Appendix A1

Model Selection Process

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Conveyance system modeling was conducted to simulate peak design flows in the separated wastewater conveyance system and to determine system capacities. The model was also used to simulate I/I flows in the system. King County acquired new hydraulic modeling software, MOUSE™ (Modeling of Urban Sewers), a personal computer (PC) based model with a graphic interface to GIS. Descriptions of the process used to select the model, model capabilities, operation and calibration of the model, and quality procedures to ensure accuracy of the model are provided below.

When modeling software is used, conveyance system alternatives can be investigated. These alternatives include storage facilities or flow swaps with adjacent agencies and operational changes over a wide range of flow conditions. Other conditions that cannot be easily measured can be considered with the aid of a computer model, such as the impact of disconnecting downspouts in a local basin or lining trunk sewers in a basin.

A1.1 Model Selection

A model selection team identified potential software vendors, prepared a Request for Proposal (RFP) for model selection, reviewed proposals, and compared features of models to facilitate selection of the best system for the I/I project needs. The model selection effort began in early January 2000. King County staff was involved in a similar City of Seattle effort before 1999, which provided County staff with additional knowledge about potential vendors. An RFP for selection of a computer package was prepared and published in April 2000 based on data collected from the City's and County's evaluation processes and from the County's early-2000 survey of vendors and users.

A1.2 Alternatives Considered

Vendors for SewerCAT, InfoWorks, and MOUSE™ software responded to the RFP. The initial review of proposals eliminated SewerCAT and clarified some issues:

- Although the SewerCAT vendor is a local company offering the advantage of convenient communication, the proposed work would require extensive customization of software. In contrast, the InfoWorks and MOUSE™ packages would not need major customization. Favorable consideration was given to off-the-shelf products where little or no customization was required.
- SewerCAT would not require paying a license fee. Lack of a licensing agreement could result in limited support and no upgrades in the future.
- While working with SewerCAT would favor the model development schedule by making use of the County's existing model data and providing continuity in the future, the need for full-scale development of a user interface would negatively impact the schedule.
- SewerCAT lacked many of the features offered by other packages. SewerCAT did not include hydrologic and infiltration modules. Features that were stronger in other packages included dry weather flow development; ESRI's ArcView™ GIS basin information import, export, and management; and graphic user interface (GUI).

The review team believed that, in addition to concern about schedule impacts, the Reid Crowther team (SewerCAT developer) could experience difficulty in providing the necessary resources to customize its package. Based on these considerations, Wallingford Software's InfoWorks and DHI's MOUSE™ were short-listed for further consideration.

A1.3 Model Evaluation and Selection

In terms of technical capability, both InfoWorks and MOUSE™ offered powerful tools for calibrating and simulating rainfall-dependent I/I (RDII) and hydraulic systems. After reviewing the proposals, the selection team members requested that vendors provide a live demonstration using the County's sewage basin data. Two primary features were evaluated during the demonstrations: (1) the model's ability to calibrate I/I flows to flow monitoring data; and (2) computation speed. The basin runoff model was calibrated using meter data and compared with an additional storm event. A 2-month simulation was conducted for comparison of computation speed during the demonstration.

Information gathered on each package during the City of Seattle's model selection process was also considered.

A1.3.1 Hydrologic Model Needs and Features

Both models had comparable in hydrologic features. InfoWorks provided more flexibility in setting up basins and more options for pervious infiltration setup. MOUSE™ offered fewer options in the hydrologic routine and pervious surface infiltration. MOUSE™ offered more for plotting components of runoff flows. MOUSE™ was stronger in terms of schedule and cost of customizations. InfoWorks could not accommodate gaps in rainfall data, while MOUSE™ could. InfoWorks could plot gaps of metered flow in plotting comparison, whereas MOUSE™ could not.

A1.3.2 Hydraulic Model Speed and Control

InfoWorks was slightly weaker in the hydraulic model speed and control. In its proposal, InfoWorks claimed to be more stable. It was difficult to verify the comparison between claimed features and actual operation of the model. MOUSE™ was stronger in setting up Manning's "n" for depth-dependent friction in circular conduits. MOUSE™ was also stronger in terms of handling flow in an internal pipe as a boundary condition.

MOUSE™ could bypass the dry period hydrodynamic simulation, but InfoWorks could only increase time steps during a dry period. This feature in MOUSE™ significantly reduced the computation time when performing long simulations. InfoWorks could allow the user to modify control elements during the simulation, while MOUSE™ could only allow the user to see the results at the end of the simulation.

A1.3.3 Data, Run, and Result Management

InfoWorks was slightly stronger in data, run, and result management. InfoWorks offered rigorous data management and tracking tools. MOUSE™ had less sophisticated data management tools with no tracking. MOUSE™ was stronger in statistical tools.

InfoWorks used a client-server setup, which is better than MOUSE™. However, this was not required as the project used a local model setup.

A1.3.4 Customization

Experience and proposal information regarding customization was more favorable for MOUSE™. DHI offered a good customization schedule, as well as providing the necessary resources. AGT's response was not clear on the schedule and resources.

InfoWorks was not as strong as MOUSE™ in several respects related to the company and product as listed below:

- In terms of the setup of technical support, MOUSE™ is directly supported by DHI, who is both the developer and the vendor. With InfoWorks, however, AGT (the vendor with some technical support) is the primary contact and then Wallingford Software (the developer with some technical support). This setup could be frustrating especially when the support time required is critical. An AGT customer expressed some frustration in this regard.

- MOUSE™ had more sewage modeling users than InfoWorks. MOUSE™ had an established user group. The user group for InfoWorks was limited to only the users of HydroWorks and there were few of these (Seattle Public Utilities was the only user identified).
- InfoWorks lacked extensive testing and, at the time of evaluation, RDII components of the model were new and not yet well tested. MOUSE™ provided a more complete history of testing, especially the RDII Module (formerly MOUSE™ NAM that had been around for some time). This was an important consideration.
- The documentation of InfoWorks was very limited with respect to the RDII routines. With all the rigorous effort during selection process, it was not clear how the RDII model in InfoWorks was set up and how equations and parameters were defined. On the other hand, MOUSE™ offered good documentation about their RDII model and how each component was defined.

While both models were ranked high in all aspects of technical capabilities, MOUSE™ was more highly rated for the company and product information.

A1.3.5 Demonstration

MOUSE™ ranked higher for the demonstration. The selection team compared the two products with respect to convenience of calibration, output handling and graphing, capability of plotting I/I components, graphic comparison between modeled and meter data, computation speed of the hydraulic engine, calibration results of the hydrologic basin, choices of I/I model, and documentation of the parameters for I/I calibration.

The calibration using MOUSE™ of the hydrologic basin was better because it demonstrated a more reliable calibration and can be extended to periods beyond the calibration period. On the other hand, InfoWorks appeared to be calibrated reasonably well in comparison to meter data for the period given, but it failed to match the flow during period beyond the calibration period. The calibration results from MOUSE™ showed more credibility in predicting storms based on rainfall data once a good calibration was achieved.

MOUSE™ has better capabilities in output and plotting I/I components, which is very useful in doing calibrations. Even though the system units in InfoWorks were changed to English units, the simulation results exported from InfoWorks were still in metric.

In terms of computation speed, MOUSE™ was faster in simulating the 7-node sample network. It took 73 seconds for MOUSE™ to finish a 2-month simulation and 114 seconds for InfoWorks to finish the same run. However, according to the network setup in MOUSE™, there were 35 computational segments. The default number of segments was about 75 for the sample network. The demonstration appeared to be set up with fewer segments in order to gain more computation speed. There were approximately 195 segments in InfoWorks. Considering the setup of the computational segments, it appeared that InfoWorks was about twice as fast as MOUSE™ in terms of hydraulic computation per computational segment. This was consistent with Seattle Public Utility's model comparison. However, the number of segments required reflects the stability of the computation. The default settings for the number of segments in each model (195 for InfoWorks, 75 for MOUSE™) should be a reflection of the stability of the hydraulic computation scheme. Therefore, it was concluded that for model steps of equivalent stability, the two models were close in speed.

The two packages were ranked on technical components, company and product, cost, and the demonstration. The final ranking was based on comparison of items listed in the original proposal in addition to the information collected during the demonstration.