BIM for Better Urban Stormwater Design and Management: Perspectives through a Multidisciplinary, International Lens

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Abstract: This paper explores the integration of stormwater simulations within the BIM site engineering process, using Swiss standards as a reference for test projects in Bangkok and Zürich. The study investigates whether combining BIM and hydrology/hydraulic software enhances workflow and provides more flexible decision support tools for landscape architecture projects. The methodology involves creating 2D CAD drawings and models in Civil 3D, followed by simulations using two different physically-based hydrologic/hydraulic models with the Rational Method option. Results show that the standard Civil 3D pipe networks require additional manhole sizes for smaller projects to reduce concrete use. The Swiss standard SN 592 000 serves as a valuable reference for projects globally, including regions with tropical climates. The research emphasizes the need for improved software tools that incorporate a wider range of pipe and manhole sizes with sustainable material options, as well as the value of applying more rigorous, conceptual hydrologic/hydraulic modeling approaches for complex design considerations, such as NbS/bioretention, pond/wetland storage, and water quality.

Keywords: BIM, stormwater simulation, grading, site engineering

1 Introduction

The correct sizing of surface and subsurface structures belongs to the overall grading process in Landscape Architecture under Swiss design workflow, and to the design engineer of record for many other countries, including Singapore, Australia, and the U.S. 'It is difficult to separate the act of grading from the act of accommodating and controlling storm water runoff, since one directly affects the other' (STORM 2009, 24). Subsurface structures consist of inlets (catch basins, manholes, channel drains) and pipes. Although globally there has been an increasing focus on Nature-based Solution (NbS) design for management of stormwater runoff in urban areas, often there is no space to divert rainwater into swales next to pavement areas, particularly when retrofitting older, more densely developed sites. The water has to flow to inlets, where pipes then lead it to receiving features, including swales, ponds, constructed/natural wetlands, or bioretention cells.

From the Landscape Architecture lens, grading is the first step for on-site water percolation. 'Managing stormwater is one of the important purposes of landscape grading', (SHARKY 2015, 233). When subsurface structures are necessary as part of the grading process, in Switzerland, standard SN 592 000 provides all necessary information on a site design scale. It is well tested in Architecture, Civil Engineering, and Landscape Architecture projects, easy to use and available in German, French and Italian. SN 592 000: 2024 will replace the old standard from 2012. One reason for the update is to better address the issue of climate change.

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Furthermore, design event rainfall data in the new standard refers to local situations which differ between areas with low and high rainfalls. This leads to different sizing of subsurface structures depending on the amount of water and in consideration of the expected more frequent, higher intensity events associated with climate change.

2 Background – BIM Site Engineering and Stormwater Simulations

2.1 Problem

Thailand, as is the case with a number of other Southeast Asian nations, takes a less formal approach to stormwater runoff design criteria. Yet, both Thailand and Switzerland rely on a form of the Rational Method, which has been employed in engineering since 1850 (TODINI 2011), to determine appropriate subsurface structure sizes. The Swiss standard SN 592000: 2024, uses the Rational Method:

$$Q = A \cdot r \cdot C \qquad [1]$$

where Q is the peak runoff (l/s), A is the site area (m^2), r is the rainfall intensity / yield factor ($l/s*m^2$) and C is the runoff coefficient (dimensionless). The tables for catch basins and pipes are based on hydraulic calculations (Stokes, Prandtl-Colebrook). Longtime maintenance criteria like shaft access define the figures in the manhole table.

This background leads us to two questions: Does combining BIM and hydrology/hydraulic software enhance workflow and provide more flexible decision support for landscape architecture projects? Optimal sizing is important since a system that is undersized will result in too frequent flood damage and potential loss of life, while a system that is oversized produces unnecessary amounts of CO2 in association with cement production (MOORE & HUNT 2013, BUTTERS et al. 2024). A conscious and reduced usage of concrete must be part of a sustainable and resilient site design. The Swiss standard SN 592000:2024 will be applied as a reference. Second, given the advances in dynamic stormwater modeling and digitalization of the landscape architecture design process (e. g. BIM) over the past decade (e. g. PETSCHEK et al. 2024) can we apply the process in Landscape Architecture projects, which are typically smaller compared to civil engineering projects?

2.2 Goal

The goal is to integrate stormwater simulations in the BIM site engineering process. The established and updated Swiss standards serve as reference in a test project applied to both Bangkok and Zürich case studies. A CDE Common Data Environment was used as the platform for all models. The workflow is summarized in Figure 1. We used the design capabilities of Autodesk Civil 3D CAD/BIM to develop a basic system of 3 subcatchments for surface hydrology and runoff that were connected to a simple drainage network consisting of catchbasins and circular pipes. In this effort, we trialed two different hydrologic/hydraulic software packages, Autodesk InfoDrainage and PCSWMM, both of which are commonly used for stormwater studies (DHARMASENA et al. 2021, CHITWATKULSIRI et al. 2022, IRVINE et al. 2023, ABDULJALEEL et al. 2023, LANCETA GUITIERREZ et al. 2024). Both models can provide runoff estimates using the Rational Method or more rigorous non-linear reservoir-type modeling, although given the prescribed approach under Swiss standard SN 592000:2024, in this paper we solely employ the Rational Method. While two specific hydrologic/hydraulic models were selected for the case applications, the intent is not to undertake a detailed evaluation of each model's performance, but rather to illustrate that BIM can be directly incorporated into the design workflow using a variety of software options.

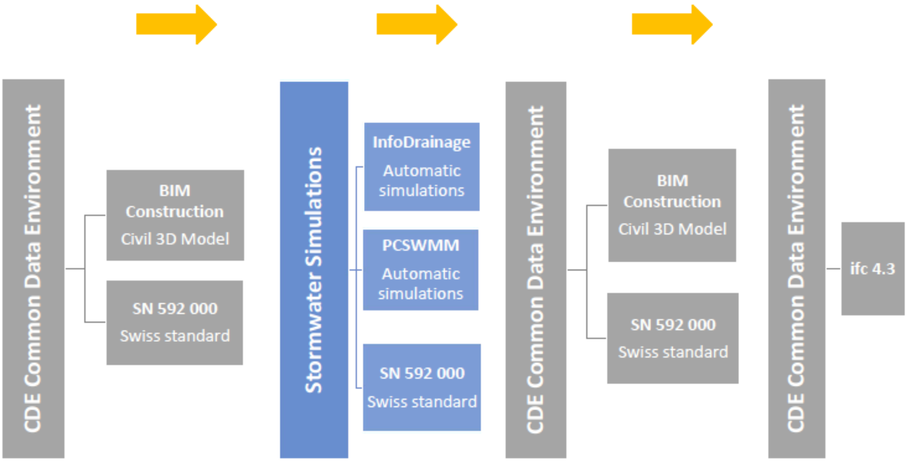

Fig. 1: Project workflow: BIM Site Engineering – Stormwater Simulations – BIM Site Engineering – ifc 4.3 (BIM Collaboration)

2.3 Approach

We have chosen to explore the hydrologic, hydraulic, and design issues of integrating stormwater runoff models and BIM software using a simple test site approach. This approach allows us to clearly explore the workflow, procedures, and challenges without the complexities introduced by a full project. The test site and its size, terrain, pavement material, etc. were chosen to represent a typical Landscape Architecture project in Bangkok and Zürich (Figure 2). The elevation change on site is less than one meter. In the center of the overall site three pavement areas are located, catchment area A1 with 100 m^2 / asphalt, catchment area A2 with 150 m^2 / concrete pavement, and catchment area A3 with 150 m^2 / compacted gravel pavement. For both InfoDrainage and PCSWMM it was assumed that subcatchments A1 (asphalt) and A2 (concrete) were 100% impervious, while subcatchment A3 was assigned a 60% impervious value to account for infiltration associated with the gravel surface. All three areas have the same grading: a funneled slope with a single low point at the center. The inlets are located at the low point. The pipe layout is a standard herringbone drainage system.

A dynamic wave approach was used to route the flow through the drainage system in both InfoDrainage and PCSWMM. The dynamic wave approach solves the St. Venant equations which are based on the laws of conservation of mass and momentum to describe flow when velocity and depth change over time and longitudinal space (JAMES et al. 2010).

To drive the runoff estimates, IDF curves developed for local conditions were used, considering different durations and return periods. For the Zürich model, the Intensity-Duration-Frequency (IDF) curve data were sourced from the Federal Office of Meteorology and Climatology (MeteoSwiss) via their standardized resources (https://www.meteoswiss.admin.ch/services-and publications/applications/standard-period.html). Specifically, we incorporated a 5-minute rain for a 10-year event (0.045 $l/s*m^2$) and 10-minute rain for a 10-year event (0.032 $l/s*m^2$). This setup ensures accurate representation of short-duration, high-intensity rainfall, which is critical for drainage system analysis. For the Bangkok model IDF curve data with a 5-minute rain for a 10-year event (0.056 $l/s*m^2$) and 10-minute rain for a 10-year event (0.047 $l/s*m^2$) were obtained from the Thai Meteorological Department (TMD).

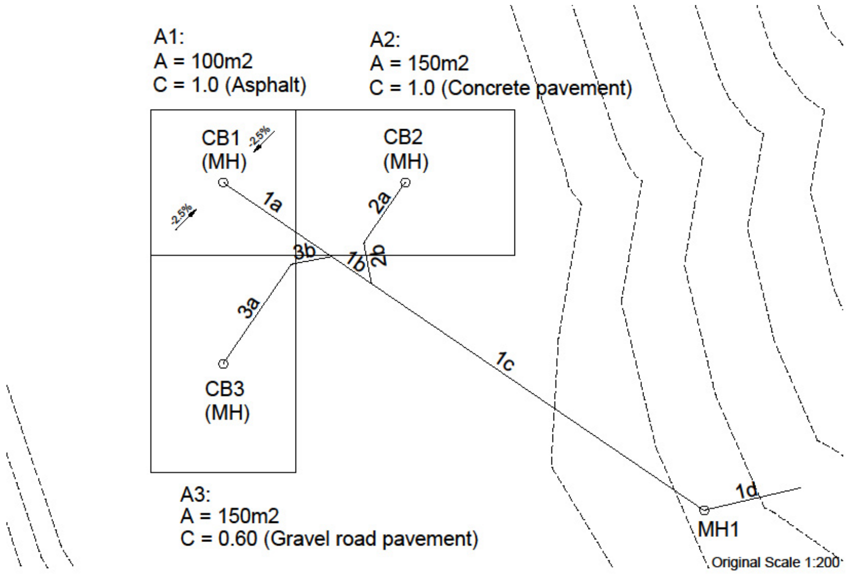

Fig. 2: One design scenario for Zürich and Bangkok

2.3.1 Zürich Test Site

ZRH Model-1 Swiss Standard 2D

In order to discuss the stormwater simulations for the Zürich test site a reference subsurface structure model based on SN 592 000 was developed. It is a 2D CAD drawing. The calculations (Rational Method) initially were done manually. The Rational Method calculation uses a rainfall intensity for a 10-minute duration with a 10-year return period (0.032 $l/s*m^2$). The Swiss standard recommends the value for regular parking spaces, pathways, etc. Catch basins, manholes, and pipes were sized based on SN 592 000 tables. The tables for catch basin and pipes use hydraulic calculations, while the inspection manhole table uses sizes based on maintenance requirements (SN 592 000, P. 116-119).

ZRH Model-2 C3D-ID-C3D

The model uses the standard out-of-the-box Civil 3D (C3D) and the C3D DACH (Germany/Austria/Switzerland) country kit with the DACH metric pipe / structure catalog and the rainwater parts list. The rainwater parts list includes part families with the part sizes inside that family. The DACH country kit is available when installing C3D. In Switzerland, catch basins are used as inlets. Catch basins are basically manholes with sump areas. The sump has a depth of one meter and has the tasks of collecting sediments which otherwise would end up in the percolation area (swale, pond or bioretention cell) at the end of the pipe system and trapping odors. Catch basins are cleaned/pumped out every half a year.

After the model was built in C3D, it was imported directly in the case of InfoDrainage. As InfoDrainage models cannot correctly calculate storage with sumps, the C3D model uses manholes without sumps. In the DACH country kit fewer manhole sizes are available and the sizes are not identical to the SN 592 000 table. The pipe sizes in the DACH country kit are identical to the SN 592 000 table but use PVC as pipe material. PP (Polypropylene) pipes exist but have less pipe diameter sizes. PE (Polyethylene) pipes do not exist. Both PE and PP can be recycled, while PVC has to be declared as hazardous waste in Switzerland. As the pipes will be calculated in InfoDrainage, an initial diameter of 100 mm was used in the C3D model for all pipes. For the hydraulic calculation in InfoDrainage the manhole and pipe libraries need to have the same sizes as in C3D.

InfoDrainage simulates peak runoff which is converted into an inflow hydrograph using the following formula (https://help.autodesk.com/view/INFDS/ENU/?guid=GUID-C4C91F42-1E26-4F8D-9DF1-879819F150D4):

$$Q = C_f \cdot A \cdot r \cdot C \qquad [2]$$

where:

Q is flow, C_f is the runoff coefficient adjustment factor that accounts for reduction of infiltration and other losses during high intensity storms; A is subcatchment area; r is rainfall intensity; and C is the runoff coefficient.

A hydrograph is produced using a recession limb multiplier, with an additional consideration of the duration of peak, or rainfall averaging period, which must be greater than or equal to the time of concentration. Should the duration of peak be the same as the time of concentration then the resulting hydrograph will be triangular in shape, while if the duration of peak is greater than the time of concentration, the resulting hydrograph will be trapezoidal in shape. The time of concentration (T_c) refers to the time it takes for runoff to travel from the most hydraulically distant point in a watershed to its outlet, with various factors such as topography, soil properties, and land use influencing its value. Urbanization typically decreases T_c by increasing flow velocity over smoother (impervious) surfaces (such as roadways and parking lots), efficient channels, and stormwater systems.

After the calculation in InfoDrainage the model was sent back to a copy of the original C3D model. Manholes and pipe sizes are automatically adapted to the InfoDrainage simulation. The manholes were manually changed to catch basins with sumps. The ACC Autodesk Construction Cloud is used as a CDE. It has advantages like internal and external file sharing, review workflow, version control, etc. (HOLLAND et al. 2024).

The model was exported with the Civil 3D IFC 4.3 Extension 2025 for BIM collaboration. The recently published BIM-Fachmodell Landschaft und Freianlage information (BRÜCKNER & PIETSCH 2024) was applied.

ZRH Model-2 PCSWMM

To prepare the ZRH Model-2 for PCSWMM, the drainage network from Civil 3D was exported as both DXF and LandXML files, ensuring that pipe connections, invert elevations, and rim elevations were fully specified. PCSWMM requires input files that define nodes, links, and subcatchments, which can be manually created or converted using compatible software. In PCSWMM, the data were imported by opening the LandXML file twice, once via the Open File panel and again through the LandXML Import Panel and then the DXF file was imported for geometric data.

The imported data were reviewed to resolve any discrepancies, such as incomplete attributes or coordinate system mismatches, ensuring alignment with the intended drainage design. PCSWMM requires additional data input for model functionality, presenting challenges due to differences in data formats between Civil 3D and PCSWMM which necessitates manual adjustments and data entry during integration. This situation underscores the potential benefits of adopting global standards, such as the Industry Foundation Classes (IFC) format used in BIM workflows, which facilitate interoperability between platforms like Civil 3D and Revit (GERBINO et al. 2021, LAAALSO & KIVINIEMI 2012). Implementing similar standards for stormwater modeling could bridge existing gaps and streamline integration, minimizing discrepancies between BIM and hydrological models while promoting efficiency and accuracy in urban infrastructure design.

PCSWMM uses a modified version of the Rational Method in which a simple hydrograph is generated. In simulating this hydrograph, the runoff is assumed to increase from zero to the value computed by the rational formula within a period defined by T_c. The same runoff rate continues for a user defined steady period and drops to zero within the T_c duration. The choice of steady duration does not affect the time of concentration or peak flow calculations, it only affects the duration that the peak flow rate is sustained (in other words, the total runoff volume changes but not the peak flow). The time of concentration for each subcatchment is based on the flow paths within the subcatchment. PCSWMM provides the option of using the Kirpich or Kerby methods to estimate T_c, where the Kirpich method is best suited for small, steep watersheds and emphasizes flow length and slope, while the Kerby method is ideal for flatter, rural areas and considers surface roughness and overland flow (GARCIA 2015). The T_c derived from these methods is then used to calculate the critical rainfall intensity from IDF curves, which, in turn, is used in the rational formula [eqn. 1] to compute peak discharge. We note, however, that to maintain a closer correspondence in modeling approach between the InfoDrainage and PCSWMM modified Rational Method estimates, we did not employ these T_c estimate approaches, but rather used a minimum T_c value of 5 minutes that often is set for urbanized areas, even if the calculations yield a shorter T_c.

2.3.2 Bangkok Test Site

BKK Model-1 Swiss Standard 2D

The BKK Model-1 Swiss Standard 2D CAD drawing, adapted from the ZRH Model-1, integrates Bangkok-specific rainfall intensity (0.047 l/s·m² for a 10-minute/10-year event) and a reference subsurface structure model based on SN 592 000 to simulate stormwater management (SN 592 000, P. 116-119). As per the Zürich model approach, the Rational Method initially was calculated manually to estimate runoff, incorporating IDF curve data from the TMD. SN 592 000 tables informed the sizing of catch basins, pipes (via hydraulic calculations), and inspection manholes (based on maintenance requirements).

BKK Model-1 Thai Standard 2D

In Thailand, the design of drainage pipes complies with national standards established to promote effective water management and mitigate the risks associated with flooding. Essential design considerations encompass the pipe's capacity to accommodate peak flow rates during periods of intense rainfall, which is assessed utilizing IDF curves specific to the region. The materials employed for the pipes must fulfill criteria for durability and corrosion resistance, often utilizing reinforced concrete, PVC, or HDPE, contingent upon their respective applications. Furthermore, the grading and alignment are designed to attain self-cleansing velocities, thereby minimizing sediment accumulation (DEPARTMENT OF PUBLIC WORKS 2020).

BKK Model-2 C3D-ID-C3D

The model uses the standard Civil 3D and no country kit, with the out-of-the-box metric pipe catalog, the generic drainage with pipe connections metric structure catalog, and the storm sewer parts list. This list includes part families with part sizes inside that family. After the model was built in C3D, it was sent to InfoDrainage for simulations that followed the same basic procedure as the Zürich model. In comparison with the DACH country kit, fewer manhole sizes are available and the sizes are similar to the SN 592 000 table, with only the125 mm pipe missing. The only pipe material available is concrete. As the pipes will be calculated in InfoDrainage, a diameter of 100 mm was used in the model for all pipes. For the hydraulic calculation in InfoDrainage manhole and pipe libraries need to have the same sizes as in C3D. After the calculation in InfoDrainage the same export process as in the ZRH Model-2 C3D-ID-C3D was applied.

BKK Model-2 PCSWMM

The BKK Model-2 for PCSWMM incorporated the same workflow as was applied for the Zürich model, integrating drainage network data exported from Civil 3D in DXF and LandXML formats. Key assumptions, such as setting the time of concentration (Tc) to a minimum of 5 minutes, were applied uniformly across both InfoDrainage and PCSWMM.

3 Results and Discussion

Zürich Model

The comparison of results in Tables 1, 2, and 3 reveals differences for inflows, manhole sizes, pipe diameters, and flow rate estimates among the Zürich model configurations. In terms of catchment inflows (Table 1), the modified Rational PCSWMM consistently predicts higher values than SN 592 000, although is similar to the modified Rational C3D-ID-C3D. The difference between the modified Rational estimates and SN 592 000 occurs because of a more detailed consideration of time of concentration under the modified simulation approach.

Table 1: Zürich model with catchment areas Q in l/s

Catchment	SN 592 000	C3D-ID-C3D	PCSWMM
Catchment1	3.0	4.0	4.6
Catchment2	4.5	6.1	6.8
Catchment3	2.7	3.4	4.1

In Table 2, manhole diameters in the SN 592 000 model show uniformity, with catch basins (CB1, CB2, CB3) consistently sized at 0.6 m and the manhole (MH1) at 0.8 m. The C3D-ID-C3D model adopts slightly larger diameters (because 0.6 m was not a provided option in InfoDrainage), with catch basins at 0.75 m and the manhole at 1.0 m, aligning with its

0.75 m application manual panel specifications. PCSWMM retains the smaller diameters of the SN 592 000 model.

Table 2: Zürich model design input with manhole (catch basin, CB) diameter in meters

Catch Basin	SN 592 000	C3D-ID-C3D	PCSWMM
CB1	0.6	0.75	0.6
CB2	0.6	0.75	0.6
CB3	0.6	0.75	0.6
MH1	0.8	1.0	0.8

Pipe diameter design (Table 3) also varies between the models. SN 592 000 generally uses smaller diameters (100-150 mm for most segments), whereas C3D-ID-C3D increases sizes moderately (up to 250 mm) to enhance hydraulic capacity. Modified Rational PCSWMM suggests larger diameters, which is consistent with the higher Q-value per pipe segment predictions, ensuring sufficient flow capacity and also to avoid conditions of surcharging, as discussed below. The higher Q-values per pipe segment are related to the greater surface runoff generated by the modified Rational Methods and the explicit pipe routing functions in InfoDrainage and PCSWMM.

Table 3: Zürich model design output for pipe diameter and Q-value per pipe segment

Name	Design Diameter (mm)			Design Q-value (l/s)		
Pipe Segment	**SN 592000**	**C3D-ID-C3D**	**PCSWMM***	**SN 592000**	**C3D-ID-C3D**	**PCSWMM**
1a	100	100	200 (155)	3	3.9	4.6
1b	125	150	200 (160)	5.7	6.9	8.7
1c	150	250	225 (225)	10.2	12.0	15.5
1d	150	250	225 (225)	10.2	11.1	15.5
2a	100	125	150 (135)	4.5	5.9	6.8
2b	100	125	150 (135)	4.5	5.8	6.8
3a	100	150	150 (140)	2.7	3.3	4.1
3b	100	150	200 (160)	2.7	3.2	4.1

* For PCSWMM output design pipe diameters, values in brackets represent the initial estimates optimized to prevent surcharging. Since these optimized diameters do not correspond to standard production sizes, they were adjusted upward to align with standard production diameters. The diameters (left) indicate the standard production diameters.

When using the standard method outlined by SN 592 000 within PCSWMM, the initial model experienced pipe surcharging, indicating the need for redesigning to prevent overloading at pipe connections. Figure 1 illustrates this process, comparing the initial pipe diameters from the SN 592 000 that produced surcharging conditions to the optimized design where surcharging is mitigated.

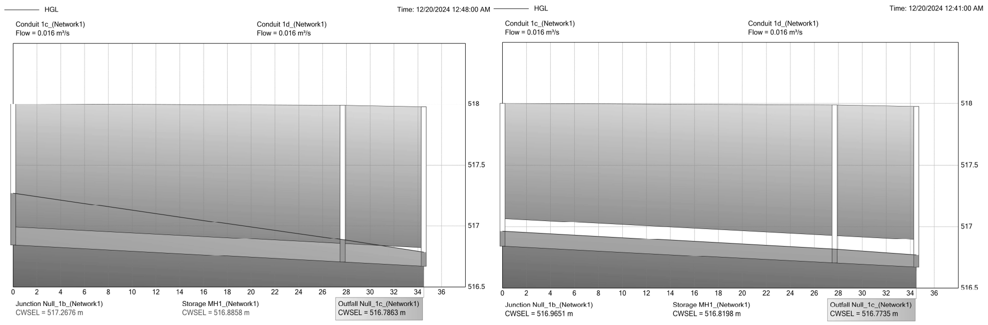

Fig. 3: Surcharging conditions produced under initial pipe diameter estimates in PCSWMM (left) and surcharging eliminated after pipe sizing was increased (right)

In general, the modeling process was entirely seamless for the InfoDrainage model, in part because it is within the Autodesk software platform that also includes Civil 3D. Additional steps for importing Civil 3D projects into PCSWMM and exporting back to Civil 3D were required, which increases workflow time, but the tasks were not onerous. Interestingly, the InfoDrainage Network Design Criteria, Design Option used the criteria "Minimize Excavation" and therefore the model used larger pipe diameters. In case the criteria Minimize Pipe Diameter is used, the minimum slope (0.5%) has to be adapted. This leads to deeper ditches, more soil excavation, and transport from the site with higher carbon emissions.

Bangkok Model

Results for the Bangkok model design exercise are summarized in Tables 4-6. Not surprising, runoff for the Bangkok model (Table 4) is greater than for the Zürich model because of the greater rainfall depth associated with the tropical climate of Bangkok (146.4 mm for Zürich compared to 182.3 mm for Bangkok). The manhole (catch basin) design standards for SN 592 000 were retained as the same for the Zürich model (Table 5), but Thai design standards recommend a larger diameter, while InfoDrainage sizes the inlet structures as much larger since only a 1.2 m manhole is available in the library. PCSWMM accommodated both the SN 592 000 and Thai standard designs for simulation. As per the Zürich model results, the InfoDrainage Network Design Criteria, Design Option used the criteria "Minimize Excavation" and therefore the model used larger pipe diameters (Table 6).

The pipe diameters (Table 6) under the Bangkok model are larger under the Thai standard design as compared to the SN 592 000 recommendation. PCSWMM was run with both the Thai standard design diameter and the SN 592 000 design diameter (including adjustments to avoid surcharging, per the Zürich model). The Q-values per segment were reasonable similar for the SN 592 000 standard, the InfoDrainage C3D-ID-C3D simulation, and the PCSWMM simulation (Table 6). The Thai standard design, however, exhibits a larger Q-value per segment than the other methods. This difference in Q-value per segment is related to the (manual) spreadsheet calculation method employed in Thailand, which considers slightly different parameters than the SN 592 000 approach.

Table 4: Bangkok model with catchment areas Q in l/s

Catchment	SN 592 000	C3D-ID-C3D	PCSWMM
Catchment1	4.7	4.7	5.2
Catchment2	7.05	7.0	7.8
Catchment3	4.23	4.0	4.7

Table 5: Bangkok model design input with manhole (catch basin) diameter in meters

Catch Basin	SN 592 000	Thai Standards	C3D-ID-C3D	PCSWMM (SN 592000)	PCSWMM (Thai Standard)
CB1	0.6	0.8	1.20	0.6	0.8
CB2	0.6	1.0	1.20	0.6	1.0
CB3	0.6	0.8	1.20	0.6	0.8
MH1	0.8	1	1.20	0.8	1

Table 6: Bangkok model design output with pipe diameter and Q-value per pipe segment

Name	Design Diameter (mm)					Design Q-value (l/s)				
Pipe Segment	**SN 592000**	**Thai Standards**	**C3D-ID-C3D**	**PCSWMM (SN 592000)***	**PCSWMM (Thai Standard)**	**SN 592000**	**Thai Standards**	**C3D-ID-C3D**	**PCSWMM (SN 592000)**	**PCSWMM (Thai Standard)**
1a	125	300	125	125 (125)	300	4.7	31.2	4.5	5.2	5.2
1b	150	600	150	140 (150)	600	8.93	198.3	8.0	9.9	9.9
1c	200	1000	250	200 (195)	1000	15.98	774.4	14.4	17.7	17.7
1d	200	1000	250	200 (195)	1000	15.98	774.4	14.5	17.7	17.7
2a	125	600	150	150 (145)	600	7.05	198.3	6.8	7.8	7.8
2b	125	600	150	150 (150)	600	7.05	198.3	6.7	7.8	7.8
3a	125	300	150	125 (125)	300	4.23	31.2	3.8	4.7	4.7
3b	125	300	150	125 (125)	300	4.23	31.2	3.7	4.7	4.7

* For PCSWMM output design pipe diameters, values in brackets represent the initial estimates optimized to prevent surcharging. Since these optimized diameters do not correspond to standard production sizes, they were adjusted upward to align with standard production diameters. The diameters (left) indicate the standard production diameters.

The Rational Method Approach to Design

The Rational Method, historically used for smaller sized drainage system designs, is attractive in its simplicity, but we also must recognize some of its shortcomings. First, the Rational Method only predicts peak discharge while the shape and volume of the runoff hydrograph need to be estimated with other empirical methods (GRIMALDI & PETROSELLI 2015). This can be done in the modified Rational Methods employed by both InfoDrainage and PCSWMM. The critical duration of rainfall is equated to the time of concentration for the catchment, but this assumption may not be appropriate if there is a higher infiltration loss (BAIAMONTE 2020) and certainly catchment shape will influence time of concentration (CHORLEY 1978). The runoff coefficient, C, collectively reflects a number of hydrologically-important variables, including percent imperiousness, soil type and infiltration, surface storage and slope, surface roughness, and rainfall characteristics (e. g. DEL GIUDICE et al. 2012). Finally, it is assumed that sewers flow at constant (pipe-full) velocity throughout time of concentration (WANG &

WANG 2018). Can we do better with more rigorous, conceptual dynamic models? Despite the simplifying assumptions, some researchers have shown that design estimates based on the Rational Method can be remarkably similar to conceptual, dynamic models (e. g. WISNER et al. 1980, SADEGHI et al. 2022) and therefore it is important to understand under which conditions a particular modelling approach may be more appropriate.

Some important areas in which the Rational Method may fall short are with respect to designs requiring consideration of runoff volume, projects that may have more complex hydrologic or hydraulic conditions, and projects that need to consider water quality. For example, with NbS designs, such as bioretention cells, constructed wetlands, and ponds, volume may be equally as important to manage as peak flow. Similarly, for certain types of NbS-oriented pavements, such as porous pavement or paving stones, it may be important to more explicitly consider surface storage, surface roughness, as it affects travel time, and possible infiltration. The traditional Rational Method, such as SN 592 000, calculates only peak flow rather than a full event hydrograph and uses functional relations to route flow through the drainage network; dynamic routing is not done, and surcharging conditions therefore are not immediately identified. These processes can be more explicitly represented in fully dynamic, conceptual models such as InfoDrainage and PCSWMM. Finally, NbS designs can provide a dual benefit of runoff/flood management and improvement of water quality. In the case of water quality, issues such as hydraulic residence time for the individual NbS features must be considered, and this cannot be done with the Rational Method. These more complex modeling situations, particularly related to NbS, need to be considered by Landscape Architects. Importantly, however, we have demonstrated that it is possible to link BIM software and hydrologic/hydraulic models that provide options to either use the simpler modified Rational Method, or more complex dynamic, conceptual approaches, depending on the needs of the project.

4 Conclusion and Outlook

Small projects, typical for Landscape Architecture, can be simulated with hydraulic software, but the standard out-of-the-box Civil 3D Pipe Network with or without county kit needs additional manhole sizes for smaller catchment areas where smaller structures can reduce the amount of concrete used in a project. The following sizes have to be in a structure catalog: 0.6m, 0.7m, 0.8m, 1.0m, 1.25m, 1,5m, 2.0m, 2.5m, 3.0m. The C3D pipe catalog needs pipe material which can be recycled and has to include all size diameters used in regular Landscape Architecture projects: 100mm, 125mm, 150mm, 200mm, 225mm, 250mm, 300mm.

Both manholes and pipes sizes and pipe material can be modelled with the Infrastructure Parts Editor, which is an extension of Civil 3D. In a BIM Landscape Architecture project where stormwater simulation will play an important role, either the Infrastructure Parts Editor needs to be integrated in the software training for the BIM construction team or a C3D consultant, who can set up the necessary catalog, needs to be hired to do the adaptations.

The Swiss standard 592 000 serves as a very good reference for a local BIM project, integrating stormwater simulations. Also, in other parts of the world, like Thailand, the SN 592 000:2024 can be an appropriate reference to calibrate the pipe network catalog for a BIM site engineering project in Landscape Architecture.

The analysis of the Zürich SN 592 000 and PCSWMM Rational Method models highlights key differences in drainage design. PCSWMM predicts higher Q-values by including time of concentration (T_c) and hydraulic routing, offering better surcharging insights and enabling design adjustments for improved system accuracy. While manhole and catch basin diameters are similar across models, PCSWMM recommends larger pipe sizes for better flow capacity and to prevent surcharging. Such routing refinements make dynamic conceptual models more effective managing stormwater and ensuring system resilience, particularly in urban environments with complex drainage challenges, although this must be balanced with increased concrete use and concurrent increases in CO2 emissions.

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