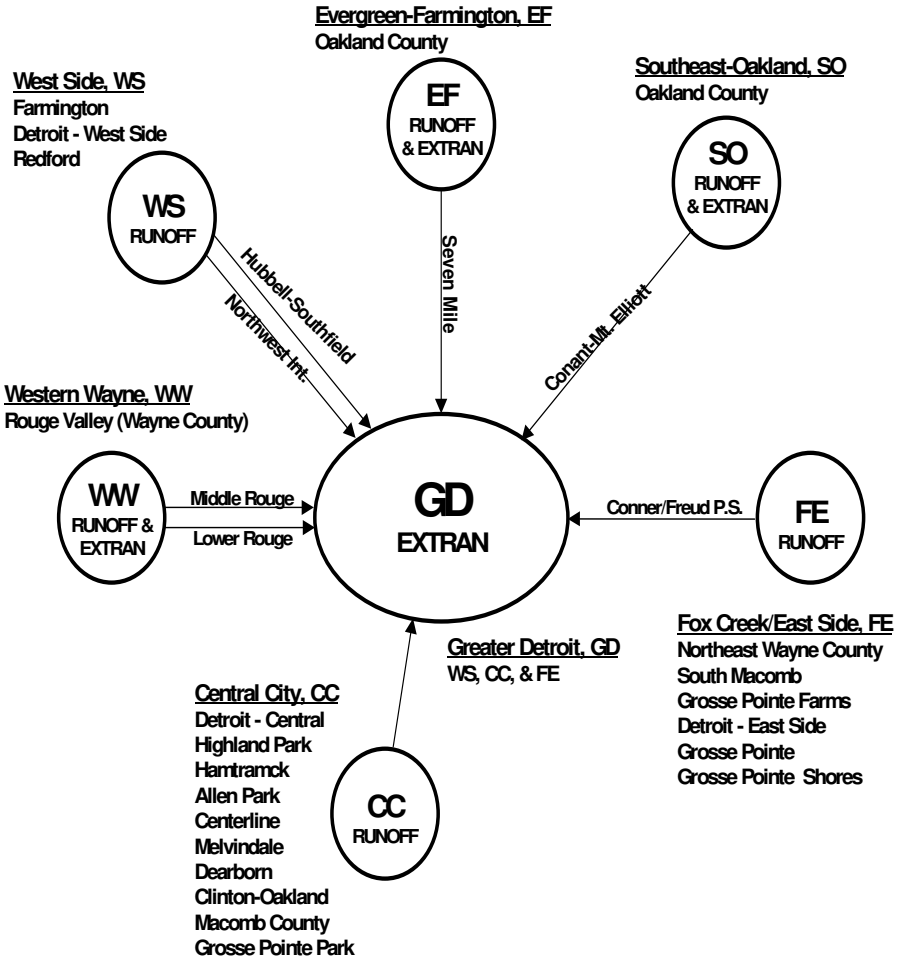

Figure 5. GDRSS Event Model Framework

Figure 6 shows the submodel interaction within the Phase III Continuous Model. In contrast to the Event Model, each submodel consists of a RUNOFF and TRANSPORT submodel. Because TRANSPORT does not account for downstream conditions such as backwater, there was not a need to combine the hydraulic submodels as was done in part for the Event Model.

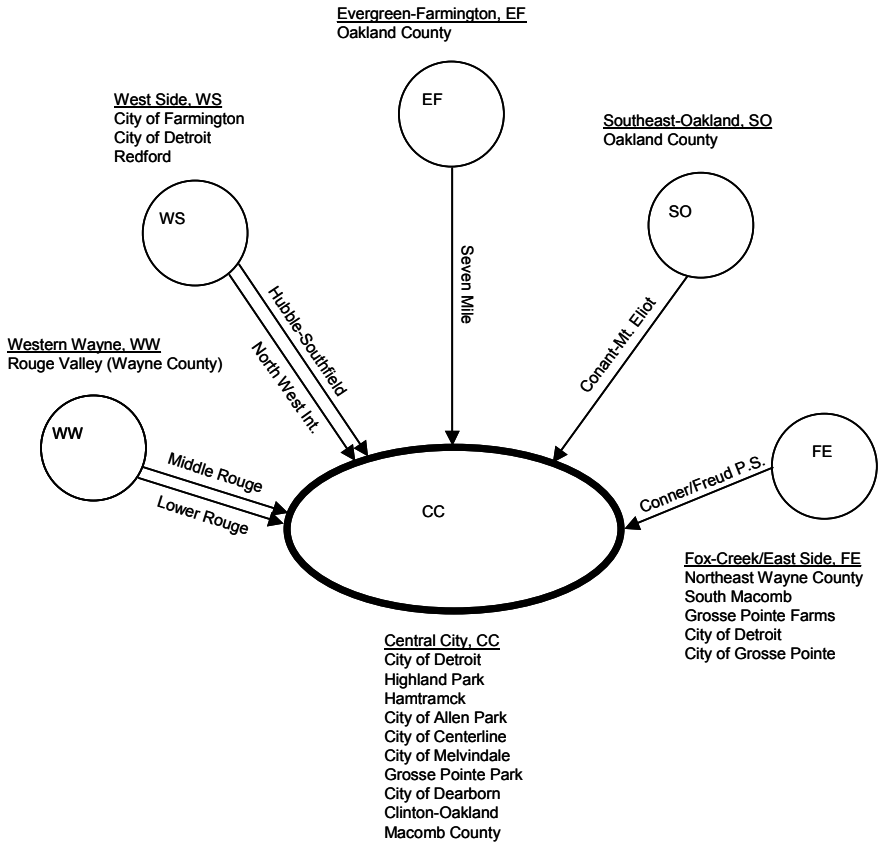

Figure 6. GDRSS Continuous Model Framework

Because the WWMP will have a greater emphasis on the transport capacity within the collection system, the use of separate submodels may not be as feasible. Use of one model will facilitate review of system-wide operations and alternatives such as dewatering of storage facilities throughout the system. The available computing power also reduces the need for dividing the system into a series of submodels.

3.4 System Conditions / Planned Facilities

The GDRSS Model was configured to represent 1998 conditions (baseline) and future conditions with 2020 dry weather flows. The baseline version of the model included all the wet weather demonstration facilities that were planned as part of the Rouge River Wet Weather Demonstration program with the exception of the City of Dearborn tunnel.

The construction of the tunnel has been delayed due to construction problems; therefore, it was not included in the baseline model. The Wayne County Lift Station 1A was included in the baseline model even though it was not on line until late 1999.

The future condition model includes the Dearborn tunnel and all other various improvements, expansions, and facilities planned by the communities that were known at the time of the development of the model future condition.

There have been a number of planned or implemented changes to the system since the time of the model development that are not included in the GDRSS Model (baseline or future). These include separation projects, screening and disinfection projects, and storage facilities. Known changes or projects not included in the model include the following:

- Southeast Oakland - Expansion of the Twelve Towns Retention Treatment Basin.
- City of Detroit – Screening and disinfection facilities at Leib, St. Aubin, and Baby Creek.
- Grosse Pointe Farms – Separation project

As part of the WWMP project, these changes will need to be evaluated and if determined useful for the WWMP modeling purposes, incorporated into the model. In addition, other planned improvements and changes such as an addition of a pump at the Northeast Pump Station or the diversion of additional flows to Western Township Utility Authority will need to be added as needed to correctly represent the planned condition of the collection system.

3.5 Collection System

The collection system sewers included in the GDRSS Model are shown in Figure 7. This figure also shows the approximate size of the conduits modeled. The model includes a total of 1,452 conduits in its representation of the collection system for baseline condition and 1,513 for future conditions. A chart showing the distribution of pipe sizes is shown in Figure 8.

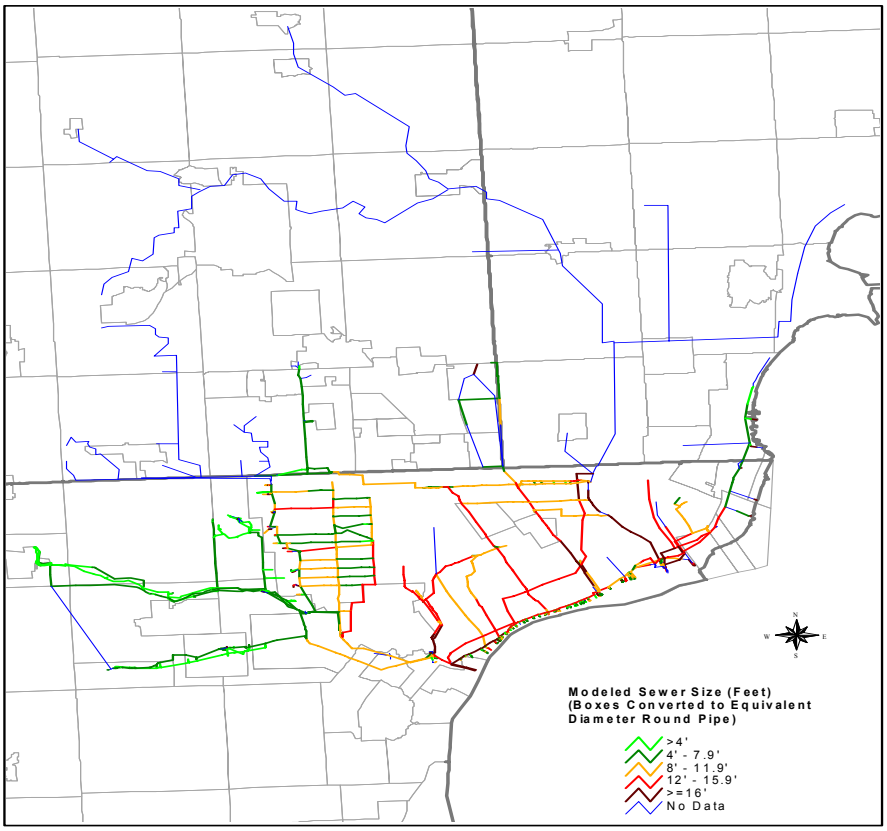

Figure 7. Size of Collection System Sewers in GDRSS Model

The model does not include all sewers but rather the major sewers required to accomplish the objective of the modeling project. Because the focus of the model development was on combined sewer overflows (CSO) and transport of flows to the WWTP, the model included sewers as needed to represent these outfalls both inside and outside the City of Detroit as well as the major transport sewers of the system. Sewers were included in the model not based on size, but on need to represent an outfall and/or transport of major flows to the plant.

The hydraulic model also does not extend to Farmington or Centerline. In both cases, these communities do not have CSOs and in addition, their respective flows were small relative to other flows being modeled in the system. These representations may need to be improved to address capacity needs for these communities.

It should be noted that in spite of the emphasis on the CSOs in the modeling effort, there are outfalls that were not included in the model. Many of the outfalls in the City of Dearborn were not included because these overflows were represented in aggregate at the two major pump stations that pump flows into the DWSD system.

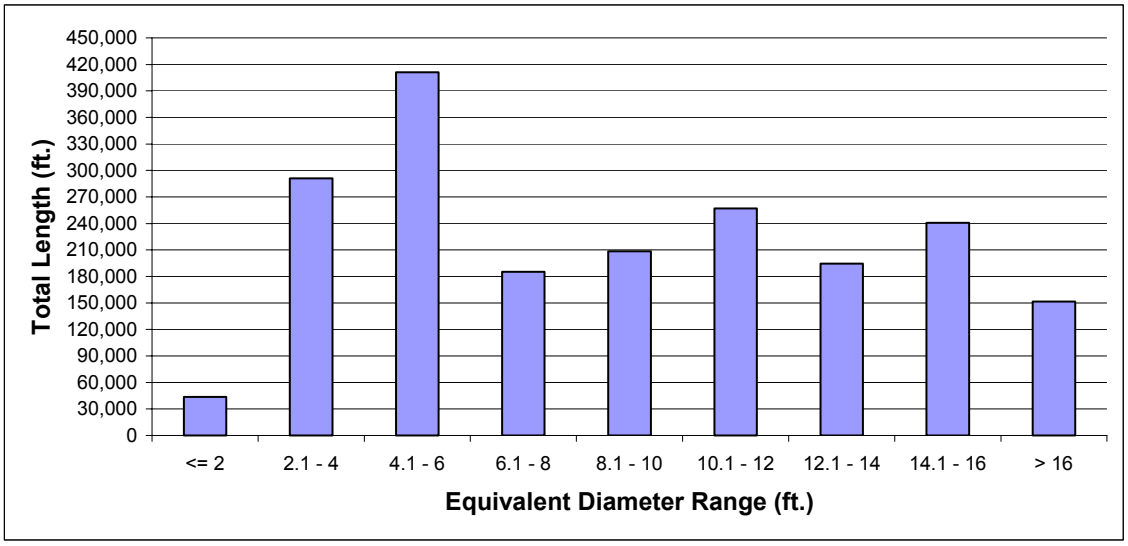

Figure 8. Distribution of Pipe Sizes (Vertical Dimension) in the GDRSS Model (Baseline Condition, Box sewers converted to equivalent diameter)

Also, there are several overflows in the northern Evergreen-Farmington district that were aggregated. It is anticipated that these representations would not need to be improved to address the capacity needs of these communities.

3.6 Pump Stations

The pump stations in the sewer collection system that are represented in the EXTRAN model are listed in Table 4. Pumping capacities included in the model are generally set at firm capacity except when noted otherwise. Firm capacity is the capacity assuming the largest pump is out of service. Where pump curves are available, the actual relationships between pumping rate and wet well levels are usually represented in the model by a three-point curve (labeled "3-pt H-Q pump curve" in the table, where H-Q denotes Head-Discharge). Otherwise, the pump station is defined as pumping rates for various wet well levels without regard to the discharge head (labeled "In line lift pump" in the table).

DWSD owned pumps that are not included in the model are Woodmere, Brennan, Belle Isle (5 stations), Chesterfield, Clintondale, Lighthouse Point, and Garfield. The Clintondale and the Garfield pump stations were not included in the model as they are part of the interceptor system in Macomb County that was not modeled explicitly. These will need to be included in the model extension into Macomb County. The Chesterfield pump station has been deactivated and is no longer in operation. The remaining pump stations are minor pump stations and are not anticipated as being required for inclusion in the WWMP Model.

3.7 Storage Facilities

The GDRSS Model includes 18 storage (equalization) and storage/treatment facilities for baseline conditions and additional 3 facilities for future conditions as shown Table 5.

The model parameters include facility volumes, overflow weir characteristics, dewatering rates and controls and assumptions on shunting and decanting. The operations of the facilities in the model are based on set rules or conditions within the system; that is, the model is not able to account for operator or manual control. The parameters used in the Phase III model may not represent the actual configurations of the CSO facilities. Some of these facilities are further defined in the Suburban CSO Basins in the DWSD Service Area Tech Memo.

For instance, the Conner Creek forebay is sometimes used for storage during large events by closing the gate in the regulator that leads from the forebay to the DRI. The Event Model is set to mimic this storage by recycling flows from the Fairview pump station until capacity is available downstream. The timing of the flows not recycling—effectively opening the regulator gate—may or may not coincide with actual manual operation of the gate. The Continuous Model was not configured to represent this operation at all, although a special version that can account for this operation was provided to DWSD for use in their CSO Notification Program.

In some respects, the Continuous Model (TRANSPORT) has more versatility than the Event Model (EXTRAN) as it can base the dewatering of a facility on the flow rate of any segment throughout the system. This feature has been used in an analysis of the impact of system-wide dewatering of basins on the flows at the WWTP.

Table 4. System-Wide Pumps Included in GDRSS Model*

Pump Station	Model Capacity	Model Type**
WWTP (1998)	1520 MGD	3-pt H-Q pump curve
WWTP (Future)	1700 MGD	3-pt H-Q pump curve
Fairview	375 cfs	3-pt H-Q pump curve
Oakwood Sanitary	20 cfs runout=24 cfs	3-pt H-Q pump curve
Oakwood Storm	382 cfs	3-pt H-Q pump curve
Fischer	15.2 cfs	3-pt H-Q pump curve
Conner Sanitary	225 cfs	In-line lift pump
Conner Storm	3500 cfs runout=3850cfs	3-pt H-Q pump curve
Freud Sanitary	20 cfs runout=25cfs	3-pt H-Q pump curve
Freud Dewatering	34.5 cfs runout=50 cfs	3-pt H-Q pump curve
Freud Storm	3150 runout=3500 cfs	3-pt H-Q pump curve
Bluehill Sanitary & Storm	790 cfs	3-pt H-Q pump curve
Northeast	249 cfs	In-line lift pump
Milk River	22 cfs	In-line lift pump
Cook Road Sanitary	3 cfs	In-line lift pump
Grosse Pointe Farms (Kerby Road)	554 cfs	3-pt H-Q pump curve
Kerby Road	127 cfs	3-pt H-Q pump curve
Grosse Pointe City Sanitary	14 cfs	3-pt H-Q pump curve
Grosse Pointe City Storm	178 cfs	3-pt H-Q pump curve
Grosse Pointe Park	84 cfs	3-pt H-Q pump curve
Marter Road	102 cfs	In-line lift pump
Miller Road (Dearborn)	50 cfs	In-line lift pump
Greenfield Road (Dearborn)	50 cfs	3-pt H-Q pump curve
Lift Station 1A (Wayne County)	250 cfs	3-pt H-Q pump curve
Murwood	152 cfs	3-pt H-Q pump curve

*Pumps recommended to be added for the WWMP Model include Clintondale and Garfield.

**H-Q denotes Head-Discharge

Table 5. Storage & Storage/Treatment Facilities included in the Phase IIIGDRSS Model

Facility	Type	Storage Volumes (MG)		
		Basins	In-System	Total
Included in Baseline Condition Model				
Detroit				
Hubbell-Southfield	Storage/Treatment	22		22
Puritan-Fenkell	Storage/Treatment	2.8	6.2	9
Seven-Mile	Storage/Treatment	2.2	2.5	4.7
Northeast Wayne District				
Chapaton	Storage/Treatment	28	8	36
Martin	Storage/Treatment	9.3	3	12.3
Milk River	Storage/Treatment	18.8	5	23.8
Oakland County				
Acacia	Storage/Treatment	4.5		4.5
Birmingham	Storage/Treatment	9.5		9.5
Bloomfield Village	Storage/Treatment	10.2		10.2
Farmington	Storage	3.2	5	8.2
Lathrup Village	Storage	3.5		3.5
12 Towns	Storage/Treatment	62	33	95
Western Wayne County				
Dearborn Heights	Storage/Treatment	2.7		2.7
Inkster	Storage/Treatment	2.6		2.6
Livonia	Storage	2.2		2.2
Redford	Storage/Treatment	1.9		1.9
WTUA* (Lower Rouge)	Storage	5.5		5.5
WTUA* (Middle Rouge)	Storage	7.8		7.8
Subtotal				261
Included in Future Condition Model				
Detroit				
Conner Creek	Storage/Treatment	27		27
Upper Rouge Tunnel	Storage/Treatment	118		118
Dearborn				
Dearborn Tunnel	Storage/Treatment	65	8	73
Subtotal				218
Total				479

*Western Township Utility Authority

3.8 In System Storage

As part of the City of Detroit's Long Term CSO Control Plan (LT CSO CP), a total of 33 facilities (inflatable dams or gates) were scheduled to be installed throughout the collection system. This contract has been scaled back since the model development of future conditions. These are in addition to the 9 gates, which have been installed along the Rouge River as part of an earlier project. The total projected storage to be gained through the implementation of these facilities is about 130 MG.

These storage dams reduce CSO and allow additional transport without overflow from the DRI, NWI and the NIEA to the WWTP. Dams located in trunk sewers are completely deflated during dry weather flow, and during wet weather flow are regulated to maintain a pre-specified hydraulic gradeline in the upstream sewers. Dams located in the outfall sewers are inflated during dry weather to use the in-system storage and during wet weather are regulated to maintain a pre-specified HGL. The dams are deflated if upstream sewers start to fill up or surcharge. To dewater the stored water, dams are deflated gradually based on downstream levels.

The Rouge River gates are included in the GDRSS Model for both baseline and future conditions. The other 33 facilities are included in the future condition version of the model only. The representation of the operation of these facilities in the model is somewhat simplified. In EXTRAN, an in-system storage facility is modeled using a wide weir. This effectively controls the upstream elevation at the 8/10ths point. A small culvert is also included to allow dry weather flow to pass through the facility. In TRANSPORT, a storage facility is defined that includes the volume of the in system storage upstream of the facility. An underflow rate is defined for DWF and an overflow rate is set for maintaining the HGL at the 8/10ths point (determined by level in the storage facility). These facilities are currently being designed, and the model representations of these facilities have been revised by the consultants on that project. It is currently anticipated that these revisions will be incorporated into model updates, though these representations had not been reviewed yet by WWMP staff.

3.9 WWTP

The baseline model representing the 1998 conditions has the WWTP represented with a capacity of 1520 MGD. The model for future conditions has the WWTP capacity at 1700 MGD. These rates represent primary treatment limit rates at the plant, not the pumping rate capacity of pump station 1 and 2. To meet these pumping rates, the model includes the individual pumps at Pump Station 1 and a composite pump representing the capacity of Pump Station 2. The pumps at pump station 2 are not modeled individually as the pumps are variable speed. Use of one pump to represent the range of pump capacity provided the best representation of that station. The model includes the discharge weir at elevation 102.1 so that the head-discharge curves are properly handled in the model. The pump curves are set so that they do not exceed the treatment capacity of the plant.

3.10 Dry Weather Flows

The dry weather flow (DWF) values in the GDRSS Model are based on data collected during the Phase III project from billing meters, WWTP, and ten detailed study areas located throughout the collection system. The projected DWFs used in the model for 1998 conditions were provided previously in Table 1. Estimates of DWF were prepared from long-term flow records. The results of this analysis were compiled as a series of monthly averages. Based on this data, the DWFs in the model were set to vary by month and by region. With the GIS, metered DWF data for larger regions were distributed to each subarea within a region based on characteristics of the subarea such as population and employment. Also, DWFs were projected to future years using a similar approach coupled with the Southeast Michigan Council of Government's (SEMCOG) 2020 Regional Development Forecast of population and employment changes.

The model's DWF have not been updated with the more recent data collected as part of the GDRSS Metering and Flow Balance (Phase IV) project. In part, this has been due to the criteria for selecting DWFs for that project being not the same as used when developing the wet weather response factors for the GDRSS Model. The Flow Balance analysis used more restrictive criteria in selecting flow data to represent dry conditions. As a result, use of the recent data may require recalculating the values of the model's wet weather parameters. Before the updated DWFs can be used, these differences will need to be investigated.

A comparison of the DWFs as used in the model for 1998 conditions and what was determined through the metering program for the last two years is given in Table 6. The total DWF used in the model is 640 MGD, compared to 563 and 536 MGD as obtained from the metering program. The majority of the difference can be attributed to the estimates of DWFs for the City of Detroit. This can be explained in part due to the use of less stringent criteria for defining DWF conditions for the model (Phase III project). Also, the estimates were projected from data collected in 1993, which could have quite different dry weather infiltration.

3.11 GDRSS Project GIS

An integral component of the GDRSS Model is the project's Geographic Information System (GIS). This system was used to support model development through compilation and analysis of spatial information including tributary area size, population, employment, and land use. The GIS provided a consistent method for making estimates of various model parameters for each tributary area for current and future conditions.

One of the goals of the Phase III project was to improve the consistency in the level of detail used to represent the various districts throughout the system. This goal was accomplished in part through the use of the project's GIS, which was able to account for model parameters in a consistent manner throughout the collection system.

For purposes of the Phase III project and its emphasis on CSOs, this goal was considered to have been largely accomplished. However, for purposes of the WWMP, the consistency in the level of detail can be improved.

As previously mentioned, for example, the representation of Macomb County and Clinton-Oakland could be improved by the addition of the major interceptors and delineation of additional subareas in those districts.

The GIS was not configured to write model-input files directly. Rather, information from the GIS underwent further analysis using database and spreadsheet programs to produce the model files. The model sewer network was also entered into the GIS along with a link to a table with attribute data. However, this network schematic was developed for the baseline condition model only and it is not linked directly to the model input files. Any changes to the GDRSS Model are therefore not reflected automatically in the GIS schematic.

3.12 Suburban Contracts

The major districts and their contract peak limits with DWSD are provided in Table 7. This table includes the total sewered populations because the contracts are population based for some districts.

The districts are divided into two groups: those that are considered "controlled" and those that are considered "uncontrolled". Uncontrolled districts are districts whose contract peaks are considered to include transport capacity of wet weather flows to a downstream outfall. These districts include Grosse Pointe, Grosse Pointe Farms, and Grosse Pointe Park. This strategy was implemented to protect the water intakes for City of Detroit. If these contracts are not included in the total of the suburban contracts, then the total is 1,264, which does not exceed the current primary capacity of 1,520 or near-term capacity of 1,700 at the WWTP. The contracts with Highland Park or Hamtramck are not included in this assessment. They have contracts, but their flows are not segregated from Detroit's flows nor are they controlled in the GDRSS model.

Table 6. Comparison of GDRSS Model DWFs with Metering Program DWFs

	Dry Weather Base Flow (MGD)[1]		
	Phase III	Phase IV Metering	
District	1998	11/97-10/98	11/98-10/99
Allen Park	1.3	3.6	4.1
Centerline	1.3	1.2	1.1
Clinton Oakland	31	30	30
Dearborn	25	30	29
Detroit[2]	330	266	255
Evergreen-Farmington	40	42	41
Farmington	2.0	1.2	1.1
Grosse Pointe	0.6	1.9	2.2
Grosse Pointe Farms	1.2	3.2	3.9
Grosse Pointe Park	1.5	2.9	2.7
Macomb	42	46	40
Melvindale	3.0	1.5	1.4
N.E. Wayne[3]	26	25	20
S.E. Oakland	55	47	43
Western Wayne[4]	74	62	62
Total	634	563	536

*Base flow is the annual average dry weather flow from residential, commercial, and industrial sources and includes dry weather infiltration. The baseflow provided is the projected dry weather flow for the year 1998.

**Includes Hamtramck & Highland Park etc.

***includes south macomb

****Represents North Huron Valley-Rouge Valley wastewater control system

[1]Base flow is the annual average dry weather flow from residential, commercial, and industrial sources and includes dry weather infiltration. The base flow provided is the projected dry weather flow for the year 1998.
[2]Includes Highland Park, Hamtramck, and portions of Harper Woods, Redford Township, Dearborn Heights and Dearborn.
[3]Northeast Wayne District includes South Macomb Sanitary District, Grosse Pointe Shores and Milk River (Northeast Wayne County).
[4]Represents North Huron Valley-Rouge Valley wastewater control system. Above value for Western Wayne does not include discharge of 6 MGD to Western Townships Utility Authority (why Table 1 gives 80 MGD for Western Wayne instead of 74 MGD as listed above)

The contract peak limits are generally implemented in the model via the capacity of a pump station. In some cases, the peak rate of discharge from a district is limited by the hydraulic capacity of the sewer connection. Macomb and Clinton-Oakland contracts at 0.4 cfs/1000 persons (residential population was used to calculate contract

peak) total 203 cfs. The industrial contribution, which is part of the contract, was assumed to be included in the 0.4 cfs/1000 people rate. The firm capacity of the Northeast pump station is 249cfs, which exceeds the current combined contract limit of 203 cfs.

3.13 SWMM Version

The version of SWMM that the GDRSS Model uses is a variant of SWMM developed by CDM that included various features not available in the official SWMM at the time. Most of these features have since been incorporated into the current version of SWMM, Version 4.4h. The features that have not been incorporated are TRANSPORT features that relate to the tracking of discharges from storage facilities.

If the WWMP project uses only the Event Model for its analyses, it may be advantageous to update the SWMM program to the current version. This update would allow the model to take advantage of updates and improvements made to SWMM over the last several years that are not in the CDM version of SWMM. These include improved ability in representing the operation of real time controls.
In addition, the model would also be able to take advantage of ongoing support of the SWMM program.

A disadvantage would be that if continuous modeling were required, then the lack of the specific features for TRANSPORT in the current version of SWMM would have to be addressed. One approach would be to maintain two versions of RUNOFF. This would allow use of the new SWMM for RUNOFF/EXTRAN while using the old SWMM for RUNOFF/TRANSPORT. Though not ideal, this would require minimal effort, as the RUNOFF portion of the two SWMM programs is not that different; most of the improvements have been to the EXTRAN program.

Another approach may be to have the TRANSPORT features added to the current SWMM. The practicality of this option would need to be confirmed by the keepers of the model. Recently some work has been done to enable EXTRAN to run in a continuous mode. However, this capability is not built into the current version of SWMM. It would require use of a specialized version of SWMM and the feasibility of this option would also need to be confirmed.

Table 7. Implementation of Suburban Districts Contracts in the GDRSS Model

District (1)	Sewered Population	Contract Peak (cfs)	Implementation of Contract Limit
Controlled Areas			
Allen Park District 1	4,401	6.0	pump capacity
Centerline	8,610	6.5	pipe with upper limit gate
Clinton-Oakland (2)	200,699	80	pump capacity--exceeds contract, see note 2
Dearborn	82,934	100	pump capacity
Evergreen-Farmington	251,645	170	hydraulically limited, can be exceeded
Farmington	8,174	6.0	pump capacity
Macomb Sanitary (2)	306,670	123	pump capacity--exceeds contract, see note 2
Melvindale	12,191	6.4	pump capacity
N.E.Wayne (3)	177,696	127	pump capacity
S.E. Oakland	307,261	260	pump capacity at basin and gate at outlet
Western Wayne (4)	~~477,378~~	~~380~~	pump capacity and hydraulic limits, can be exceeded
SUBTOTAL:	1,837,658	1,264	
Uncontrolled Areas			
Grosse Pointe (5)	4,410	192	pump capacity
GP Farms (5)	8,529	554	pump capacity
GP Park (5)	10,672	~~84~~	pump capacity
SUBTOTAL:	23,611	830	
TOTAL:	1,861,269	2,094	

1 Districts are divided into two groups: those that are considered "controlled" and those that are considered "uncontrolled", where uncontrolled districts are districts whose contract peaks are considered to include transport capacity to a downstream outfall (see note 5). Also, note that Highland Park and Hamtramck are not included in the above table--they have contracts, but their flows are not segregated in the GDRSS model.

2 Macomb and Clinton-Oakland contracts at 0.4 cfs/1000 persons (residential population, not equivalent population, was used to calculate contract peak). Also, the industrial contribution is assumed to be included in the 0.4 cfs/1000 people rate. NEPS firm capacity of 249 exceeds combine contracts of 203 cfs

3 Northeast Wayne District is comprised of City of Grosse Pointe Shores, Southeast Macomb Sanitary District, and Milk River (Northeast Wayne County).

4 Represents North Huron Valley-Rouge Valley wastewater control system

5 GP, GPF, & GPP contract peaks are considered to include transport capacity to a downstream outfall.

3.14 Model Interface Programs

The GDRSS Model consists of text data files that are read directly by the SWMM program, which operates in the command line (DOS) mode. The output results are also written to text files. There are several interface programs available for the SWMM program for processing the input and output of model simulations.

The GIS database was used to generate the data required for the hydrology, but it was not configured to write input files or read output files directly.

For the RUNOFF data files, much of the information was obtained from the GIS database. These were processed within a spreadsheet to calculate related parameters. For example, the routing channels used for the combined areas were defined based on size, imperviousness, and population. Once the parameters were calculated, the data would be written to a text file in the format required by RUNOFF.

This process was fairly efficient given the limited number of scenarios and changes required; however, the process as a whole could be cumbersome. A change to a subarea delineation required substantial reprocessing of the model related data within GIS.

Review of the GDRSS Model output was accomplished through the use of a post-processing program called Model Turbo View. This program has many sophisticated and useful features, which enabled extensive and efficient review of the model output. In addition, it links seamlessly with the output files produced by SWMM. It is not windows based, however, and it does not have graphic-rich backgrounds such as one might expect these days with the advent of GIS programs.

4. Expansion and Updating of the GDRSS Model

Based on the evaluation of the model and the various related components, a number of recommendations for enhancing the model capabilities for use in the WWMP project have been developed. As previously noted, the GDRSS Model was focused on wet weather related issues, in particular Combined Sewer Overflows (CSOs).
For the WWMP, the model needs to be extended to better address system capacity for future needs and demands over the next 50 years. How wet weather is handled in the system is still critical, but in addition, the transport capacity needs of the customers throughout the system need to be evaluated. To meet these needs, the following improvements and updates to the model are recommended:

- The model should be expanded to include DWSD owned transport system components that are currently not included in the model. In particular, this recommendation refers to the interceptors in Macomb County up to the location of the billing meters. This extension would enable review of the transport needs where demands are continuing to increase due to growth and SSO issues.

- The model should be extended to include the major DWSD pumping stations in Macomb County. These are Clintondale and Garfield pumping stations. This extension will allow a more detailed evaluation of energy and service impacts of replacing these stations with gravity sewers.

- The model should be expanded to include the interceptors in the Clinton-Oakland Sanitary District. These interceptors are not DWSD owned; however,

this district is also under growth pressure. Inclusion of these interceptors will improve the level of consistency in the representation of the regional system, especially with respect to travel time and attenuation of flows in the system and improve resolution of results. It also would enable DWSD to better regulate the current contract of 0.4 cfs/1000 by individual community versus by district, should that be desired. A SWMM TRANSPORT model has already been developed for the system by the district. Obtaining this model should facilitate the incorporation of the model into the GDRSS framework though converting it to EXTRAN would require additional data and verification work.

- The spatial resolution of model tributary area needs to be increased by delineating additional subareas to include at a minimum one subarea per DWSD billing meter. This work applies in particular to the Macomb County and Clinton-Oakland districts with the extension of the interceptors in the model. In addition, existing subareas in the model need to be reviewed and further divided if any span political boundaries. This update would facilitate obtaining model results on a community basis.

- The GDRSS Phase IV flow metering should be used to obtain estimates of RDI/I parameters for the new subareas in Macomb County. The flow data as available can be used to confirm earlier estimates of these flows and to improve spatial resolution of the wet weather response in these areas. Data for other separated communities should also be used if available to improve model results.

- The model's representation of suburban connections to the DWSD system should be reviewed and updated or extended to better represent connection hydraulics. This will allow review of peak discharge rates relative to contract capacities. Several communities have indicated having problems discharging flows into the system during certain wet weather events. These communities include Centerline, Allen Park, Melvindale, and Dearborn. The model accounts for the problem of available capacity for Dearborn, but it does not currently have that capability for the other communities.

- The model should be updated to include facilities that have recently been built and are not currently represented in the model. Facilities that will need to be reviewed and/or added to the model includes storage basins, in-system storage devices, pump stations, WWTP updates, real time control, and other structures that could impact capacity analysis. Changes to the system such as separation of a combined sewer system also need to be incorporated. The current known updates needed are the expansion of the Twelve Towns Retention Treatment Basin in the Southeast Oakland District and the separation project in Grosse Pointe Farms.

- A list of improvements and/or changes to the collection system needs to be maintained in order to ensure that the model reflects current conditions. Items such as an addition of a pump at the Northeast Pump Station, diversion of

additional flows to Western Township Utility Authority, construction of in-system storage dams, etc. and the date of implementation need to be documented. An approach needs to be developed for how and when periodic updates to the collection system should be incorporated into the model.

- The projected changes to the service area to the year 2050 need to be incorporated into the model for analysis. It is anticipated that these projections would be provided for on a 10-year increment basis for the model simulation scenarios (2000, 2010, 2020, 2030, 2040, & 2050).

- The model may need to be updated to handle issues relative to real time control and other operational control. This will allow review of impact of basin and in-system storage operation, for example. Updating the model to the current version of SWMM would provide a certain level of ability in this regard. If necessary, use of a program called SewerCat may be warranted. This program has the ability to run EXTRAN with interactive processing which enables real time control scenarios to be developed and modified during a simulation. Coordination with the CS-1281 Real Time Control work group is also recommended if needed.

- The DWFs as determined from the metering program conducted by DWSD over the last several years (CS-1249 Phase IV and Amendment 4) should be incorporated into the model to improve the accuracy and spatial distribution of DWFs throughout the system. This update needs to be carefully implemented, as the criteria for defining DWFs for the metering program are not the same as for the modeling program. The impact of this change will need to be assessed and if necessary taken into account if the updated DWFs are to be used.

- The model updates should be confirmed using flow data available from the metering program at key locations throughout the regional system. This should be done for up to three events.

- Diurnal variations in base flows can impact peak hourly flows at the WWTP. These are not included in the GDRSS Model. If it is determined that this is needed for some analysis, how it might be incorporated in a special version of the model would need to be addressed.

- The integration of the model with GIS and related database needs to be improved to facilitate the analysis of a number of scenarios anticipated to be investigated.

  This would include development of RUNOFF and EXTRAN data files. In addition, the model output such as average and peak dry weather flows and peak wet-weather flows should be stored in a GIS related database for visual review of alternative scenarios.

- In addition to these recommended improvements, model development and use needs to be coordinated with other ongoing DWSD Projects. To this end, the modeling team will be participating in applicable CS-1281 technical work groups such as the System Capacity work group and the Sanitary Sewer Overflow work group. In addition, model updates and refinements to the model should be provided to the GDRSS modeling team through participation in the in the GDRSS Model Users Group. Use of the metering program data will also require coordinating with the metering task force.

5. Summary

The GDRSS Model is well suited for master planning of the DWSD collection system. It represents a collective effort of modeling the system over the last 13 years. As the model has been focused on CSO related issues, the model does need to be expanded and updated to better meet the needs of the WWMP. With these recommended refinements to the model, the model can be used to investigate customer needs over the next 50 years. The model will also be able to review alternatives developed to meet these projected needs.

6. Appendix A.

List of current members of the GDRSS Model Users Group (as of February 16, 2000)

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