City of New Haven Long Term CSO Control Plan

The City of New Haven

New Haven Water Pollution Control Authority

Technical Memorandum #2
Database Design and System Modeling Approach

July, 1997

CH2MHILL

CH2M HILL
50 Staniford Street
10th Floor
Boston, MA
02114-2517
Tel 617.523.2260
Fax 617.723.9036

CH2MHILL

Celebrating 50 Years

July 15, 1997

135807.BA.02

Mr. Richard Miller, P.E.
City of New Haven
City Engineer's Office
200 Orange Street, 5th Floor
New Haven, CT 06510

Mr. Raymond Smedburg, P.E.
City of New Haven
Water Pollution Control Authority
East Shore Water Pollution Abatement Facility
345 East Shore Parkway
New Haven, CT 06512

Dear Sirs:

Subject: New Haven LTCP Project
Task 2 - Model Development

Attached for your review and comment is Technical Memorandum #2. This memorandum documents the goals and approach which will be used to develop the project's model. Specific topics addressed in the memorandum include: identification of modeling goals, selection of software tools, database design, and data conversion procedures. Although we do not anticipate revising this material until the model development is completed, any comments you have which may impact this work would be appreciated.

Sincerely,

CH2M HILL

Chris Goz /BOS
Task Manager

c: Cliff Bowers/CH2M HILL

CITY OF NEW HAVEN LONG-TERM CSO CONTROL PLAN

TECHNICAL MEMORANDUM #2

Prepared for

The City of New Haven
The New Haven Water Pollution Control Authority

Prepared by

CH2M HILL
50 Staniford St, 10th floor
Boston, MA 02114

July 1997

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Introduction

The City of New Haven and the New Haven Water Pollution Control Authority operate a wastewater collection and treatment system which serves over 100,000 residents in the City of New Haven, and through inter-local agreements, the Towns of Woodbridge, Hamden, and East Haven. This service area includes both combined and separated sewers. Many older neighborhoods are served by a single sewer system designed to collect both sanitary sewage and stormwater runoff (a combined sewer). Other areas are served by two separate sewer systems: one to collect sanitary waste and the other to collect stormwater runoff (a separated sewer).

During dry weather, New Haven's sewer systems transport a combination of sanitary flow and groundwater infiltration to the East Shore Wastewater Treatment Plant (WWTP). All dry weather flows receive secondary treatment at the East Shore plant. During wet weather, large quantities of stormwater enter the combined sewer system. As a result, portions of the system may become overloaded, and combined sewage is overflowed to the surface waters.

A facility plan, which evaluated alternative methods for controlling combined sewer overflows (CSOs), was completed in 1981 and updated in 1988. The plan evaluated controls required to convey, treat, or store overflows associated with a 10-year storm. The plan concluded with the recommendation that sewer separation was the most cost-effective method of meeting the evaluation criteria. Work toward constructing separate sewers is now approximately 35 percent complete. Because of the significant advancements in regulatory requirements and technological issues, the City has decided to reevaluate this approach.

The objective of this project is to develop a long-term plan which mitigates the impacts of CSOs in a cost effective and environmentally sensitive manner. The general objective of Task 2 is to develop and calibrate a computer model of the East Shore WWTP's sanitary sewer collection system. This model will be used to evaluate the performance of the existing sewer system and to evaluate alternative CSO control strategies. To manage and maintain data used by the model, a geographic information system (GIS) will be constructed.

This memorandum documents the specific programs, tools, methods, and the limits of the service area to be included in the proposed model. Specific topics addressed in this memorandum include:

- Objectives of the Model: The objectives of the model are discussed. Issues which must be addressed or directly supported by the model are identified. These issues include: computation of CSO volumes and frequencies, estimation of pollutant loads, evaluation of hydraulic bottlenecks, and evaluation of CSO control alternatives.
- Model Requirements: Features or processes which must be included in the model to support its objectives are discussed. These features include computational procedures related to modeling specific processes (storm water runoff, the hydraulic characteristics

of surcharged sewers, seasonal fluctuations in infiltration), and those features relating to convenience (graphical interface, links to GIS).

- Alternative Models: The general capabilities of four models considered for this project are outlined. The strengths and weaknesses of the models are rated, and a system of tools are identified for use in this project.
- Data Requirements: Data required to support model development and calibration are discussed. The discussion addresses the specific data needs for the model (pipe diameters, materials of construction, land use characteristics, population estimates).
- Baseline Conditions: The limits of the service areas to be included in the model are identified. The different approaches used within the City of New Haven and in the neighboring service areas are discussed. The scope and status of on-going sewer separation projects is discussed and those projects to be included in the baseline conditions model are identified. Approaches for modeling both the sanitary and the stormwater systems are described.
- Database Design: The design of the database used to support the model is discussed. This discussion identifies the facilities to be included in the database, their attribute data, data types, formats, and naming conventions.
- Data Conversion Plan: The plan for constructing the project's GIS and model database is documented. This discussion includes documentation of the processes used in translating data from the original paper-copy construction drawings to GIS coverages, and the linkage between the GIS and the hydraulic models.
- Pilot Testing: Pilot tests will be performed on a small portion of the study area prior to building city-wide database coverages. These tests are designed to identify potential shortfalls in the proposed database design, the data conversion plan, and/or model links.

Modeling

System Overview

The City of New Haven's collection system includes over 600,000 linear feet of combined sewers. During dry weather these sewers convey sanitary flows to the East Shore WWTP for treatment. During wet weather these sewers convey both sanitary flows and stormwater runoff. Stormwater runoff enters the combined sewer system through direct connections such as catchbasins and downspouts. Evidence of stormwater in separated sewers can also be found. During wet weather, flows can enter these sewer systems through cracks, misalignments and illegal connections.

Because large quantities of stormwater runoff can overload the sewer system, New Haven's sewer facilities also include 22 permitted regulating structures. These regulating structures (and other cross connections) allow excess flows to be diverted before the sewer system causes backups into basements or streets. The diverted flows are conveyed to the local receiving water bodies and discharged at combined sewer overflows (CSOs). The location of the combined sewer regulating structures are shown in Figure 1.

A schematic representation of a typical combined sewer system is shown in Figure 2. This schematic shows typical sources of inflow to a combined sewer system. Regulating structures such as a weir or an orifice are typically constructed where combined sewers connect to major interceptors. These regulating structures control the amount of flow conveyed from the combined sewer service areas to the interceptor system and the WWTP. Depending on the state of the sewer system when stormwater is introduced and the routing of the flow through the system, CSOs may or may not occur. Therefore, it is necessary to understand how the sewer system responds to various rainfall events.

Goals of Model

A model is a mathematical representation of a process or series of processes. Processes of interest related to studies of combined sewer systems include: the generation of sanitary wastewater flows, the conversion of precipitation to stormwater runoff, and the collection, conveyance, treatment, or storage of collected flows. A computer model will be developed to simulate these processes within the service area tributary to the East Shore WWTP. The general goals for the model are to support the understanding of how the network responds to a variety of precipitation events and to predict how its performance may be improved.

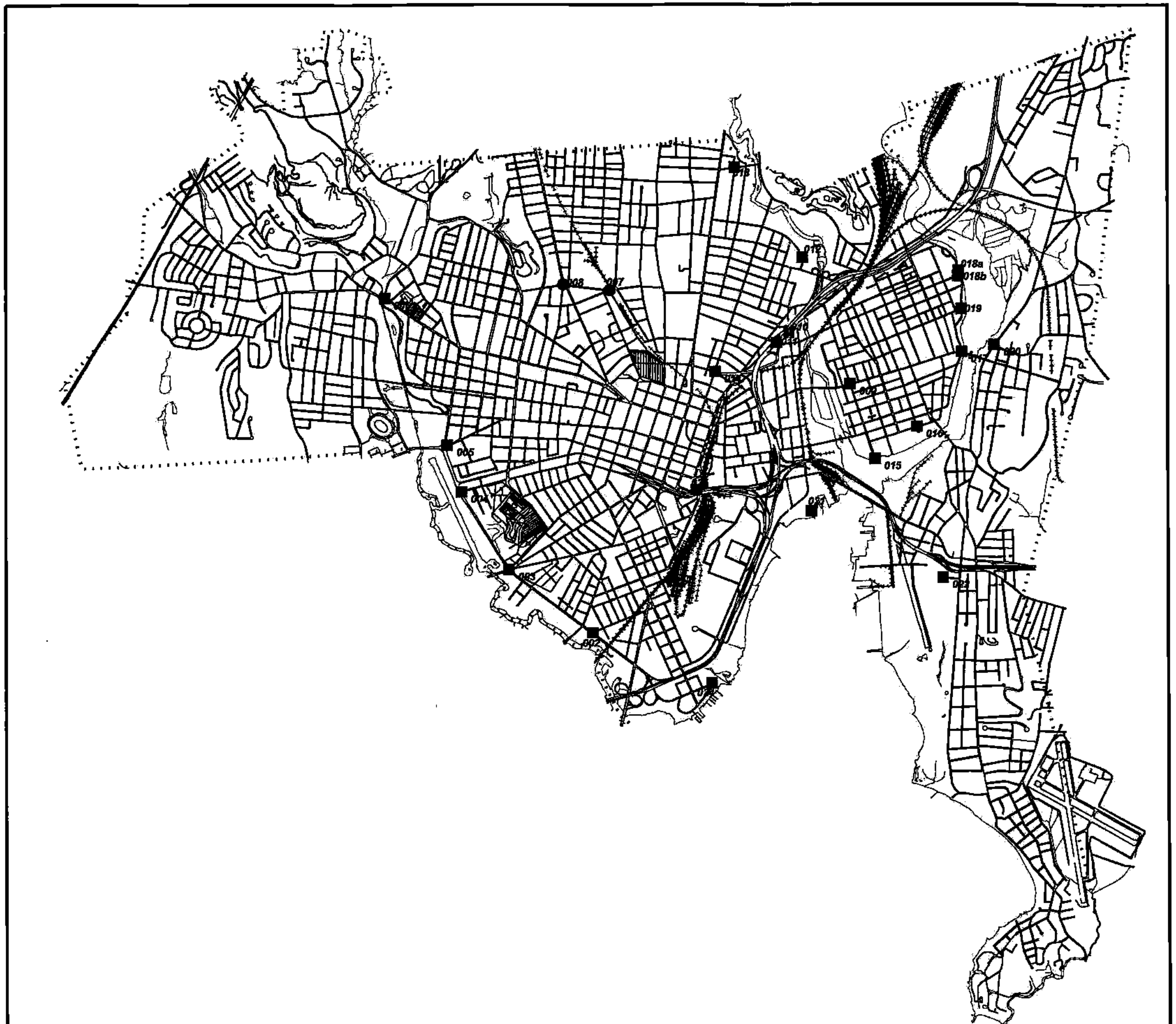


Figure 1: CSO Regulator Locations

City of New Haven LTCP

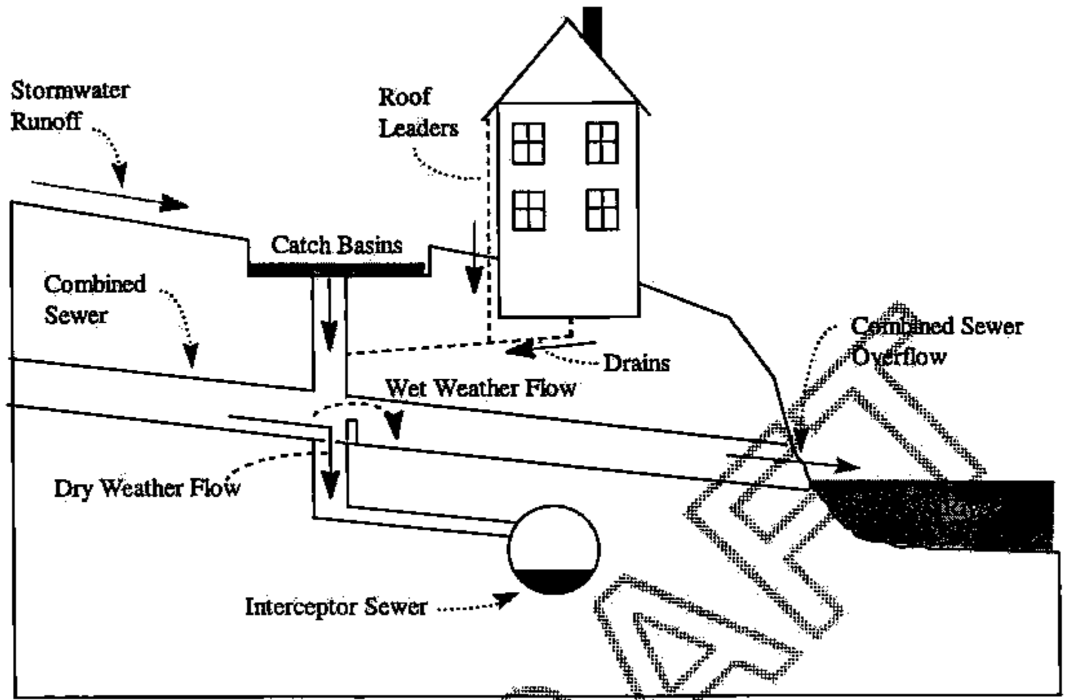


Figure 2: Schematic of a Typical Combined Sewer System

Specific goals to be supported by modeling were discussed during the initial scoping of the project, and later, at kickoff meetings and workshops. Many of these goals are driven by regulatory requirements related to improving water quality or the level of service provided to the community. Figure 3 summarizes the relationship between the model and the project's goals. A brief discussion of the primary goals to be supported by the model is provided below.

Regulatory or Water Quality Goals

- compute the volume, frequency, and duration of overflows on an average annual basis for the baseline conditions
- estimate pollutant loads on an average annual basis for the baseline conditions (the key water quality issues and pollutants for this project will be identified during a future workshop)
- compute the volume and peak rates of overflows for the following design storms: three month, six month, one year and ten year.
- estimate pollutant loads for a range of precipitation events for the baseline conditions
- estimate pollutant loads associated with stormwater discharges and other sources

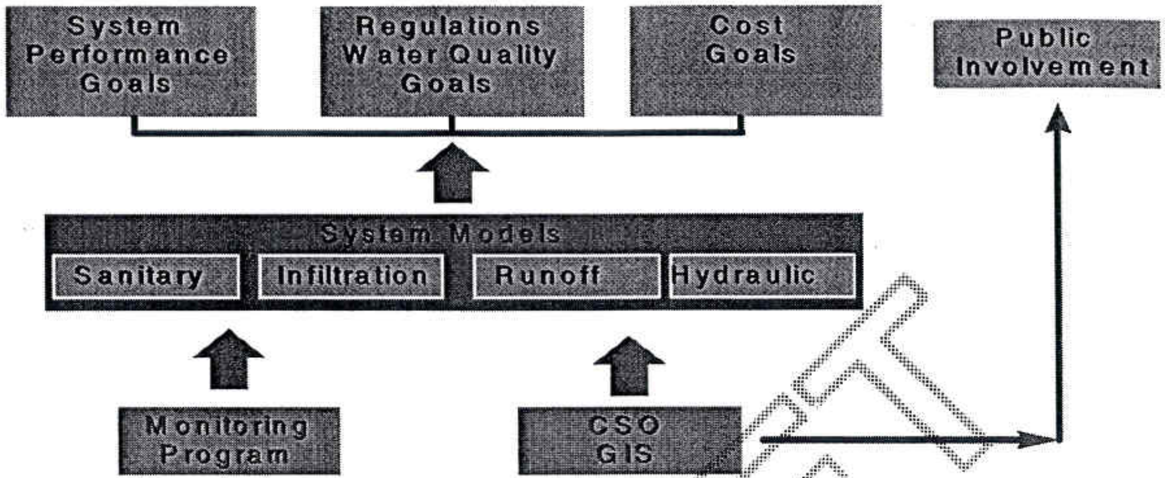


Figure 3: Summary of Project and Modeling Goals

- evaluate the potential impacts associated with short-term controls which may improve the system's performance (eliminate dry weather overflows (DWOs), implement Best Management Practices (BMPs), maximize use of storage within the system, minimize untreated overflows, control discharge of solids and floatables, and maximize conveyance to the East Shore WWTP)
- evaluate the potential impacts associated with long-term controls toward reducing overflows and pollutant loads (continued sewer separation, construction of storage facilities, construction of high-rate treatment facilities, modifications to the East Shore WWTP).

Operational or Service Goals

- identify hydraulic bottlenecks within the collection system which contribute to significant surcharging, basement flooding, and/or street flooding
- estimate how the implementation of short-term controls may reduce surcharging and flooding during wet weather
- identify areas with hydraulic properties which may contribute toward the accumulation of sediments
- estimate how the implementation of short-term controls may reduce the accumulation of sediments during dry weather
- estimate the impacts of roof leader connections to the combined and partially separated sewer systems, and identify a plan for managing roof leader connections and disconnections
- investigate the feasibility of reducing the number of pump stations in the system
- quantify the system-wide impacts of infiltration and inflow (I/I) and identify those neighborhoods with significant I/I contributions

Model Requirements

To assess CSO activity in New Haven, a computer model of the combined sewer system will be developed to simulate stormwater runoff and wastewater collection and conveyance.

Presently, there is an existing model of the sanitary system, developed by a consultant in the 1970's using EPA SWMM. The model consists of two SWMM blocks, Runoff and Transport. Changes in New Haven's sanitary sewer system as a result of the ongoing sewer separation program require that the models be updated.

Recent advancements in computer hardware and modeling software provide an opportunity to improve the City's existing model. The selection process comprises three steps: first, identify important features to modeling needs; second, select the models to be evaluated; and third, rate the selected models based on the chosen features to determine the most suitable modeling software.

The following sections discuss each of the model components or features considered for this project. In general, they range from those that are integral to the philosophy of the model operation, to those relating to convenience.

GIS Compatible

As part of this study, a geographic information system (GIS) of the sewer facilities will be created. Physical data such as manholes, pipe lengths, diameters, invert elevations and construction material will be included in the GIS. The GIS may also include some land based data required for generation of sanitary flows and/or stormwater runoff. In the future, the City may wish to add other non-model related data to the GIS. Potential future uses of the GIS may include facilities management or information services applications.

Models capable of directly interfacing with the GIS will reduce the amount of effort required to setup the model now and the effort required to maintain it in the future. A one-way link will allow the GIS to supply the model with input data describing the sewer facilities and their service areas. A two-way link (preferred) will allow also allow the GIS to access model results. Figure 4 shows the general relationships between the GIS, the model, and potential future uses.

Generate Stormwater Runoff

The model must be able to simulate the urban flows received by the sewer system in New Haven. The four flow sources required are stormwater runoff, base sanitary flow (BSF), inflow/infiltration (I/I), and rainfall derived inflow and infiltration (RDII). Stormwater runoff calculations should incorporate real storms, and time-varying processes such as infiltration. Methods that include diurnal BSF patterns based on population estimates are required to support objectives related to simulating sediment deposition and scour.

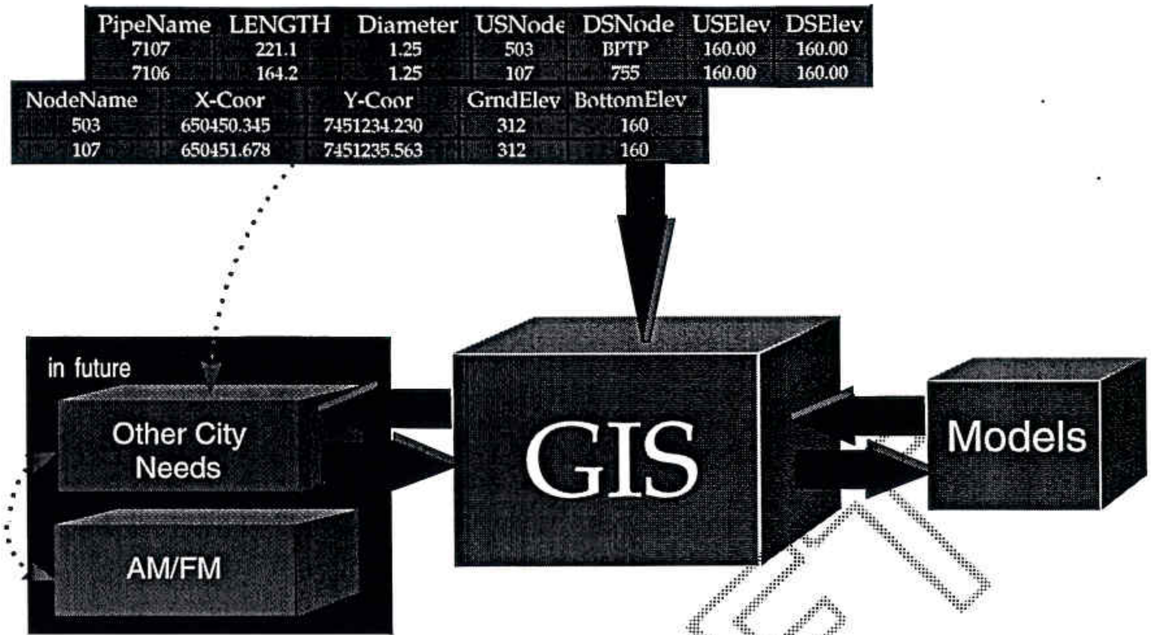


Figure 4: Relationships Between GIS and Model

Incorporate Externally-Developed Hydrographs

Flow hydrographs for the areas external to New Haven that contribute flow to the sewer systems will be developed independently from the sewer model. The approach for this task will include statistical analysis of recorded flow data. The chosen software must be able to easily incorporate these hydrographs into the system model because the files tend to be very large for annual simulations.

Sewer Capacity and Velocity Analysis

A comprehensive evaluation of capacity and velocity in the sewer system entails determining surcharge as well as changes in extraneous flow rates to the sewer system during wet weather. The capability to simulate surcharged conditions in a looped sewer system with control structures such as pumps, weirs and orifices will enable available system capacity and flow velocity to be more accurately evaluated. Therefore, a fully dynamic model is required.

Evaluate Basement and Street Flooding

To perform comprehensive flooding analyses, sewer surcharge levels must be accurately modeled. Basement and street flooding are concerns in New Haven. The model must be able to identify areas where flooding is likely to occur under real storm conditions.

Analysis of Control Alternatives

Models that are capable of analyzing the hydraulic performance of control alternatives such as pumps, storage, diversions, and inflow reduction under long-term continuous simulation facilitate the design of control measures. Real time control measures at pump stations or regulators may also be investigated and evaluated. Performance analysis of potential controls under real storm conditions is important and the ability to perform such analyses would increase a model's applicability to New Haven's system.

Owner and Regulatory Approval

The model used for this project must be accepted and supported by the Consulting Team, the City's staff, and the Connecticut DEP. During this project, the model will be used to as the basis for the Long-Term CSO Control Plan. In the future, the model is likely to be used by the City to support other planning or operations related decisions.

It is expected that system responses in New Haven, as simulated by the hydraulic model, will be affected by dynamic and transient conditions, spatial variability (tied to rainfall variability), and variability within a particular event (infiltration potential, pipe conditions, pump operation). The selection of the model software will be influenced by its ability to incorporate these system and simulation complexities. Other factors to be considered are software cost, vendor technical support, in-house model experience, and a graphical interface (user friendly, on-screen graphics).

Model Evaluation and Selection

Several significant developments have occurred within the GIS and modeling software industry in the 12-months since the scope-of work for the project was prepared. Therefore the tools originally identified for use in this project were compared with currently available GIS and modeling packages. Although there are many models available for hydraulic analysis of sewer systems, not all can meet the goals or requirements for this project. Based on the required features, and similar model selection exercises recently performed by CH2MHILL for other communities, four models were chosen for evaluation:

- the US EPA's SWMM 4.3 model,
- XP-Software's XP-SWMM model,
- the Danish Hydraulic Institute's (DHI) MOUSE model, and
- Wallingford Software's HYDROWORKS model.

A brief outline of the capabilities of the four models is given in Appendix A.

A list of criterion was developed to summarize this project's needs. Table 1 illustrates the criterion and the relative weighting given to each. It also documents the rank and score developed for each model. For each of the criteria, the models were scored from worst (1) to best (5). A composite score for each model was calculated as the sum of the products of respective feature weighting factors and scores.

During the early stages of the evaluation, it was recognized that the US EPA's SWMM 4.3 model would not satisfy the project's needs related to GIS links and data visualization. From evaluations recently completed for other CH2M HILL projects, it was also recognized that the costs of the HYDROWORKS models are significantly greater than the XP-SWMM or MOUSE models. Therefore, the greatest level of consideration was given to the comparison of the XP-SWMM and MOUSE models.

As shown, DHI's MOUSE model received the highest score, followed by XP-SWMM, Hydro Works, and finally EPA SWMM 4.3. These rankings were developed and discussed amongst the Consulting Team. They were later presented to the overall Project Team at a Workshop held at the WPCA on June 26th. Presentation materials used at this Workshop and minutes from the Workshop are contained in Appendix B. The advantages, disadvantages, and costs of several different configurations of models and GIS links were discussed and it was agreed to proceed with the DHI's MOUSE model. Factors having significant impacts on the decision included:

- the existence of a proven link between an ESRI GIS and the hydraulic model,
- strong graphical representation of input and output data,
- automated network simplification algorithm,
- low cost of the hydraulic model and linkage, and
- ability to incorporate other models (sediment transport, receiving water) in the future, if needed.

TABLE 1
Model Evaluation and Ranking

Criterion	Weight	EPA SWMM4.3		XP-SWMM		MOUSE		HYDROWORKS	
		Rank	Score	Rank	Score	Rank	Score	Rank	Score
GIS Link	5	0	0	3	15	5	25	4	20
Generate Stormwater Runoff	5	5	25	5	25	5	25	5	25
Incorporate External Hydrographs	5	2	10	2	10	4	20	3	15
Fully Dynamic Routing	5	5	25	5	25	5	25	5	25
Control Alternative Evaluation	4	3	12	3	12	5	20	4	16
Cost	2	5	10	3	6	2	4	0	0
Vendor Technical Support	3	1	3	2	6	5	15	3	9
Past Experience	3	5	15	5	15	3	9	0	0
Graphical Interface	5	0	0	3	15	5	25	4	20
Total			100		129		168		120

Note:
A score of 1 is worst or least favorable; 5 is best or most favorable
A priority of 1 is least important; 5 is most important

Based on the evaluation described above and the materials included in the Appendices, the DHI's MOUSE model has been selected for modeling of New Haven's combined and sanitary sewer systems.

Data Requirements

Each of the model components requires different sources of data. As part of this project, the physical components of the sewer system (pipes, pumps, manholes) will be archived in a geographic information system (GIS), as described in the Database Management section.

Stormwater Runoff

The City of New Haven will be divided into drainage subcatchments or sewersheds. The sewersheds will be described in terms of land area, percent impervious, surface slope, catchment width, infiltration rates, and degree of sewer separation.

Precipitation falls on land which is classified as either pervious (grass) or impervious (paved). Pervious lands have the ability to infiltrate a portion of the precipitation, depending on the type of soil. There is a limit to the infiltration rate, after which, additional precipitation results in surface runoff from pervious lands. Impervious land may have small depressions that store some of the initial precipitation, but once these spaces are filled, additional precipitation results in surface runoff from impervious lands. Both sources of runoff can be collected by the sewer system. The amount and source of flow that is captured depends on hydraulic connectivity and the degree of sewer separation.

Percent impervious is a key parameter for converting rainfall to runoff. Impervious lands include roadways, parking lots, rooftops, and other similar surfaces. In combined areas, flow from these surfaces enter the combined sewer system. In areas with storm sewers (partial separation), flow from roadways and parking lots enter the storm sewer while flow from rooftops enters the sanitary system through connected downspouts.

A SWMM Runoff model was created in the late 1970's as part of a CSO Facilities Plan for New Haven. It is expected that limited new development has recently occurred in New Haven, and therefore, most of the hydrologic data describing the City will remain the same. However, the City's ongoing sewer separation program may change some of the sewershed boundaries, and hydraulic connectivity. As mapping in areas with noticeable change becomes available from the City's new mapping contract, the hydrologic parameters from the original 1970's model will be refined.

The data requirements for the simulation of stormwater runoff in the MOUSE modeling system are similar to those required in SWMM's Runoff model. The catchment data from the original models will be adapted to the MOUSE model where valid.

Base Sanitary Flow

Base sanitary flow (BSF) is the flow in sewers during dry weather, which is composed of dry weather infiltration, and sanitary flow. Infiltration is the result of water entering sewers from wet areas and high water tables through cracks and misalignments in the sewers. Infiltration is typically at a constant rate that varies seasonally. Sanitary flow is the result of human activities, and typically varies during the day.

To determine the BSF, flow monitoring and rainfall records will be investigated. Extended periods of dry weather will be identified and diurnal flow patterns will be established. Water consumption records will be reviewed to determine major industrial and commercial users. Assuming that most the water is returned to the system, base sanitary flow estimates can be adjusted accordingly. Together, these patterns will be incorporated into the models as BSF. To verify flow assumptions, the BSF estimates will be compared to population records and average wastage rates per capita, and typical infiltration rates.

Rainfall Derived Inflow and Infiltration

Rainfall derived inflow and infiltration (RDII) is the unintentional input into sewers during and immediately after a rainfall event. RDII originates from near-surface infiltration seeping around and into manhole structures, direct inflow into manholes from streets and parking lots, and increased infiltration from higher soil moisture following storm events. In combined sewers, RDII contributions are significantly smaller than stormwater runoff, and are often not modeled. In separate sewers, special considerations are required to incorporate RDII into the computations.

Statistical analyses of recorded rainfall and sewer flow in separated areas will be performed by CH2M HILL's RDII model. The analysis will determine regression terms relating rainfall to flow. These parameters will be used to create input hydrographs for separated areas that contribute flow to the sewer system during the modeled storm events.

System Inflow from External Areas

As with the separated areas within the study area, flow hydrographs will be developed for system inflows from the Towns of Hamden, Woodbridge, and East Haven using CH2M HILL's RDII model. Existing flow monitoring data collected at the inflow points will be obtained and compared with historic precipitation records to develop lumped hydrologic parameters through regression analysis. These parameters will be used to establish simple inflow models for the connected towns that will be incorporated into New Haven's CSO model.

Hydraulic Routing

Modeling the conveyance of flow requires detailed information about the sewer system. Model data for the sewers (diameter, inverts) will be obtained from the GIS that is being constructed as part of this project. Also required in the model, and stored in the GIS, will be information detailing pump stations and their operation schedules, and the configuration of weirs and orifices. The specific data requirements for the conveyance models are described in the Data Management section.

Model Calibration

Task 3 is devoted to collecting new flow data in the sewer system of New Haven. As the results of this task become available, they will be used to calibrate the CSO model to current conditions. Once the model is calibrated, then it can be used as a predictive tool for expected CSO activation frequencies, volumes and durations under a variety of precipitation events. These simulated parameters are required to evaluate various alternatives that will be used to develop the long-term CSO control plan for New Haven.

Data Management

Existing System Information

Detailed information about the existing sewer system is stored on approximately 2,300 as-built plan and profile strip maps. When new sewers were constructed, their drawings were added to the paper archives. Information on the plan and profile maps include pipe shapes, dimensions, and inverts, and the year of construction. They also contain information describing manholes such as the elevation of the rim and invert.

The City also has 1"=40' scale planimetric maps that were created in 1964. These maps show the line features that were transferred from aerial photographs, but not specific elements in the sewer facilities.

Geographic Information Systems

In general, a geographic information system (GIS) is a computerized database that consists of elements with real world coordinates, and the attributes that describe them. Elements sharing common attributes, such as pipes and manholes are collected and grouped together in coverages or themes.

As part of this project, CH2M HILL will build an electronic repository of the sewer facility data required to support the computer modeling task. The data that is currently available in hard copy format as plan and profile strip maps will be converted from paper to digital format, and then be stored in the GIS. The GIS will export the data required to create the computer models.

In order to be compatible with information created and stored in other departments of the City, (Planning, Operations), ESRI's ArcInfo has been selected as the GIS inventory software for the sewer system data. The sewer facility coverages developed as part of this study will be referred to as the 'CSO GIS'.

Database Development

The CSO GIS database will be developed in a two step process: data transfer followed by data digitization. Sanitary and storm sewer facility data currently exists on 11" x 24" strip maps (approximately 2,300 sheets), as-built plans and record drawings. In the first step, the location of the sewer system facilities and relevant data will be transferred to 1"=40' scale mylar planimetric maps (approximately 460 sheets). The pavement edges and building footprints displayed on the mylar maps will be used to locate the elements of the sewer facilities. The locations will be schematic in nature, and are intended for planning level purposes only. Where necessary, conflicting data from multiple sources will be resolved directly with the City.

Once the data transfer process is complete, the second step will be to digitize the sewer system facility data from the mylar maps into the CSO GIS. As each feature is digitized, attribute data describing the sewer system component will be added to the CSO GIS database. The relationship between the GIS and the model is depicted in Figure 5.

Before the CSO GIS database can be built and populated with attribute information, the purpose and use of the database must be designed.

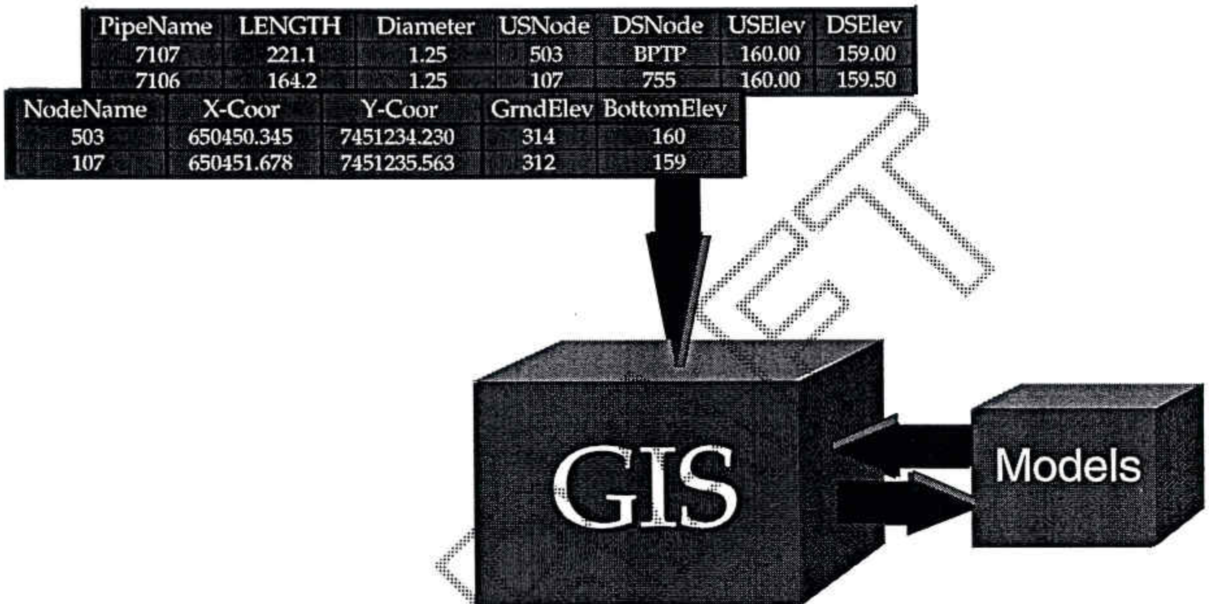


Figure 5: Relationship Between sanNode Coverage and Associated Tables

Database Design

Designing a database is a three step process, and consists of determining (i) the purpose, (ii) the fields and (iii) the relationships. It is important to be specific. A properly designed database will define data requirements and formats, expected and allowed values, and relationships between data.

To develop a Long-Term CSO Control Plan for New Haven, computer models of the sewer system will be built. The purpose of the CSO GIS database is to manage and maintain sewer information required by the models.

Although detailed hydraulic models of the storm sewers will not be made, the CSO GIS will include data pertinent to storm sewer facilities. Some limited information that is not required by the models will also be obtained and included in the CSO GIS.

Sewer facility data is being transferred from existing 11" x 24" strip maps to 1"=40' scale mylar base maps. By digitizing the mylar base maps, six ArcInfo coverages of the sewer systems in New Haven will be created. They are:

- sanNode,
- sanLink,

- stmLink,
- stmMH,
- stmCB, and
- stmLat.

Detailed descriptions of the field formats and data sources are provided in Appendix C.

SanNode

The *sanNode* point coverage indicates the physical location of four types of sanitary sewer elements, classified by the *san_Class* field. Allowed values for this field are 'MH', 'RG', 'OF', and 'PS' which represent manholes, regulating structures, outfalls and pump station wet wells respectively. Physical elements are located by their (x, y) coordinate pairs, and are identified by their unique id, *san_Name*. The *san_Quad* field is the sheet name of the 1"=40' scale mylar map.

Additional tables are associated with the nodes in the *sanNode* coverage, with the relationships determined by the *san_Name* field as shown in Figure 6. These tables provide descriptions of the element and additional information required by the CSO modeling task.

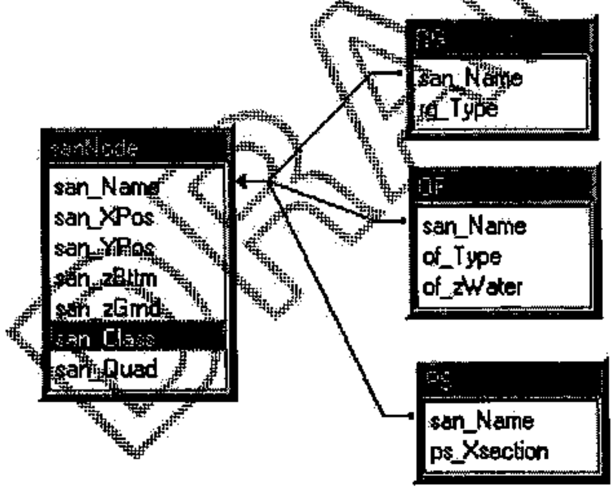


Figure 6: Relationship Between sanNode Coverage and Associated Tables

MH

Information related to sanitary manholes are wholly contained in the *sanNode* coverage, and no supplemental table is required.

RG

This table provides the user with a description of the type of regulator that is used to divert flow to each CSO. The actual parameters that describe the physical characteristics of the regulator are not contained in the point coverage; the coverage fixes the regulator location in space. The text field for the 22 regulators is coded with one of the following character strings: 'Weir', 'Orifice', or 'Weir/Orif' for combinations of both weirs and orifices. Other devices that regulate flow in the sewers may be found, and their descriptions will be added where appropriate.

OF

Outfalls are located where the sanitary sewer physically discharges into a receiving water body. Outfalls are described by the type of discharge that exists. Free outfalls ('FO') exist when the pipe is not submerged, whereas submerged pipes discharge under fixed backwater ('FB') conditions. Outfalls may also have flap gates ('FG') present that prevent the river from draining into the sanitary system. Each outfall is described in the *of_Type* field in this table. Where backwater conditions exist (FB, FG), the *of_zWater* field contains the water surface elevation, otherwise it is left blank.

PS

The location of each pump station's wet well is identified in the *sanNode* coverage. This associated table contains the cross-sectional area of the wet well, as required by the CSO modeling task.

SanLink

The *sanLink* line coverage indicates the flow paths within the sanitary sewage system, including the flow through sewers, pump force mains, and diversions. All features have an upstream end and downstream end that correspond to the nodes identified in the *sanNode* coverage. The type of feature represented in the coverage is identified by the *san_Class* field. Allowed values in this field are PI, FM, WR, and OR which correspond to sewers, pump station force mains, weirs and orifices respectively. As with the *sanNode* coverage, the *san_Quad* field is the sheet name of the 1"=40' scale mylar map.

Four tables are associated with the four different types of link features, as illustrated in Figure 7. Parameters required by the CSO models are stored in these tables and associated with the *sanLink* coverage by the unique id stored in the *san_Name* field.

PI

Sanitary sewers have seven additional attributes that are required by the CSO modeling task. The *pi_Shape* field is a text description of the shape of the pipe. Allowed values for this parameter are: 'Circular', 'Egg', 'Elliptical', and 'Horseshoe'. As more shapes are identified, they will be added. The *pi_Width* and *pi_Height* fields are the primary and secondary dimensions of the sewer. For circular pipes, these values are identical. *pi_Length* is calculated from the (x, y) coordinate pairs of the element's end points.

The *pi_consMat* field represents the construction material used for the sewer. Rules to determine the type of material have been developed based on the year of construction (*pi_consYear*), and the sewer diameter (*pi_Height*). If the construction date is prior to 1945, then pipes having a diameter of 24" or larger are assumed to be made from brick, and all others are assumed to be made from tile. If the date of construction is 1945 or later, then all pipes having a diameter of 12" or larger are assumed to be made from reinforced concrete, and all others are assumed to be made from tile. In cases where the actual material of construction is known, that information supersedes the assumption. To distinguish between assumed and observed values, assumed construction material values are preceded with *'A_'*. For example, *'A_tile'* as opposed to *'tile'* distinguishes assumed tile sewers from observed tile sewers.

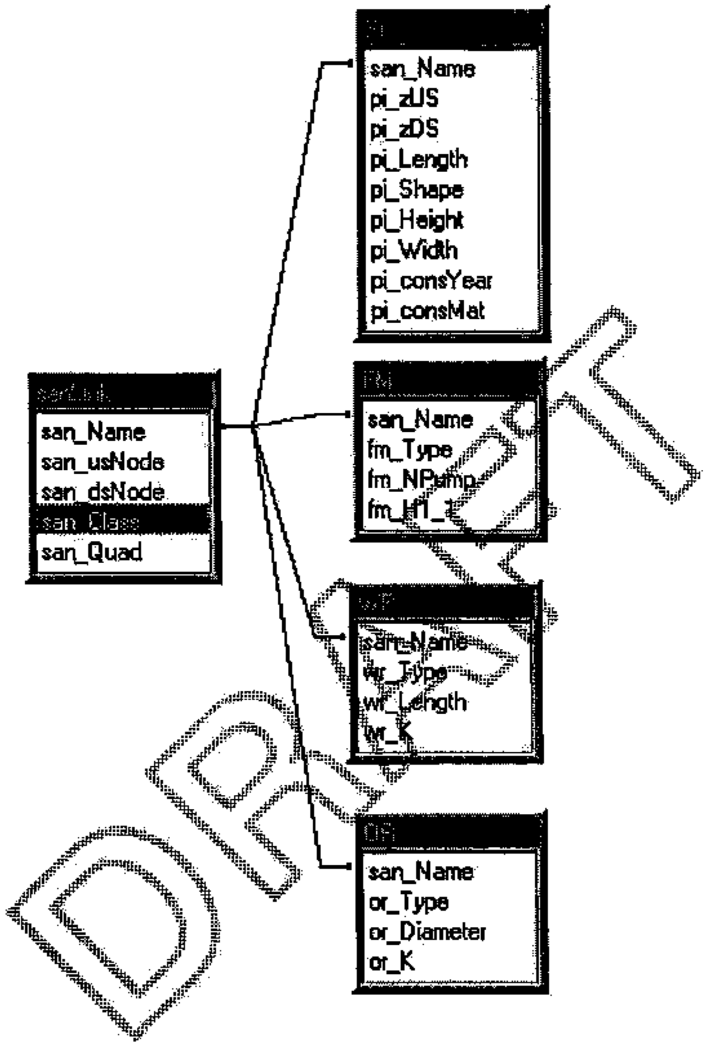


Figure 7: Relationship Between sanLink Coverage and Associated Tables

FM

The table describing the pump stations is structured to convert pump curves and operating information to input to the CSO models. Flow rates and on/off heads are tabulated, along with the type and number of pumps. Allowed values for the type of pump (*fm_Type*) are 'IB' and 'OB' corresponding to inline and off-line boosters respectively.

These values will be collected during the field investigation task, and input into the tables directly as the information becomes available.

WR

The table associated with weirs provides information required by the CSO modeling task, including the weir length, the weir type (longitudinal, transverse), and the weir discharge coefficient.

These values will be obtained during the field investigation task, and input into the tables directly as the information becomes available.

OR

The table associated with orifices provides information required by the CSO modeling task, including the orifice type (side, sump), the orifice diameter, and the orifice discharge coefficient.

These values will be obtained during the field investigation task, and input into the tables directly as the information becomes available.

StmNode

The *stmNode* point coverage indicates the physical location of three types of storm sewer elements, determined by the *stm_Class* field. Allowed values for this field are 'MH', and 'SOF' which represent manholes, and storm sewer outfalls respectively. Physical elements are located by their (x, y) coordinate pairs, and are identified by their unique id, *stm_Name*. The *stm_Quad* field is the sheet name of the 1"=40' scale mylar map.

MH

Information related to manholes are wholly contained in the *stmNode* coverage, and no supplemental table is required.

SOF

Storm sewer outfalls are located where the storm sewer physically discharges into a receiving water body. Outfalls are described by the type of discharge that exists. Free outfalls ('FO') exist when the pipe is not submerged, whereas submerged pipes discharge under fixed backwater ('FB') conditions. Outfalls may also have flap gates ('FG') present that prevent the river from draining into the storm system. Each outfall is described in the *sof_Type* field in this table. Where backwater conditions exist (FB, FG), the *sof_zWater* field contains the water surface elevation, otherwise it is left blank. The relationship between the *stmNode* and associated SOF table is depicted in Figure 8.

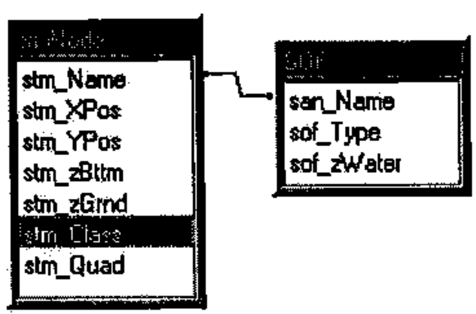


Figure 8: Relationship Between stmNode Coverage and Associated Table

StmLink

The *stmLink* line coverage contains storm sewers only. Ditches, culverts and other drainage features are not be included. Eleven attributes describing the storm sewers are stored in the GIS, including pipe inverts upstream and downstream, pipe shape height, width and length, and the date and material of construction.

StmCB

StmCB is a point coverage that provides the location of storm sewer catchbasins throughout New Haven. The coverage is provided for graphical representation only, and no attribute data other than (x, y) coordinates pairs are collected or stored.

StmLat

StmLat is a line coverage that provides the location of catchbasin laterals and their connections to the storm sewer. The laterals do not intersect or join the storm sewer coverage. The coverage is provided for graphical representation only, and no attribute data other than the segment's length and endpoints are collected or stored.

Data Conversion Plan

The CSO GIS database will be in Connecticut State Plane coordinate system. All coverages will be in the North American Datum 1983, in units of feet. Additional GIS mapping products such as digital orthophotos and/or base mapping files (AutoCad drawing files or ArcInfo coverage format) will also be acquired from the City's GIS consultant as they become available. These files are expected to include line features delineating pavement edges and building footprints that will be used as base maps and for quality assurance purposes.

The sewer facilities will be transferred from the plan/profile strip maps to the 1"=40' mylar maps. The facilities will be located within the pavement edges on the mylar maps with the same accuracy as provided in the original plans, and the CSO GIS coverages are intended for planning level purposes only. In conjunction with the City's overall GIS, the CSO GIS will be used to plot 1"=100' scale maps of the sewer facilities of New Haven.

The areas will be converted in the following order: Fair Haven and East Fair Haven, the Boulevard drainage basin, and the East Street drainage basin. By prioritizing the areas in this manner, three benefits are realized:

- Create portions of the sewer model during the data transfer and digitization phases
- Coordination between the creation of the CSO GIS and the City's GIS consultant
- Design drawings for the separation projects will be incorporated last

Initially, aerial triangulation data files will be acquired from the City's GIS consultant who is producing 1"=100' scale ArcInfo coverages for the City of New Haven's Planning Department. These files will be used for internal quality control procedures to assure that the sewer system coverages will overlay with the City's GIS coverages currently under development.

Sanitary Sewer System

The components that make up the sanitary sewer system include manholes, pipes, pump stations, weirs, and orifices. The City does not currently have a numbering scheme or unique identifier for the manholes and pipes. Therefore, a unique identifier will be derived from each of these features based on the 1"=40' planimetric map that contains the feature. The naming convention may change in the future.

The numbering scheme for the manholes will consist of seven alphanumeric characters (limit in MOUSE) and pipes will be composed of 14 alphanumeric characters. The first three characters of manhole identifiers contain the mylar sheet number, the fourth character contains a letter identifying the type of feature as follows:

- N - node
- P - pump station
- O - outfall
- R - regulator
- D - dummy node
- X - flag

The fifth through sixth characters denote a unique number for the feature within that grid tile, in increments of 10. For example, *Q11N050* denotes a location within the mylar planimetric map Q11, and is a manhole (N), with a unique number 050.

Pipe identifiers will be the result of concatenating the names of the upstream node and the downstream node.

It is expected that the detailed information that pertains to the regulators and pump stations will not be available from the strip maps. These elements will be added to the CSO GIS as the data is collected from field inspections.

Storm Sewer System

The components that make up the storm sewer system include manholes, pipes, and catch basins. As with the sanitary system, the City does not have a unique numbering scheme for the storm sewer features either. The naming convention will be structured the same as described in the sanitary sewer system section.

Catchment Data

Drainage basins capture flow that is added to the sewer system. The City will be delineated into areas that contribute flow at a certain point based on the extent and type of sewers, and ground slope. The basins will be described with respect to their physical characteristics of area, width , ground slope and percent impervious. Additional parameters that are required for hydrologic modeling will be stored in the coverage including infiltration rates, surface roughness, and depression storage. Catchments will be classified according to the degree of sewer separation within them: combined, partially separated, or fully separated. The attributes that are used to describe the sewersheds will reside in the CSO GIS as a separate catchment coverage.

Miscellaneous Data

Additional data are required to establish the modeling parameters that will not be prepared as part of this study. As the City's GIS coverages currently under development become available, they will be used to verify assumptions and to update information that may be out of date. In particular, as streets and building footprints become available, portions will be converted to percent impervious values and compared to the assumptions made. Refinements will be made as necessary.

Link to Model

The ability of the modeling software to directly access the data that is stored in the CSO GIS was one of the most important criteria that was used in model selection. MOUSE GIS is an application written by Danish Hydraulic Institute (DHI) that provides such a link. MOUSE GIS works within ESRI's ArcView environment and consists of two parts: the Network Editor, and the Results Presentation. Both parts support the general features available in ArcView.

The Network Editor allows the user to extract data from a number of different asset management systems including ArcInfo, to automatically reduce the number of elements in the physical model to simplify hydraulic simulations, and to store the data as a model for further analysis with MOUSE.

The Results Presentation allows the user to present the results from the fully dynamic MOUSE simulations combined with other GIS data.

ArcInfo stores spatial data elements or features (points, polygons, lines) as a collection of thematic layers or coverages. Tables are used to record and store attribute information that relates to each feature. In ArcInfo, these tables reside as separate files in INFO format, where rows represent the different records or features in a coverage, while columns describe each feature's attributes. As shown in Figure 9, ArcInfo internally maintains the first several attributes of each table.

Attribute Table for Lines (i.e., Sewers)

ARC/INFO maintained							User-defined Attributes						
FNODE_	TNODE_	LPOLY_	RPOLY_	LENGTH	SEWERS_	SEWERS_ID	LinkName	USNode	DSNode	USInvert	DSInvert	Length	Diameter
449	437	0	0	275.4746	1	1	x9005x9004	x9005	x9004	100.00	99.73	275	1.25
22	12	0	0	584.0216	2	2	x9004x9003	x9004	x9003	99.73	99.33	400	1.25
390	389	0	0	184.6122	3	3	x9003x9002	x9003	x9002	99.33	99.04	290	1.25
389	391	0	0	309.0482	4	4	x9002x9001	x9002	x9001	99.04	98.73	310	1.25
391	392	0	0	322.0216	5	5	x9001x9000	x9001	x9000	98.73	98.40	325	1.25

Attribute Table for Points (i.e., Manholes)

ARC/INFO maintained				User-defined Attributes				
AREA	PERIMETER	BPPOINTS_	BPPOINTS_I	MHName	X_COORD	Y_COORD	BttmElev	RimElev
0.000000	0.000000	1	1	107	356021.600000	293987.100000	100	110
0.000000	0.000000	2	2	755	355521.100000	293454.800000	99.8	108
0.000000	0.000000	3	3	106	355235.000000	293309.500000	99.7	121
0.000000	0.000000	4	4	750	354718.100000	293057.900000	96.5	111

Figure 9: Example GIS Attribute Tables

From within MOUSE GIS, a definition file is created to provide a 1:1 mapping between the attribute tables and the MOUSE model. The definition file is used to extract the required modeling information from the GIS and stores it in ArcView shape files. Sewer network simplifications can be made before the data is exported into the SWF files that MOUSE uses to create the hydrologic and hydraulic models.

When data in the ArcInfo coverages change, the definition file and associated INFO files must be loaded into MOUSE GIS, and the process repeats. A schematic of the relationship between the ArcInfo GIS and the model is provided in Figure 10.

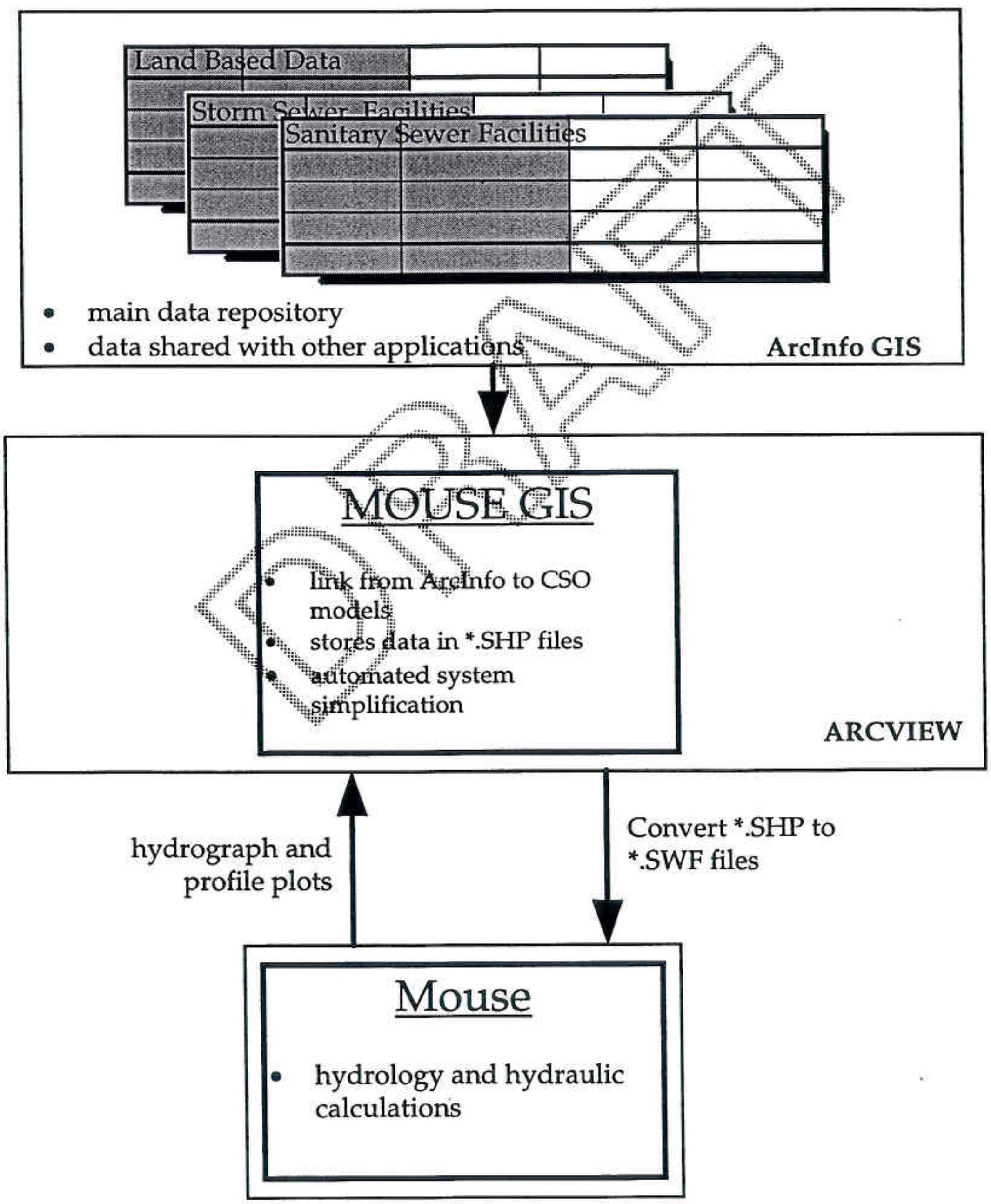


Figure 10: Schematic of ArcInfo GIS and Links to MOUSE

Pilot Project

A pilot project is being conducted to test the data conversion/model process. The pilot will step through all of the tasks of data conversion, CSO GIS database development, and hydraulic modeling. The pilot project is intended to identify any potential problems in the procedures of the data conversion/modeling process before a full scale implementation of data conversion takes place. Once the pilot has been completed, any refinements and modifications to the process or database will be made ensuring minimal changes/problems during the project. Basic steps to be used in the pilot are shown in Figure 11.

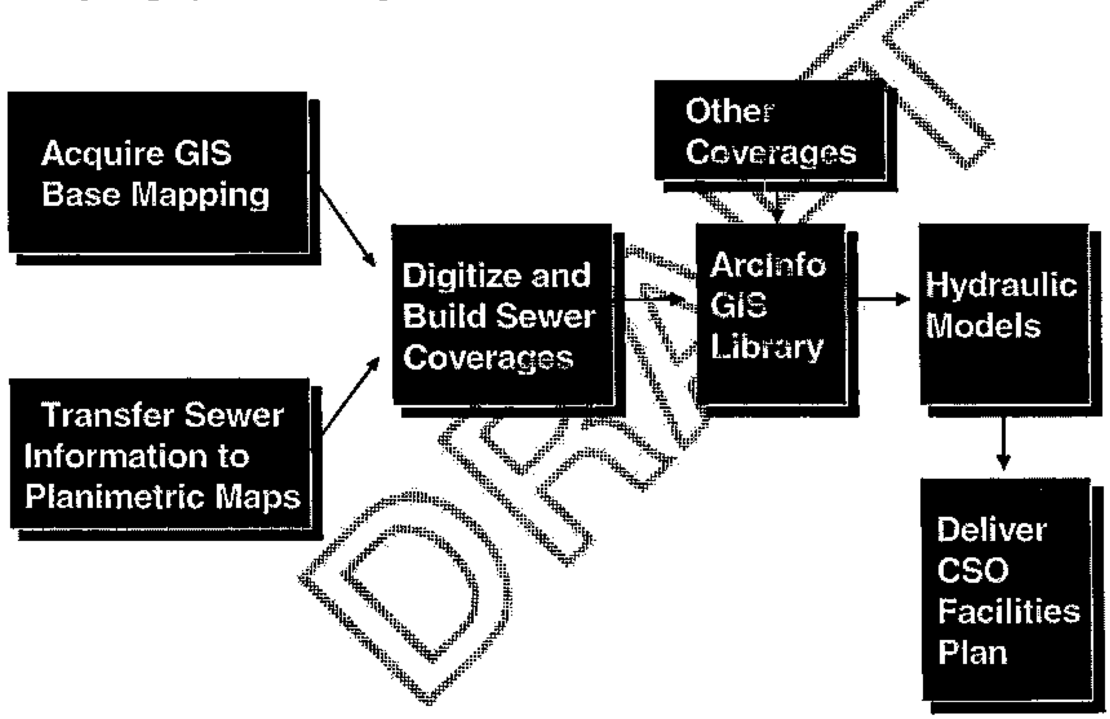


Figure 11: Data Conversion Procedures used in the Pilot Test

On May 20th a meeting was held at City Hall to discuss the CSO program's pilot project and coordination with mapping and GIS services procured by the City's Planning Department. The procedures to be used in the creation of the CSO GIS were discussed and a plan for coordinating work between the CSO project and the Planning departments GIS contractor was developed. Minutes from the meeting are attached in Appendix D.

At this meeting it was agreed to use the Elm Haven area for the pilot test. This area encompasses the following planimetric grid maps: N-11, N-12, N-13, N-14, O-11, O-12, O-13, and O-14.

A schedule for the pilot test was developed at the meeting. This schedule is included with the minutes in Appendix D. This schedule shows the pilot test being completed by the end of July 1997. Currently, the sewer system data has been transferred to the City's mylar maps, these data have been digitized to create ArcInfo coverages, attribute data for the facilities has been added to the coverages, and the data has been imported into MOUSE using their GIS link. Based on the results observed to-date, several modifications to the process have already been identified and implemented. Remaining work related to the pilot test is predominantly limited to comparison of the sewer system coverages and new maps produced by the City's GIS and mapping consultant.

Baseline Conditions

The existing storm and sanitary sewers within the limits of New Haven for which there are records will be converted and stored in the CSO GIS. The limits of the detailed hydrologic model are also the city limits of New Haven. However, the sewer system is under-going a series of continual modifications. Therefore it is necessary to fix the conditions that will be incorporated into the model.. Baseline conditions are defined in terms of the physical sewer data and the locations of gauged inflow from the Towns of Hamden, Woodbridge and East Haven.

Sewer Separation

Sewer separation, which has been adopted to control CSO discharges, is on-going in New Haven. There are currently nine contracts that have been identified as *"In Progress"* by City staff, and have been listed in Table 2. These contracts and previously executed contracts were examined to determined the current status and extent of the separation program.

Table 2
Ongoing Sewer Separation Projects

Contract Number	Location	Include In Baseline
90-130-1	East Rock Road	No
90-131-1	Livingston Street	Yes
94-70-1	Orange Street Phase II	Yes
94-71-1	Orange, Bishop and Clinton	Yes
95-125-1	Humphrey Street	Yes
94-72-1	Lombard East	No
94-128-1	Wooster Square	Yes
95-99-1	Kimberly and Columbus	No
96-146-1	Elm Haven	Yes

In order to maximize the benefits of the on-going sewer separation program in light of developing a Long-Term CSO Control Plan data describing the specific location, costs, status of each project were collected and reviewed. The following additional elements of each project were discussed:

- impacts on annual pollutant loads,
- cost per acre of separation
- location within the service area

- CSO elimination
- neighborhood impacts
- local flood reduction possibilities
- other pending projects in the area
- potential for other solutions

Data collected for each project were presented and discussed at the Modeling and Sewer Separation Workshop. This Workshop was held on June 26, 1997. The agenda and power point slides used at the Workshop are provided in Appendix C. The discussions at the workshop focused on the purpose of each project, its status, and impacts of implementing or post-poning the project. The projects that were selected by group consensus to be included in the baseline conditions are identified in Table 2. Additional documentation of the discussions are included in the meeting minutes.

System Inflows from External Areas

Aside from flow generated in New Haven, the sewer system accepts flow from the neighboring Towns of Hamden, Woodbridge, and East Haven. Gauged flow data at 12 locations monitor the flow contribution from these communities. Rainfall derived inflow and infiltration models (RDII) will be built using historical data from these locations. It is assumed that the historical data will serve as the baseline conditions for these areas, and that the sewershed characteristics will not change in the near future.

Appendix A

SWMM 4.3 (Runoff, Transport and EXTRAN)

SWMM 4.3 is the latest version of SWMM distributed by the U.S. Environmental Protection Agency's Center for Exposure and Assessment Modeling (CEAM). It is a public domain program and copies of the program can be obtained from U.S. EPA, Athens, Georgia. User support for SWMM is currently provided by U.S. EPA but is limited to identification of software problems. There are however large user groups where information can be readily exchanged. SWMM documentation is thorough.

The Runoff block of SWMM simulates both the quality and quantity of urban runoff. Surface runoff is generated using rainfall and snowmelt data. Both single event and long-term continuous simulations may be analyzed. Routing of surface runoff on subcatchments or flow in pipes and channels is accomplished by approximating them as non-linear reservoirs, using the spatially lumped continuity equation with Manning's equation. When surcharge occurs, water in excess of the pipe/channel flow capacity is stored until the pipe/channel is free to accept the water. Backwater and surcharge effects are not modeled but can be carried out by the EXTRAN block.

The Transport block of SWMM can be useful for routing quantity and quality of sewage. Dry weather flow and infiltration of the sanitary sewer can be estimated. However, Transport has been found to be cumbersome to apply and difficult to calibrate to flow monitoring data. Very often, dry weather flow and wet weather infiltration flows are generated by other programs for direct input into SWMM.

The EXTRAN block of SWMM uses the full dynamic equation for hydraulic routing and is useful in the evaluation of complex, surcharged sewer systems. It can simulate pumps, weirs, orifices, storage and outfalls with control water elevations.

XP-SWMM

XPSWMM is a proprietary graphical user interface package developed by XP-Software for the U.S. EPA's SWMM 4.2 model. The Runoff, Transport and EXTRAN blocks of SWMM 4.2 are included in the package. XPSWMM uses a graphical expert environment in which the user can create the drainage network interactively using a mouse. CAD drawings can be imported as a background image to the sewer network for easy location of pipes and control measures. Model input data can be imported to create new models from a variety of sources, including comma separated values (CSV), and user-defined file formats.

XPSWMM provides output in both graphical and tabular form. The standard SWMM output file is also saved for review by the user. Graphing of flow, velocity, and depth may be displayed on screen for any location in the system. Pipe system profiles may be generated for display and printed. The user may also replay portions of the simulation using a profile plot to view the hydraulic grade line as it varies with time.

With XPSWMM, the time consuming task of input data preparation, debugging coding errors, and the awkward manipulation of simulation results that are experienced with regular SWMM has been greatly simplified.

MOUSE

MOUSE is a menu-driven software package, developed by the Danish Hydraulic Institute (DHI), for the simulation of surface runoff, water quality and sediment transport in urban catchments and sewer systems.

The Surface Runoff Model computes runoff using one of two methods: the time-area method, or the non-linear reservoir method.

The Pipe Flow Model is used for the computation of unsteady flow in the sewer system. The model comprises three alternative computational levels: kinematic, diffusive or dynamic wave theory. The model can simulate looped networks containing pumps, weirs, detention storage, and other real-time control operations.

Built-in printing and plotting routines can present input and output data on-screen, or they can be sent to a printer, or plotter. Output results from the Surface Runoff Model include the computed runoff hydrographs generated for each catchment. Results from the Pipe Flow Model that can be displayed include computed discharges and water levels for each pipe and manhole as well as discharges and water levels for each overflow structure and pump station.

HYDRO WORKS

HYDROWORKS is a proprietary software package developed and supported by Wallingford Software. Hydro Works is designed to integrate with a broad range of Information Systems. Hydro Works links with the leading network design software and sewerage databases. Results can be defined for standard word processing, database, spreadsheet, or CAD packages. Hydro Works uses automatic time-stepping and an implicit numerical solution to optimize runtime and ensure stability. The model has the capability to simulate backwater effects and reverse flows. The model includes an on-line help system, comprehensive diagnostics that show when a run can not be completed successfully. The model includes interactive views of data is spreadsheet, menu list, plan, section, and graphs.

Appendix B

Modeling and Sewer Separation Workshop

A workshop at the WPCA Offices in New Haven was held on June 26th, 1997 to discuss computer modeling issues. The purpose of the workshop was to:

- discuss the current status of the ongoing sewer separation program in New Haven,
- establish baseline conditions for the development of the Long-Term CSO Control Plan, and
- select appropriate modeling software

A copy of the agenda, meeting minutes, and the slides that were used during the workshop are included on the following pages.

Agenda: June 26, 1997

NEW HAVEN LONG-TERM CSO CONTROL PLAN

SEWER SEPARATION STATUS AND MODELING WORKSHOP

LOCATION: WPCA OFFICE

Topic	Presenter	Time
Purpose of Workshop	P. von Zweck	2:00 pm
Computer Modeling		
Modeling Goals	PvZ	2:10 pm
Model Requirements	PvZ	2:35 pm
Tools and Evaluation	PvZ	3:00 pm
Model Recommendation	PvZ	3:25 pm
Break		3:45
Sewer Separation		
Scope and Status	C. Goz	4:00 pm
Evaluation and Rating	CG	4:10 pm
Other Issues	All	4:30 pm
Set Baseline Conditions	All	4:40 pm
Summary and Adjournment	All	4:55 pm

ATTENDEES: Ray Smedberg/WPCA, Rich Cleary/City of New Haven, Henry Goetz/WPCA, William Root/WPCA, Michael O'Brien/DEP, Peter von Zweck/CH2M HILL, Chris Goz/CH2M HILL, Bangalore Neelakantiah/UIC, Joe Cermola/Cardinal, Bob Borus

MEETING DATE: June 26, 1997

LOCATION: WPCA

MINUTES BY: Chris Goz/CH2M HILL

COPY: Attendees, Dick Miller/City of New Haven, Bill Hogan/DEP, Cliff Bowers/CH2M HILL

DATE: July 16, 1997

SUBJECT: New Haven CSO LTCP - Computer Modeling and Sewer Separation Prioritization Workshop

Purpose of Workshop

Peter described the purpose of the workshop. As a group, we wanted to confirm the goals of the modeling task, and to determine which of the current sewer separation projects should be completed in the next two years and included in the baseline conditions of the models.

Computer Modeling Goals

Peter outlined the project goals that will be supported by computer modeling:

- System Performance Goals

  - minimize hydraulic bottlenecks

  - evaluate infiltration/inflow impacts

  - evaluate and control scour and sedimentation

  - evaluate and identify plan for roof leaders

  - reduce the number of pump stations

- Regulatory Goals

  - identify short-term plan to optimize performance of existing system to meet NPDES permit requirements

  - identify long-term plan that meets EPA's policy and planning guidance documents

- Water Quality Goals

  - compute volume, frequency, duration and peak rates of overflows

  - estimate pollutant loads from CSOs

  - evaluate water quality impacts for various CSO control alternatives

- Cost Goals

  - evaluate alternative technologies for CSO control

  - identify plan that balances costs and benefits

Computer Model Requirements

Peter outlined the various data requirements that are needed to develop models of the sanitary sewer system to meet the goals of the project. The CSO GIS that is being developed as part of the study will store and manage data that is required by the models. The need for a computerized link between the models and the GIS for data exchange was highlighted.

Tools and Evaluations

Peter described the modeling approach that was included in the project proposal, and reviewed the planned costs for computer hardware and software. As a result of significant changes in technology, Peter identified alternative approaches that will meet the modeling goals, provide a link to the GIS, and are available at the costs originally proposed.

The MOUSE modeling software by the Danish Hydraulic Institute (DHI) was identified as the preferred alternative.

Ray asked about software obsolescence. Chris indicated that the original approach required customized programming of mini-applications to link the GIS to the model. Past experience has revealed that when the model software had been updated, it was required to re-write the custom programs. Peter stated that in the preferred alternative, the GIS-model link was written by DHI, and that as the software is updated, it is expected that the link will be maintained.

Peter asked Ray and Rich if there were computer standards that should be followed in the purchase of the project computers. Ray commented that the WPCA was in the process of upgrading their computer and SCADA systems, and that they were using Hewlett Packard computers. Rich was unsure of any standard policy and would inform CH2M HILL of the City's requirements.

Model Recommendation

It was agreed that the preferred alternative of DHI's MOUSE model will be adopted for the project.

Evaluation of On-going Sewer Separation

Chris chaired the discussion of the nine sewer separation projects that are designated as '*In Progress*'. The discussion focused on the background, benefits and relative importance of each project. The table at the end of these meeting minutes summarizes the consensus that was reached.

East Rock: Currently on hold because of problems acquiring easement. Additional funding is required to complete the design. Contributes flow to Regulator 013 which Bob and Henry believed to be active on 1-yr storms and less. Chris suggested that project is of lower importance because it is unclear if any benefit will be derived from the project. Generally agreed to be of lower priority.

Livingston St.: Construction bids received, and project is expected to proceed this summer. Agreed that Livingston will proceed.

Orange St. Phase II: The design has been completed, and the outfall and interceptor have already been constructed along Orange St. Bob stated that an investment has already been made to collect the stormwater. Henry mentioned that due to favorable ground slopes, the Orange Street interceptor will collect a certain percentage of surface flow from the side streets with or without separation.

Orange, Bishop and Clinton: This project, currently under design, spans two distinct areas of the City, Orange/Bishop and Clinton.

Completion of the Orange St. Phase II and Orange/Bishop portion of the Orange, Bishop and Clinton project would complete the separation of Storm Basin E4. It was believed that there was a high likelihood that overflows at Regulators 010 and 011 would be reduced or eliminated. Generally agreed that these projects are of higher priority.

Humphrey St.: Project consists of work under the I-91, and construction difficulties are expected since many utilities are located in the area. The sewers upstream of the project have already been separated. Consensus was reached that the project was of higher priority.

Orange, Bishop and Clinton and Lombard East: The Clinton portion of the first project and the Lombard East project will complete the separation of storm Basin S2. Henry mentioned that flow monitors were installed at the James St. Siphon about one month ago to occurrences of basement and street flooding along Front Street. Henry felt that these separation projects should be of the highest priority. Bob said that the sewer systems in Fair Haven were somewhat isolated and acted as their own "system within a system". It was felt that the problems might not be solved by separating only one of the nine basins that contribute flow to the siphon. Chris commented that looking at other alternatives such as increasing flow through the siphon may be a more cost effective solution. It was generally agreed that the priority of these two projects was lower than others.

Wooster Square: Wooster Street has been separated, and the design for the remaining streets are in progress. Henry commented that at the downstream portions of the system, some of the sewers are under-sized and inadequate to convey flow. Chris commented that fixing the bottleneck might be a more cost-effective solution to reports of basement and street flooding than complete separation of the area. The group consensus was that this project was of high priority.

Kimberly and Columbus: Both portions of this project are in areas with combined sewer systems. Group consensus was that both portions were of lower priority.

Elm Haven: Henry has done some preliminary calculations for the proposed development. He indicated that population density will drop in the area. Consensus was reached that the project will proceed, and that the estimated flow to the sewer systems should be included in the baseline conditions.

Baseline Conditions for Computer Modeling

It was identified that the City wanted to spend $8M/year for two years while the Long-Term CSO Control Plan is being reviewed and completed. Bob suggested that if the costs of the high priority projects added to $16M, that they should be included in the baseline conditions for the sewer system GIS and models. The group agreed that this would serve as a starting point for sewer separation. Rich will confirm the opinions of probable construction costs for the various projects.

If you have any comments or corrections related to these minutes, please contact Chris Goz at 617/523-2002 x208.

TABLE 1
Evaluation of On-going Sewer Separation Projects in New Haven

Project Name	City Project Number	Design Firm	Current Priority[1]	Status of Design	Opinion of Probable Cost	Storm Basin	Basin Rank[2]	Local Flooding[3]	Elimination of Overflow[4]	Est. Area (ac)	Cost/Acre of Separation	Other Issues
East Rock Road	90-130-1	Montgomery Watson	Low	Complete[5]	$400,000[6]	E1	5	Yes	013	20	$20,000	Only remaining combined area contributing to OF013. Potential to stock Mill River upstream of tide gates with fish.
Livingston St.	90-131-1	Goodkind & O'Dea	High	Complete (bid rec'd)	$1,959,410	E2	6	Yes	013 & 012	80	$23,000	Flushing velocities maintained? Construction to commence summer 1997.
Orange St. Phase II	94-70-1	Cardinal Engineering	High	Complete	$3,682,750	E4	8	Yes	012	140	$27,000	Last remaining combined area tributary to OF012
Orange, Bishop, Clinton	94-71-1	Goodkind & O'Dea	High & Low	In Progress (50%)	$3,500,000[6]	E4 & S2	8 & 9	Yes	012 & 018	110	$31,500	
Humphrey St.	95-125-1	URS Greiner	High	In Progress (10%)	n/a[7]			No	011			Areas upstream are separated.
Lombard East	94-72-1	Westcott & Mapes	Low	Complete	$4,250,000[6]	S2	9	Yes	018	70	$61,800	
Wooster Square	94-128-1	Center for Engineering	High	In Progress (10%)		E7	9	Yes		104		
Kimberly and Columbus	95-99-1	Diversified Technologies	Low & Low	Complete	$4,344,203	B12 & E8	9 & 9	No & Yes	024	125	$34,500	
Elm Haven	96-146-1	Lourerio		Undecided[8]		E5	13	Yes	No			Extensive urban renewal program; current sewers believed to be undersized for future demand.

Notes
1. Current priority of project determined by consensus at June 26/97 Modeling and Separation Workshop. High/Low ranking are relative between current separation projects.
2. Basin ranking determined in previous studies.
3. Basement and street flooding complaints, or flood prone areas indicated by previous modeling efforts.
4. Reduction in flow reaching overflow regulator may eliminate or reduce the likelihood of overflow activity.
5. Design 95% complete. Pending notice to proceed with supplemental engineering.
6. Cost estimate based on comparison with construction of similar nature.
7. Design incomplete. Cost comparison not possible; construction will involve jacking under I-91.
8. Sewers believed to be inadequate for increased demand; no confirmation to proceed with sewer design.

City of New Haven, CT
Long-Term CSO Control

Computer Modeling Workshop
June 26, 1997

The City of New Haven
The City of New Haven Water Pollution Control Authority
The State of Connecticut Dept of Environmental Protection

Meeting Objectives

- Discuss Project & Modeling Goals
- Discuss Requirements for GIS and Models
  - Overview of Approach to Model Development
  - Review Original Plan
  - Discuss Alternative Modeling Tools
- Confirm Approach for Project

Project & Modeling Goals

Project Goals

- Three Primary Project Goals Identified in Scope of Work
- Specific Goals Confirmed via Workshop Process
- Task 1 Identified Series of Workshops

Primary Project Goals

- Produce documents required for CSO related issues as described in the WPCA's existing NPDES permit
- Identify a plan that complies with US EPA's CSO Control Policy (1994)
- Reduce overall cost of constructing CSO controls

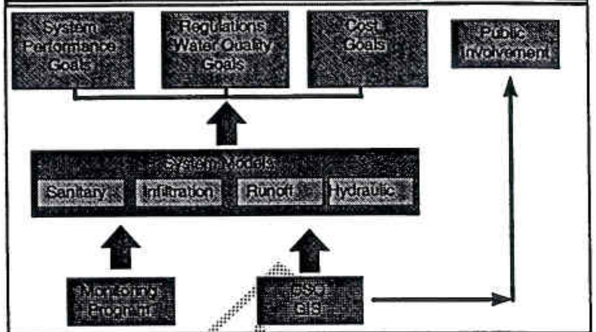
Issues Which Need Specific Goals

- Modeling
  - Baseline Conditions (On-going Projects)
  - Model Requirements
- System Performance
- Regulations & Water Quality
- Monitoring Program
- Costs
- Public Involvement

Process for Identifying Model Requirements

- Identification of Specific Project Goals
- Identification of those Supported by Modeling
- Identification of Processes to be Simulated by the Model
- Identification of Tools & Approach for Model Development

Specific Project Goals



Regulatory Goals

- Identify a Short-Term Control Plan that optimizes the existing system's performance and meets NPDES requirements
  - » eliminate DWOs, implement BMPs, maximize in-system storage, minimize untreated overflows, solids & floatables, maximize conveyance to East Shore WWTP

Regulatory Goals

- Identify a Long-Term Control Plan that meets the EPA's policy and planning guidance documents
  - » Inventory, Monitoring, Modeling, Characterization, Public Participation, Sensitive Areas, Water Meet Quality Standards

System Performance Goals

- Identify and Evaluate Controls which Minimize Hydraulic Bottlenecks
  - » Excessive Surcharging
  - » Basement Flooding
  - » Street Flooding
  - » Reduce Untreated Discharges
- Evaluate Impacts and Identify a Plan for Infiltration/Inflow

System Performance Goals

- Identify and Evaluate Controls for Scour & Sedimentation Issues
  - » Dry Weather Flows
  - » Separation Methods
- Evaluate Impacts and Identify a Plan for Roof Leaders
  - » Wet Weather Flows
  - » Impacts on Scour & Surcharging
- Reduce Number of Pump Stations

Water Quality Goals

- Compute Volume, Frequency, Durations, and Peak Rates of Overflows for Events and Average Annual Basis
- Estimate Pollutant Loads from CSOs and Other Sources
- Evaluate Water Quality Impacts of CSO Control Alternatives

Cost Goals

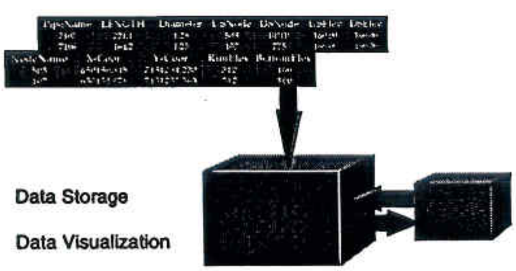
- Evaluate Alternative Technologies for CSO Control
  - Continued sewer separation, storage, high-rate treatment, increased conveyance, WWTP modifications
- Identify Control Plan that Balances Costs and Benefits

Approach to Model Development

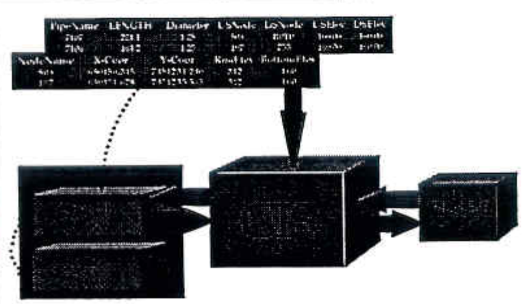
Objectives

- Develop a model which supports the regulatory, water quality, system performance, and cost goals established for the project
- Develop a GIS that supports the data storage and visualization needs of the model

What We Need in a GIS

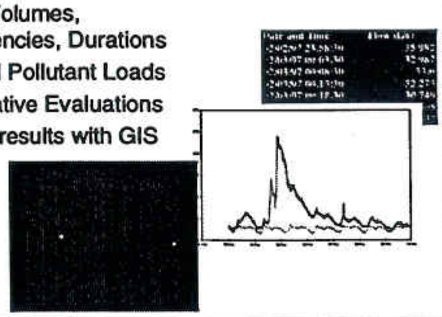


Future GIS Needs

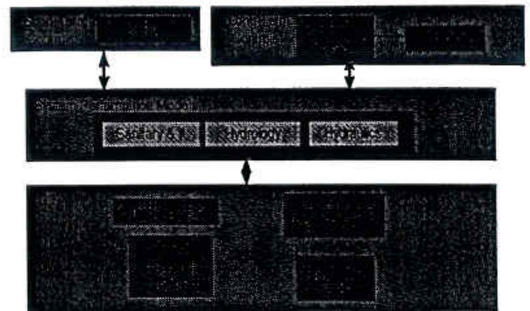


What We Need in a Model

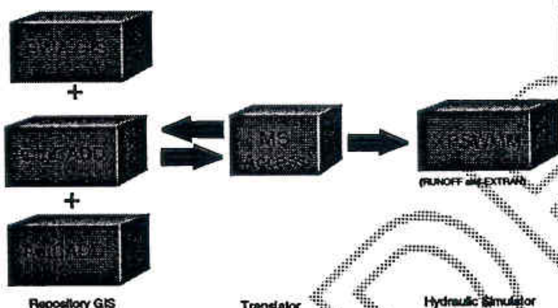
- CSO Volumes, Frequencies, Durations
- Annual Pollutant Loads
- Alternative Evaluations
- Share results with GIS



Modeling Approach



Proposed Approach #1



Original Plan Costs

Item	Quantity	Unit Cost	Total Budget
Computers	2	$4,000	$8,000
AutoCADD	2	$3,000	$6,000
ArcCADD	2	$2,500	$5,000
ArcVIEW	2	$1,500	$3,000
XP-SWMM	1	$5,000	$5,000
RWA GIS	1	$50,000	$50,000

Total Cost $77,000

Alternative Tools

Software Possibilities

GIS

- ESRI ArcCADD
- ESRI ArcInfo
- ESRI ArcView
- Microstation
- MapInfo
- others...?

Links

- MS Access
- Lynx
- Mouse GIS
- HydroWorks
- others...?

Models

- EPA SWMM
- XP-SWMM
- Mouse
- HydroWorks
- others...?

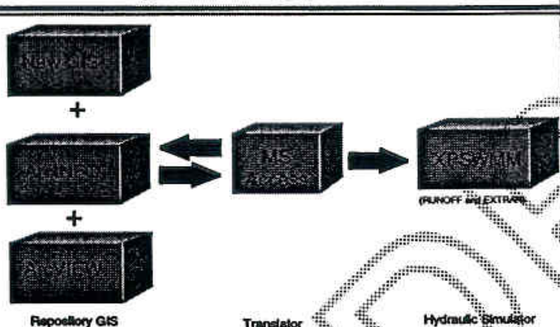
Software Possibilities

GIS	Links	Models
~~ESRI ArcCADD~~	MS Access	~~EPA SWMM~~
ESRI ArcInfo	~~Lynx~~	XP-SWMM
ESRI ArcView	Mouse GIS	Mouse
~~Microstation~~	~~HydroWorks~~	~~HydroWorks~~
~~MapInfo~~	others...?	others...?
others...?		

City's Mapping and GIS Contract

- The City has reflown the entire city (April 1997, separate contract)
- Base Mapping will be complete by the end of 1997
- ESRI ArcInfo coverages will be built within two years
- We need to prioritize their digitizing efforts

Proposed Approach #2



ESRI and XPSWMM

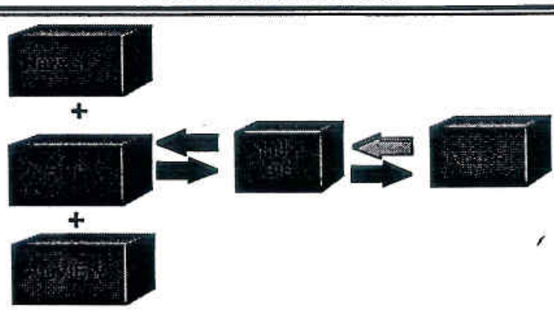
Pro

- Fits with existing GIS and models
- Experience
- Good Graphical views of outputs

Con

- Automated link (?)
- Requires programming (?)
- No inherent network simplification
- No RTC operation capability

Possible Solution #3 ESRI and Mouse



ESRI and Mouse

Pro

- Proven linkage
- ESRI in use by other departments
- Network simplication tools
- Good Graphical views of outputs

Con

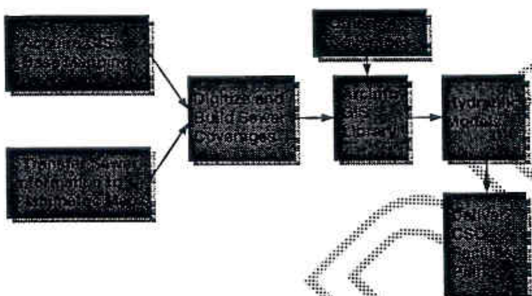
- Limited Experience
- Software Cost

Cost Comparison

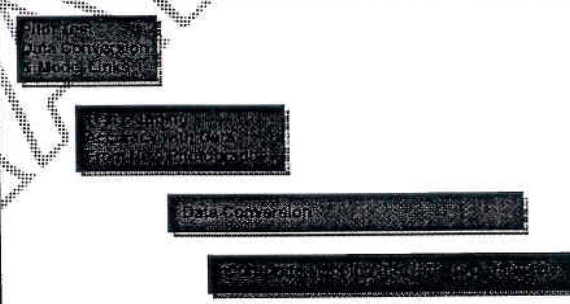
Item	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Total Costs	$77,000	$69,500	$76,700

Recommended Approach

Sewer System Data Conversion

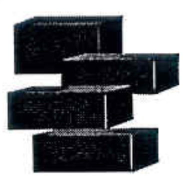


CSO Project Schedule



Summary

- Basemapping
- GIS Software
- Link
- Hydraulic Model



Break

Evaluation of On-going Sewer Separation

Objectives

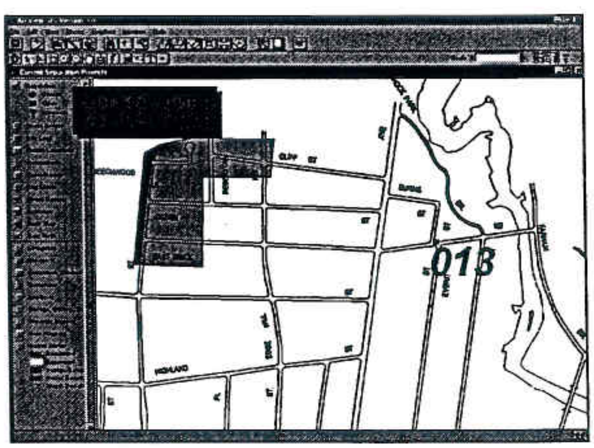
- One Project Primary Objective is to:
  "Reduce cost of constructing CSO controls"
  - » Maximize the benefits of current separation program in light of developing a LTCP
  - » Establish baseline conditions for sewer system modeling

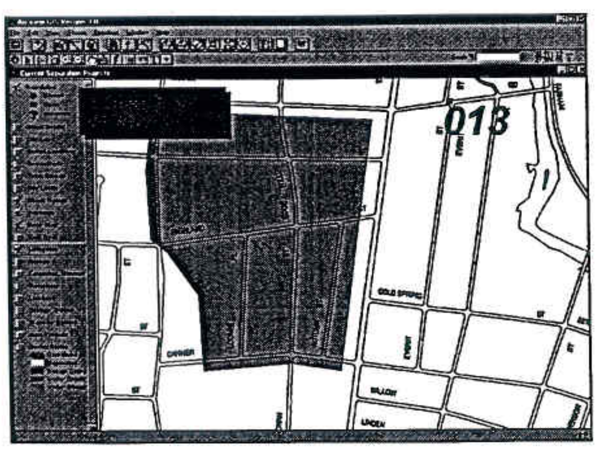
Evaluation Criteria

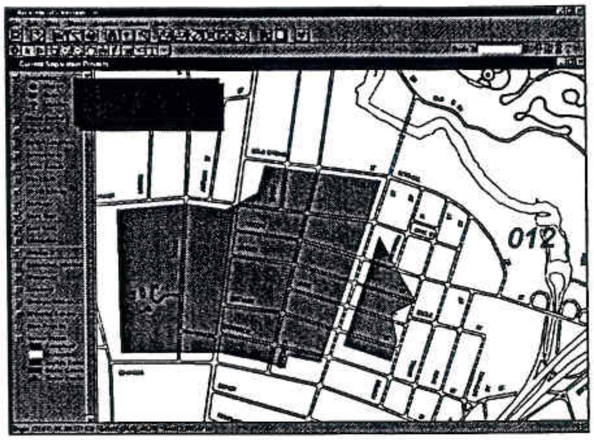
- Review data according to following criteria:
  - » location in service area
  - » CSO elimination
  - » alleviate flood prone areas
  - » coincident with other projects
  - » potential for other solutions

Current Separation Projects

- Nine Projects
  - » 4 have completed design phase
    - – 1 has received bids
  - » 3 have designs in progress
  - » 1 design on hold
  - » 1 design pending
- Expected Cost for Construction: +$20M



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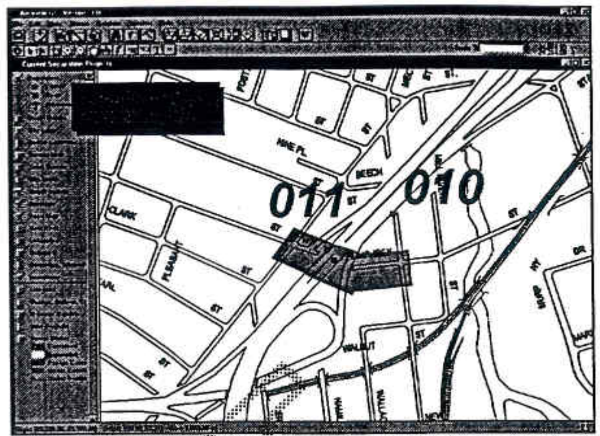
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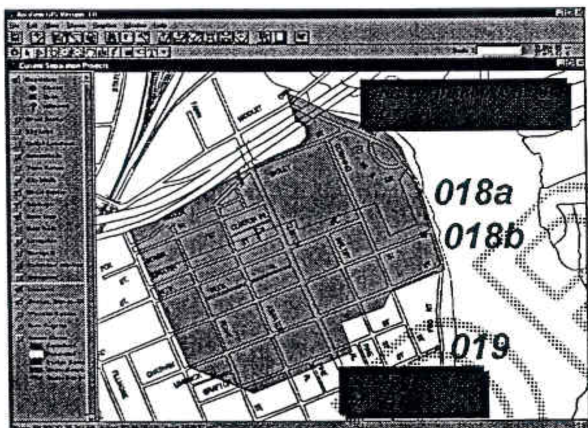
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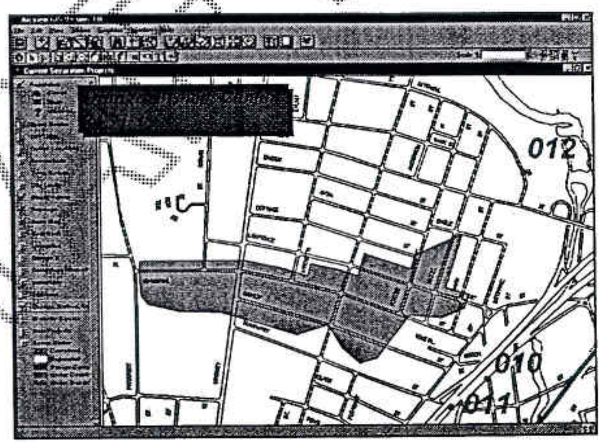
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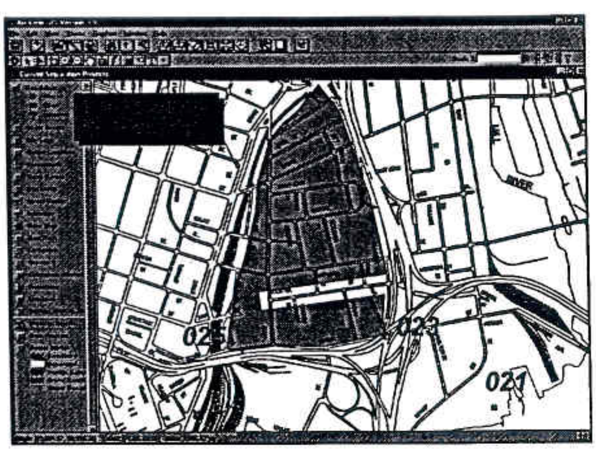
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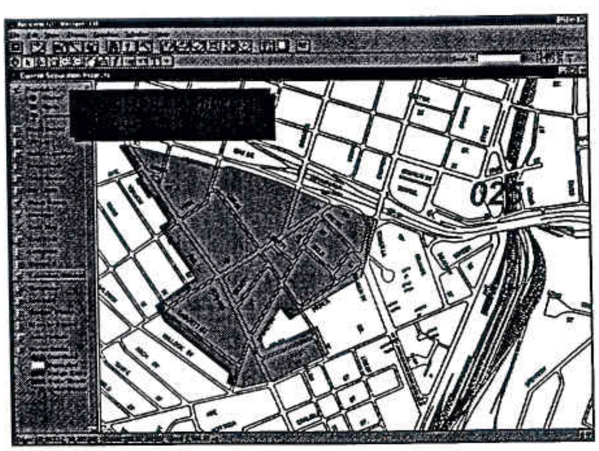

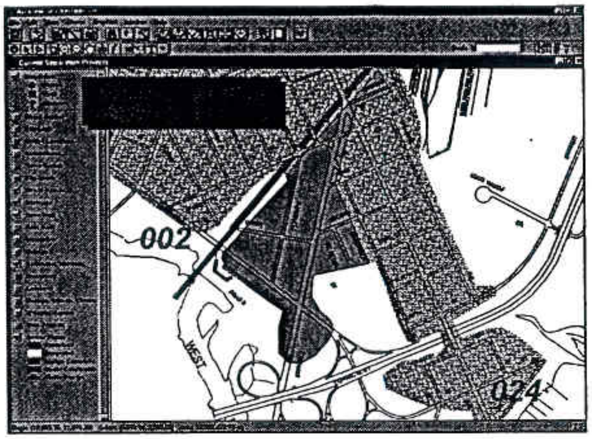
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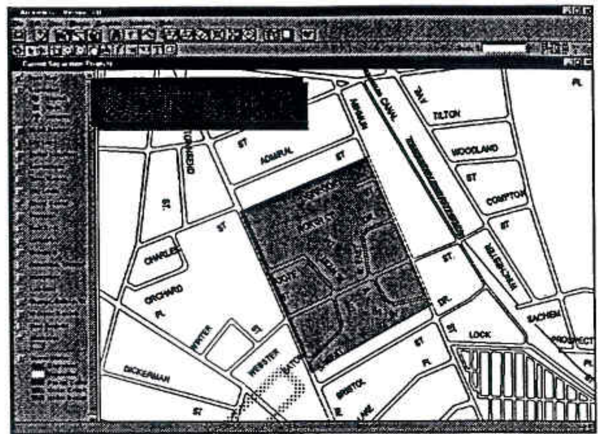
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BRISTOL
LOCK
SACHEM
PROSPECT
DR.

Appendix C

Attributes in the Sanitary Point Coverage

Coverage: SanNode (Point)	*Sanitary nodes (MH, pump wetwell, outfall, regulator)*				
fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
san_Name	char*10	no	yes	name of node element	specified naming convention
san_XPos	float	no	no	x-coordinate (easting)	Plan/profile strip map
san_YPos	float	no	no	y-coordinate (northing)	Plan/profile strip map
san_zBttm	float	no	no	elevation of manhole invert	Plan/profile strip map
san_zGrnd	float	no	no	elevation of ground	Plan/profile strip map
san_Class	char*2	no	no	node classification	Plan/profile strip map (MH:manhole;RG:regulator;OF:outfall;PS:pumpstation)
san_Quad	char*10	no	no	basemap sheet name	Mylar basemap

Associated Tables

Table RG				
fieldname	*type*	*null values allowed*	*unique*	*description*
san_Name	char*10	no	yes	name of node element
rg_Type	char*10	no	no	type of regulator (weir, orifice, weir/orif)

Table OF				
fieldname	*type*	*null values allowed*	*unique*	*description*
san_Name	char*10	no	yes	name of node element
of_Type	char*10	no	no	FO:free outfall;FB:fixed backwater;FG: flapgate
of_zWater	float	yes	no	if of_Type=FB, then the water surface elevation at outfall

Table PS				
fieldname	*type*	*null values allowed*	*unique*	*description*
san_Name	char*10	no	yes	name of node element
ps_Xsection	float	no	no	cross-sectional area of pumpstation wet well

Attributes in the Sanitary Line Coverage

Coverage: SanLink (Line)		*Sanitary flow paths (sewer, pump forcemain, weir, orifice)*				
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	san_Name	char*16	no	no	name of coverage feature	Following naming convention
	san_usNode	char*10	no	no	name of upstream node	Plan/profile strip map; name from San Manhole Table
	san_dsNode	char*10	no	no	name of downstream node	Plan/profile strip map; name from San Manhole Table
	san_Class	char*2	no	no	path classification	Plan/profile strip map (PI:sewer;FM:forcemain;WR:weir;OR:orifice)
	san_Quad	char*10	no	no	basemap sheet name	Mylar basemap

Associated Tables

Table PI						
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	san_Name	char*10	no	yes	name of coverage feature	
	pl_zUS	float	no	no	upstream elevation	Plan/profile strip maps
	pl_zDS	float	no	no	downstream elevation	Plan/profile strip maps
	pl_Length	float	no	no	sewer length	Calculated from (X,Y) pairs
	pl_Shape	char*10	no	no	sewer shape	Plan/profile strip maps
	pl_Height	float	no	no	sewer height	Plan/profile strip maps
	pl_Width	float	no	no	sewer width	Plan/profile strip maps
	pl_consYear	integer	no	no	year of construction (YYYY)	Plan/profile strip maps
	pl_consMat	char*10	no	no	construction material	calculated/observed

Table FM						
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	san_Name	char*10	no	yes	name of coverage feature	
	fm_type	char*2	no	no	type of pump	Pump rating curves IB:inline;OB:offline
	fm_npump	integer	no	no	number of pumps (to a max of [illegible]	Pump rating curves
	fm_H1_1	float	no		pump 1 on/off head	Pump rating curves
	fm_H1_2	float	no		pump 1 on/off head	Pump rating curves
	fm_H1_3	float	yes		pump 1 on/off head	Pump rating curves
	fm_Q1_1	float	no		pump 1 flowrates	Pump rating curves
	fm_Q1_2	float	no		pump 1 flowrates	Pump rating curves
	fm_Q1_3	float	yes		pump 1 flowrates	Pump rating curves
	fm_H2_1	float	yes		pump 2 on/off head	Pump rating curves
	fm_H2_2	float	yes		pump 2 on/off head	Pump rating curves
	fm_H2_3	float	yes		pump 2 on/off head	Pump rating curves
	fm_Q2_1	float	yes		pump 2 flowrates	Pump rating curves
	fm_Q2_2	float	yes		pump 2 flowrates	Pump rating curves
	fm_Q2_3	float	yes		pump 2 flowrates	Pump rating curves

Table WR						
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	san_Name	char*10	no	yes	name of coverage feature	
	wr_type	char*12	no	no	type of weir	Field
	wr_length	float	no	no	length of weir	Field
	wr_k	float	no	no	discharge coefficient	Engineer

Table OR						
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	san_Name	char*10	no	yes	name of coverage feature	
	or_type	char*12	no	no	type of orifice	Field
	or_diameter	float	no	no	diameter of orifice opening	Field
	or_k	float	no	no	discharge coefficient	Engineer

Attributes in the Storm Point Coverage

Coverage: StmNode (Point)		Storm Manholes				
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	stm_Name	char*10	no	yes	name of manhole	Plan/profile strip map; specified naming convention
	stm_XPos	float	no	no	x-coordinate (easting)	Plan/profile strip map
	stm_YPos	float	no	no	y-coordinate (northing)	Plan/profile strip map
	stm_zBttm	float	no	no	elevation of manhole invert	Plan/profile strip map
	stm_zGrnd	float	no	no	elevation of ground	Plan/profile strip map
	stm_Class	char*10	no	no	node classification	Plan/profile strip map (MH, SOF)
	stm_Quad	char*10	no	no	basemap sheet name	Mylar basemap

Associated Table

Table SOF					
	fieldname	*type*	*null values allowed*	*unique*	*description*
	stm_Name	char*10	no	yes	name of manhole
	sof_Type	char*10	no	no	FO:free outfall;FB:fixed backwater; FG: flap gate
	sof_zWater	float	yes	no	If sof_Type=FB or FG, then the water surface elevation at outfall, otherwise blank

Attributes in the Storm Line Coverage

Coverage: StmLink (Line)		*Storm sewers*				
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	stm_Name	char*16	no	yes	pipe name	specified naming convention
	stm_usNode	char*10	no	no	name of upstream node	Plan/profile strip map; name from Storm Manhole Table
	stm_zUS	float	no	no	upstream invert	Plan/profile strip map
	stm_dsNode	char*10	no	no	name of downstream node	Plan/profile strip map; name from Storm Manhole Table
	stm_zDS	float	no	no	downstream invert	Plan/profile strip map
	stm_length	float	no	no	sewer length	Calculate from (x,y) pairs
	stm_shape	integer	no	no	sewer shape	Plan/profile strip map
	stm_height	float	no	no	sewer height (=diameter if circular)	Plan/profile strip map
	stm_width	float	no	no	sewer width (=diameter if circular)	Plan/profile strip map
	stm_consYear	integer	no	no	year of construction (YYYY)	Plan/profile strip maps
	stm_consMat	char*10	no	no	construction material	Calculated/observed
	stm_quad	char*10	no	no	basemap sheet name	Mylar basemap

Attributes in the Storm Catchbasin Coverage

Coverage: StmCB (Point)		Storm Catchbasins				
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	stmcb_	char*10	no	yes	unique ID	
	stmcb_XPos	float	no	no	x-coordinate (easting)	Plan/profile strip map
	stmcb_YPos	float	no	no	y-coordinate (northing)	Plan/profile strip map

Attributes in the Storm Lateral Coverage

Coverage: StmLat (Line)		*Storm Laterals*				
	fieldname	*type*	*null values allowed*	*unique*	*description*	*source*
	stmlat_	char*16	no	no	unique id	specified naming convention
	stmlat_From	char*10	no	no	unique id of "from" catchbasin	Plan/profile strip map
	stmlat_To	char*10	no	no	dummy endpoint near storm sewer	Plan/profile strip map
	stmlat_length	float	no	no	sewer length	Calculate from (x,y) pairs.

Appendix D

GIS and Modeling Meeting

A meeting at City Hall was held on May 20th, 1997 to discuss coordination of GIS and computer modeling. A copy of the agenda, meeting minutes, and the slides that were used during the workshop are provided in this Appendix.

Agenda: May 20, 1997

New Haven Long-Term CSO Control Plan

GIS-related Issues

Topic	Presenter	Time
Purpose of Meeting		1:00 pm
Introductions		1:10 pm
Data Requirements for City's CSO Control Plan		1:15 pm
Data Conversion Process		1:45 pm
Potential Data Sources		2:05 pm
Status of City's GIS Project		2:20 pm
Integration of CSO and GIS Contracts		2:30 pm
GIS Hardware/Software		2:50 pm
Summary and Adjournment		3:00 pm

MEETING MINUTES CH2M HILL

ATTENDEES:
Dick Miller/City of New Haven
Peter von Zweck/CH2M HILL
Karyn Gilvarg/City of New Haven
Donna Hall/City of New Haven
Chris Goz/CH2M HILL
Barb Schmitz/CH2M HILL
Joe Cermola/Cardinal
Henry Goetz/WPCA
Bill Brodie/The Brodie Group

MEETING DATE: May 20, 1997

LOCATION: City Hall

MINUTES BY: Chris Goz/CH2M HILL

COPY:
Attendees
Ray Smedberg/WPCA
Cliff Bowers/CH2M HILL

DATE: July 16, 1997

SUBJECT: New Haven LTCP - GIS Related Issues

The discussions focused on the mapping and data needs of the CSO project, how they relate to the City's GIS project, and how to coordinate efforts between the two projects.

The following represents a summary of the issues and action items discussed at the meeting.

- A convention for assigning material of construction for pipes mapped during the CSO project was agreed upon: If the install date is prior to 1945, all pipes < 24" diameter = tile, =>24" dia = brick. If the install date is after 1945, all pipes < 12" = tile, => 12" = reinforced concrete.
- New mapping generated by the City's GIS contract will reference the NAD83 coordinate system.
- The City's GIS will reside in ArcInfo format. Bill has yet to decide on which platform (NT/Unix) and version. The City is currently using ArcView 2.1, and a Novell LAN is being installed in the Planning Department.
- The City's existing planimetric maps will be used as the first step in transferring sewer data from the strip/plan and profile maps to the GIS coverages. These maps reference NAD27. It was agreed that this data could be converted from NAD27 to NAD83 without problems using ArcInfo or they could be converted during the digitizing process.
- It was agreed that the RWA's GIS will not be purchased for the CSO project. Because the RWA's GIS will not be purchased, the data conversion process described in the CSO project's scope-of-work will be modified. Mapping from the City's current GIS contract will be incorporated into the CSO project. The sewer system coverages developed during the CSO project will be tied to mapping produced for the City's GIS project.
- Several methods of creating the sewer coverages and sharing the map data were discussed (providing digital orthophotos first, providing mapping of only curb lines, phasing the work). Bill noted that rearranging the GIS project's production schedule would require additional setup time and effort (higher costs). It was agreed not to rearrange the GIS project's production schedule. Instead, it was agreed to coordinate the production schedules for both projects.
- It was agreed that Bill would provide aerial triangulation data files to Barb before June 6th to be used in pilot testing of the data conversion process. This data will aid in the digitization process by supplying target coordinate information located throughout the City. Bill will then provide

completed planimetric mapping files in AutoCad or ArcInfo format as they become available. Bill noted that the mapping would be completed by the end of the year.

- Dick proposed that $50,000.00 included in the CSO project's scope of work for purchasing the RWA's GIS be re-appropriated for the City's current GIS project. Barb noted that use of the triangulation data and other modifications to the data conversion process will add costs above and beyond those included in the CSO project's current scope of work. Peter suggested that no action be taken on reallocation of these funds until impacts related to the scope changes were better defined. Barb agreed to identify increased costs associated with the modified plan. Dick noted that the City's is applying for contingency funds which could cover this type of scope change.

- Pilot testing of the data conversion process was discussed. Dick noted that the Elm Haven area is a priority for CSO control and redevelopment, and suggested that this area be used as the area for the process pilot. Karen suggested that the area for the pilot include part of Yale University to satisfy some of the Planning Department's needs. It was agreed that the pilot test for the CSO project's data conversion process and the GIS project's mapping include the area shown in the City's planimetric maps N-11, N-12, N-13, N-14, O-11, O-12, O-13, and O-14.

- The schedule for pilot testing the CSO project's data conversion process and the coordination of mapping from the GIS project were discussed. It was agreed that Joe would transfer the sewer data from the plan and profile drawings to the pilot area's mylar sheets by June 6, 1997. Barb will digitize the information from the mylar sheets into ArcInfo coverages by June 20, 1997. Chris will create hydraulic models from the ArcInfo coverages by June 30, 1997. Bill will confirm when the map data for the pilot task will be complete. The new map data will be used to confirm the locations of sewers mapped during the CSO project.

- It was agreed that mapping for the two projects will be coordinated by dividing the City into 6 areas and prioritizing which areas would be done in which order (1 area per month for 6 months). Common grid lines will be established to coordinate the data transfer work with the photogrammetry work. Bill will communicate to Barb where the 3000' x 2000' grid areas are located and Chris will prioritize the order in which they should be completed.

- Barb will input the planimetric grid layout and superimpose the orthophoto grid so we can track which grids are complete.

- Bill reiterated that the line mapping and digital orthophoto tasks for the entire city will be completed by the end of December, 1997.

- Karen gave Barb a street index of New Haven in AutoCAD12 format. She also provided an AutoCAD 12 file of the 100 scale mapping for the downtown area (Map #18-28-44-45-36).

- Karen indicated that the City had no land use information that was accurate and current. Existing maps are based on data prior to 1960. The Planning Department is currently undertaking the task of updating their records. It was also noted that zoning information is not indicative of actual land use. It was decided that the data the City could provide for our CSO project was not very useful and we would not benefit from using it.

- The schedule for the sewer data conversion and mapping work was discussed. The agreed upon schedule is illustrated below.

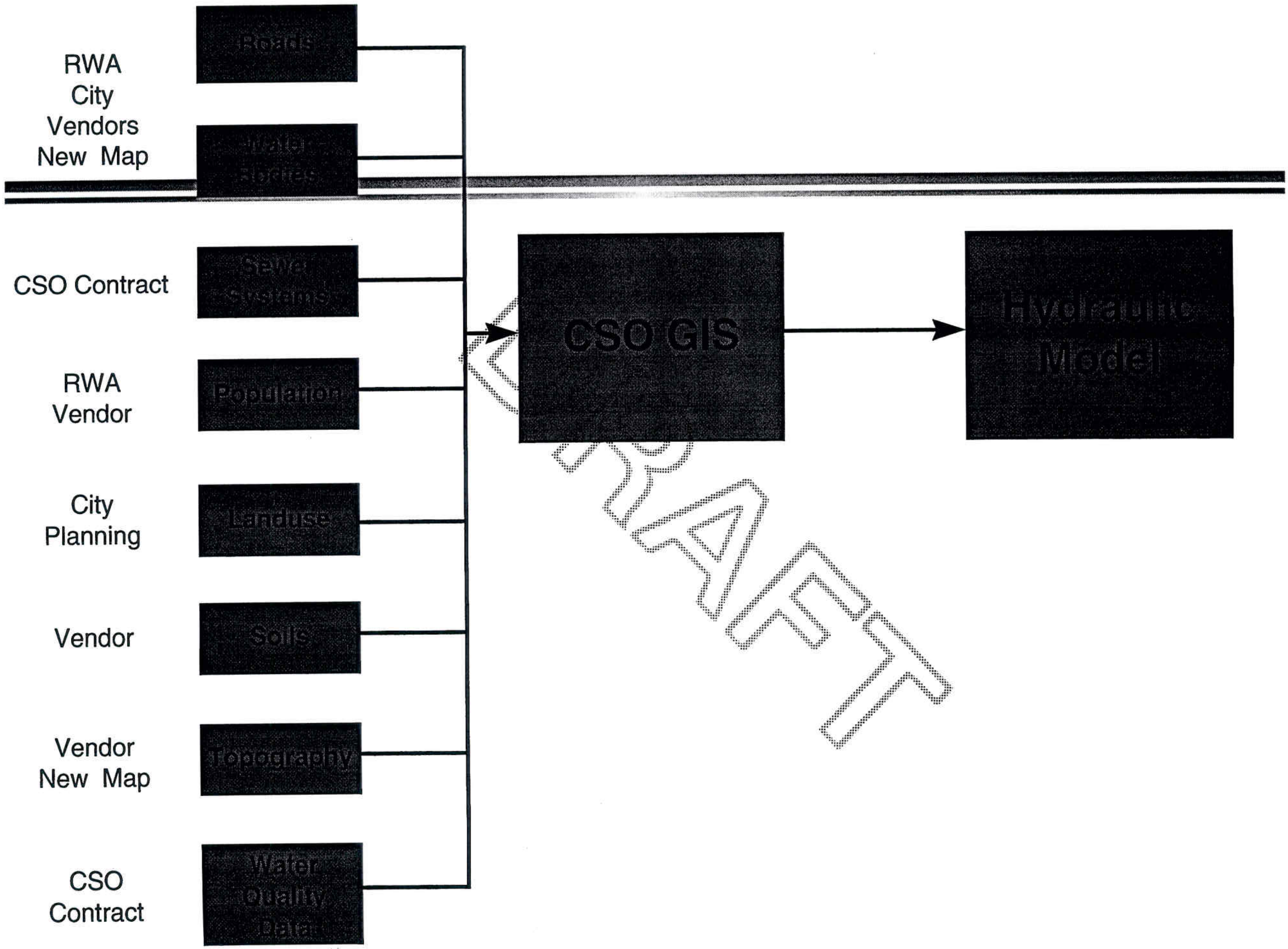
If you have any comments or corrections related to these minutes, please contact Chris Goz at 617/523-2260.

City of New Haven
Long-Term CSO Control

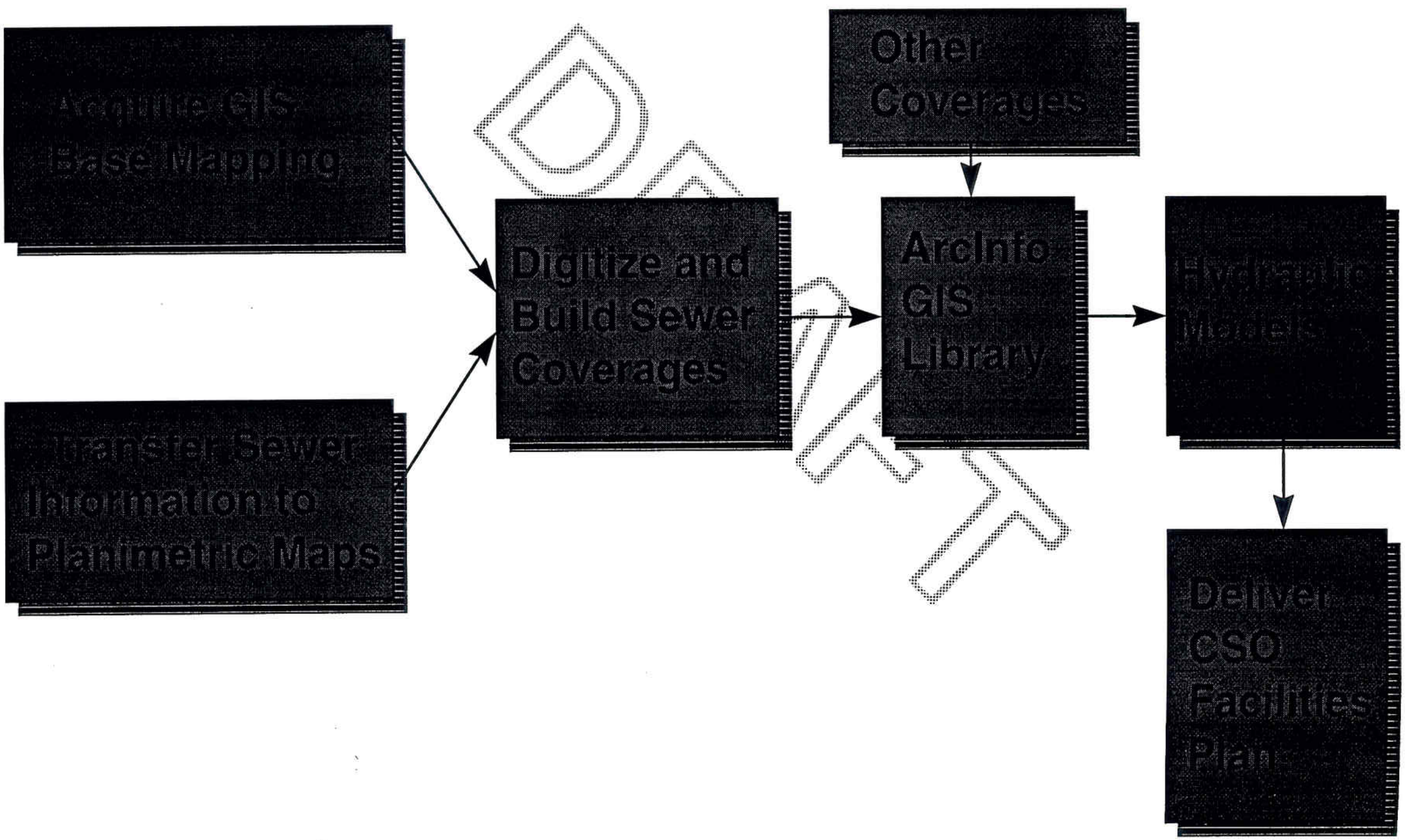
GIS-Related Issues

Purpose of Meeting

- Communicate Data Needs of CSO Plan
- Outline Conversion Process and Need for Base Mapping
- Identify Best Solution for Lowest Cost
- Coordinate Efforts Between CSO and GIS Contracts


RWA
City
Vendors
New Map
Roads
Water Bodies
CSO Contract
Sewer Systems
RWA
Vendor
Population
City
Planning
Landuse
Vendor
Soils
Vendor
New Map
Topography
CSO
Contract
Water Quality Data
CSO GIS
Hydraulic Model
DRAFT

Sewer System Data Conversion



Base Map Options

- RWA
- City Maps
- Venders
- New Orthophotography
  - Digital Orthophotos
  - Partial Mapping
  - Phased Approach

RWA

- High Cost
- Old Map Base
- Conversion Not Complete

\+ Complete Base Maps

\+ Accuracy +/- 1'

\+ GIS Coverages

- Water Utilities
- Population Data
- Water Bodies
- Catch Basins

City Maps

- AutoCad 12
- Tiger Files

? Accuracy

? Content (Landuse, Zoning, ?)

? Extent of Coverage

CSO Project Schedule

Pilot Test
Data Conversion
& Model Links

Test Mapping
Accuracy with Data
From New Photography

Data Conversion

Incorporate Mapping Info into CSO Database