# Summary of Data Gaps and Assumptions in the Hooffs Run Watershed

PREPARED FOR: City of Alexandria

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PREPARED BY: CH2M HILL

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The purpose of this memo is to document the range of assumptions made to fill data gaps and correct anomalies in the GIS data for the Hooffs Run Watershed. All data gaps have been filled in a personal geodatabase (.mdb) referred to as the "model geodatabase." The model geodatabase is a copy of the City's geodatabase, created after the City's geodatabase was populated with survey data collected during Task 3 of the City of Alexandria Storm Sewer Capacity Analysis (CASSCA) project.

## City of Alexandria GIS Data and Data Gaps

The City of Alexandria maintains a geodatabase of the storm drainage network for the City that includes gravity main storm drains and series of junction features (manholes, inlets, catch basins, etc.). The data in this geodatabase will be used to build a hydraulic model of the storm sewer network. This model requires several pieces of data, including rim and invert elevation of pipes and junctions, pipe diameter, shape, roughness, length, and slope. Data required for modeling is stored in attribute tables within the geodatabase; however, there are gaps that need to be filled before the hydraulic model can be built. In order to fill the data gaps, a set of standard assumptions were generated and documented in training materials. These assumptions are provided in detail in this document.

### Sources of Depth Data

Both the pipe and junction features contain depth data in the geodatabase from the City. Because of the uncertainty surrounding the validity of these depth data and methods of collection, the depth data in the geodatabase were compared to depth data collected during a pilot survey of about 90 manholes to assess the accuracy of each.

The comparison revealed that the depth data in the junction features was more reliable, with 85 percent of the surveyed depths falling within ±0.5 feet of the depth data in the geodatabase. By comparison, only about 73 percent of the surveyed depth in the pipe features data fell within the same ±0.5-foot-depth range. Because of the greater confidence in the depth data provided on the junction features, the junction depth data were assumed for the US/DS ends of the pipe even when depth data were available on the pipe feature. This causes a very large percentage of the modeled gravity mains to have an assumed invert, but the assumptions must be reviewed with the understanding that the assumed data are from the junction features. The exception to this assumption is that wherever a drop was indicated by the depth data on the downstream end of a pipe, the depth on the pipe data was used to represent that drop. This exception was only applied where it did not cause a reverse slope in the pipe.

In general, with the understanding of the two sources of depth data, depth data for modeling was pulled from the following sources, in the following order of precedence:

- Survey data
- Depth data from points
- Depth data from lines

- Assumption (extrapolation, interpolation, 6-inch depth to crown for most upstream inlets and nodes)

## Data Gaps and Assumptions on Junctions

The following is a summary of data gaps and assumptions on the junction feature classes in the City of Alexandria's Hooffs Run geodatabase. There are eight types of junctions in the City of Alexandria's storm sewer database. Data required for hydraulic modeling includes rim elevation and invert elevation. Where both rim and depth data were available for junctions, invert was calculated as rim minus depth. If an assumption was made to determine a rim or a depth, this was documented as such and not as an invert assumption, though it does indirectly imply that an assumption was made on the invert. If an invert was computed directly, such as by interpolation between two known inverts, it was documented as an assumption on the invert. In total, 979 (39 percent) structures have at least one assumption made to determine rim or invert.

Table 1 below shows the types of junctions in the Hooffs Run watershed, the count in the original database, the count in the hydraulic model database, and the number of assumption made for the rim, depth, and invert. The model database does not include private or disconnected structures. The table below does not include structures in the pilot subwatershed.[1]

TABLE 1
**Summary of Feature Classes**

| Feature Class | Count of Structures (City Geodatabase) | Count of Structures (Model Database)* | Count of Rim Assumptions | Count of Depth Assumptions | Count of Invert Assumptions | Count of Structures with at Least One Assumption |
|---|---|---|---|---|---|---|
| DCatchBasin | 282 | 266 | 4 | 0 | 12 | 12 |
| DControlDevice | 3 | 0 | 0 | 0 | 0 | 0 |
| DCulvertPoint | 32 | 17 | 17 | 0 | 17 | 17 |
| DInlet | 1,462 | 1,182 | 3 | 395 | 180 | 576 |
| DManhole | 793 | 641 | 3 | 8 | 30 | 38 |
| DNode | 391 | 322 | 322 | 11 | 311 | 322 |
| DPipeIO | 70 | 28 | 10 | 0 | 10 | 14 |
| DStorageBasin | 2 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **3,035** | **2,456** | **359** | **414** | **560** | **979** |
| | | | | | **Percent of Total:** | **40** |

* Does not include private or disconnected structures.

It is important to note that there are no rim or invert data on DNodes (blind connections/ terminal nodes with unknown connectivity) in the GIS. Assumptions were made for 100 percent of the DNode features, which accounts for about 90 percent of the rim assumptions and 56 percent of the invert assumptions. Additionally, a 6-inch depth to crown was assumed for 395 inlets, or 95 percent of the total number depth assumptions. These were all inlets at the most upstream point in a line. The types of assumptions made for each type of data, rim, depth, and invert, are shown in Tables 2, 3, and 4, below.

The City of Alexandria provided CH2M HILL with 2-foot contours and a HEC-RAS model of Cameron Run. The contours were used to create a digital elevation model (DEM) of the city. This elevation model has been used to develop the hydrologic model as well as to fill rim elevation data gaps. The HEC-RAS model contains information on streams in Hooffs Run watershed, including culvert inverts and road deck elevations. The lowest value of the deck/roadway high chord was assumed as the rim elevation of culvert points.

[1] During the effort to model the remainder of Hooffs Run watershed, assumptions made in the pilot subwatershed were not revised.

TABLE 2
**Rim Assumptions**

| Rim Assumptions | Total Count of Assumption | Catch Basin | Culvert Point | Inlet | Manhole | Node | Pipe In/Out |
|---|---|---|---|---|---|---|---|
| Rim from contours | 2 | - | 2 | - | - | - | - |
| Rim from DEM | 333 | 4 | - | 3 | 3 | 321 | 2 |
| Rim from HEC-RAS model | 22 | - | 15 | - | - | 1 | 6 |
| Rim from GIS ELEV + DEPTH | 2 | - | - | - | - | - | 2 |
| **Total** | **359** | **4** | **17** | **3** | **3** | **322** | **10** |

Note: Survey data or GIS ELEV data in PipeIO attribute table assumed to be best available rim elevation in all other cases.

TABLE 3
**Depth Assumptions**

| Depth Assumption | Count of Assumption | Catch Basin | Culvert Point | Inlet | Manhole | Node | Pipe In/Out |
|---|---|---|---|---|---|---|---|
| 6-inch depth to crown | 406 | - | - | 395 | 1 | 10 | - |
| Depth from DS pipe | 4 | - | - | - | 4 | 1 | - |
| Depth from US pipe | 3 | - | - | - | 3 | - | - |
| **Total** | **414** | **0** | **0** | **395** | **8** | **11** | **0** |

TABLE 4
**Invert Assumptions**

| Invert Assumption | Count of Assumption | Catch Basin | Culvert Point | Inlet | Manhole | Node | Pipe In/Out |
|---|---|---|---|---|---|---|---|
| 5-foot depth to invert* | 1 | 1 | - | - | - | - | - |
| Invert from DS pipe | 12 | 7 | - | 1 | 4 | - | - |
| Invert from US pipe | 2 | 1 | - | | 1 | - | - |
| Extrapolated from DS data | 54 | 1 | - | - | 2 | 50 | 1 |
| Extrapolated from US data | 3 | - | - | - | - | - | 3 |
| Invert from GIS ELEV | 3 | - | - | - | - | - | 3 |
| Interpolated invert | 465 | 2 | - | 179 | 23 | 261 | - |
| Invert estimated from contours | 1 | - | - | - | - | - | 1 |
| Invert from HEC-RAS model | 19 | - | 17 | - | - | - | 2 |
| **Total** | **560** | **12** | **17** | **180** | **30** | **311** | **10** |

* In some cases, a standard assumption does not apply, and engineers' judgment must be used.

## Data Gaps and Assumptions on Gravity Mains

The following is a summary of data gaps and assumptions on the DGravityMain feature class in the City of Alexandria's Hooffs Run geodatabase. Data required for hydraulic modeling includes: US/DS rim elevation, US/DS invert elevation, length, shape, roughness, pipe dimensions (diameter/height, width), and slope. Slope (percent) is a calculated value equal to ((US invert – DS invert)/Length)*100, therefore assumptions made on either invert or the length implies an assumption on the slope. In this project, the pipe length is always assumed to be equal to the shape length in GIS per the protocol of the City of Alexandria. Since this is the length used by the City, it is not documented as an assumption for the purposes of the hydraulic modeling.

Table 5 below shows a summary of the number of assumptions made for each required data field. In total, 2453 pipes are being modeled, 2,081 of which have at least one piece of assumed data. Tables 6 through 10 show the type and count of assumptions made for each data type. Please note that because there was greater confidence in the depth data stored in the junction features, an assumption was made for the US/DS invert of the pipes even where depth data were available (assumption was pulled from the junction). Therefore, a majority of the assumptions on the US/DS inverts are locations where data from the original database is still being used. This includes the following assumption types: US invert from US junction, US invert from US pipe, DS invert from DS junction, and DS invert from DS pipe depth.

TABLE 5
**Summary of Assumptions on Gravity Mains**

| | Count of Structures (City Geodatabase) | Count of Structures (Model Geodatabase) | Count of US Invert Assumptions | Count of DS Invert Assumptions | Count of Shape Assumptions | Count of Material Assumptions | Count of Dimension Assumptions | Count of Structures with at Least One Assumption |
|---|---|---|---|---|---|---|---|---|
| DGravityMain | 3,068 | 2,453 | 1,618 | 1,497 | 1 | 0 | 40 | 2,081 |
| | | | | | | | **Percent of Total:** | **85** |

TABLE 6
**US Invert Assumptions**

| US Invert Assumptions | Count of US Invert Assumptions |
|---|---|
| US invert extrapolated from DS data | 54 |
| US invert from US junction | 1,097 |
| US invert from US pipe | 4 |
| US invert interpolated | 462 |
| US invert from US pipe depth | 1 |
| **Total** | **1,618** |

TABLE 7

**DS Invert Assumptions**

| DS Invert Assumptions | Count of DS Invert Assumptions |
|---|---|
| DS invert extrapolated from US data | 1 |
| DS invert from DS junction | 223 |
| DS invert from DS pipe depth* | 502 |
| DS invert interpolated | 771 |
| **Total** | **1,497** |

*358 depths from DS pipe depth to reflect drop.

TABLE 8

**Shape Assumptions**

| Shape Assumptions | Count of Shape Assumptions |
|---|---|
| Assumed circular pipe shape | 1 |
| **Total** | **1** |

TABLE 9

**Dimension Assumptions**

| Dimension Assumptions | Count of Dimension Assumptions |
|---|---|
| Assumed 12-inch diameter | 16 |
| Diameter from DS pipe | 8 |
| Diameter from HEC-RAS | 7 |
| Diameter from US pipe | 9 |
| **Total** | **40** |

## Data Anomalies

After filling all fields required for modeling, the data were reviewed for several anomalies, including reverse slopes, large slopes (slopes over 10 percent), drops, sunken pipes, and daylighting pipes. Several assumptions were made to correct anomalies in the modeled system. Anomalies upstream of the point where flow is to be entered in the hydraulic model were left in the database. Anomalies were handled in the following ways:

- Reverse slopes
  - Leave if both ends of the pipe were surveyed
  - Leave if < -1 percent slope
  - Leave if upstream of the model load point

  - Leave if pipe/node data indicates a reverse slope is correct and engineering judgment indicates reverse slope is possible
  - Review available data on pipe and junction features and apply a data gap assumption to correct if deemed necessary by engineering judgment
- Slopes over 10 percent
  - Leave if both ends of pipe were surveyed
  - Leave if upstream of model load point
  - Leave if pipe/node data indicates a reverse slope is correct and engineering judgment indicates large slope is possible
  - Review available data on pipe and junction features and apply a data gap assumption to correct if deemed necessary by engineering judgment
- Drops
  - Leave if ≤ 5 feet
  - Review available data on pipe and junction features if > 5 feet and apply data gaps assumptions to correct if deemed necessary by engineering judgment
- Sumps
  - Leave if ≤ 1 foot (xpswmm may not allow sumps—if not use standard assumptions and treat as data gaps to correct)
  - Review available data on pipe and junction features if > 1 foot and apply data gaps assumptions to correct if deemed necessary by engineering judgment
- Daylighting
  - Review available data on pipes and nodes for corrections
  - Apply data gaps assumptions to correct to correct if deemed necessary by engineering judgment

Table 11 below summarizes the types and counts of anomalies in the Hooffs Run system.

TABLE 11

**Data Anomalies Identified in Hooffs Run**

| Data Anomalies | Count of Data Anomalies |
|---|---|
| Large drop surveyed by city | 11 |
| Large drop US of model load point | 1 |
| Large slope based on pipe/node data | 110 |
| Large slope surveyed by City | 2 |
| Large slope US of model load point | 474 |
| Reverse slope < -1% | 78 |
| Reverse slope based on pipe/node data | 12 |
| Reverse slope surveyed by City | 11 |
| Reverse slope US of model load point | 51 |
| **Total** | **750** |