Introduction

The information included in this document is intended to illustrate the current number, footage, risk profile and approximate costs (where presently available) of "Point Repair", "Point Lining" or "Full Replacement" standardized structural recommendations associated with MSD main sewers as of July, 2016. These recommendations are produced by MSD's framework of integrated business support tools analyzing main sewers that have been inspected using PACP condition assessment methods. The body of work identified in this Exhibit will comprise a significant portion of the work completed through the Prioritized Wastewater Collection system Improvements CIP allowance.

MSD is committed to the continuous improvement of its Asset Management Processes, and the systems used to support these processes. As more standardized condition assessment work is completed, and as systems and support tools are refined (particularly in regard to the automated application of specialized cost estimating tools), these quantities will inherently change.

Point Renewals – Method of Construction, Cost Estimating, and Decision Making

Within InfoMaster, MSD associates default Renewal Methods with specific PACP defects gathered through the completion of standardized main sewer condition assessments. The initial standardized decision process for a main sewer asset may result in the identification of multiple "Point Repairs" and/or "Point Liners" along a single main sewer asset as a "Draft Rehabilitation Plan." InfoMaster spatially represents the actual location and extent of these draft Point Repairs and Point Liners along the length of the entire sewer segment asset in GIS. By default, InfoMaster applies simple one-to-one cost estimates to these preliminary (Draft) rehabilitation methods using only pipe attributes such as sewer diameter. As part of the process to generate the Final Rehabilitation Plan, the total costs of these individual renewal items are compared to the replacement cost of the full asset to see if it is more reasonable to move forward with "Full Replacement."

The primary problem with this methodology lies in the fact that the actual cost of completing point repairs to pipes of the same diameter and material can vary dramatically based upon the actual location of the repair, and the construction method required to complete the repair.

MSD staff has developed a GIS-based application outside of InfoMaster that evaluates proximity to other physical features, and calculates the approximate depth of the proposed repair using a digital terrain model to identify the most likely Method of Construction associated with each point repair. Using this tool, Methods of Construction for point repairs requiring excavation are automatically categorized as Standard, Enhanced Shoring, Deep Shaft, and Tunnel. This Method of Construction information and estimated unit costs as shown in **Table 1** were used to develop the approximate costs of discrete Point Repairs presently included in the "Final Rehabilitation Plan." As part of it efforts to continually improve the standardized decision making process, MSD is currently developing the framework to apply these Method of Construction costs as well as asset appropriate "project add-ons" such as by-pass pumping and traffic control to improve repair-specific estimates at the Draft Rehab Plan

level. Once these estimates can be applied with an acceptable level of confidence, they will be applied to the individual Draft Rehab features, and used by InfoMaster in the final standardized decision process to determine the most cost-effective means to address structural deficiencies in the "Final Renewal Plan." As automated cost estimating capabilities improve, the final structural recommendation for many assets may change, and the estimated costs of the final structural recommendations will change. It is critical to understand that the costs shown in this exhibit are high level planning estimates, and should not be used as a basis to estimate the cost of individual projects on individual assets.

Table 1 shows the approximate unit prices that have been used in this Exhibit to calculate planning-level costs for Point Repairs with different Construction Methods, and Point Liners.

Point Repair Method	Average Cost /Ft
Standard Point Repairs	$ 600
Enhanced Shoring Point Repairs	$ 1,300
Deep Shaft Point Repairs	$ 3,280
Tunnel Point Repair	$ 1,670
Partial Lining	$ 560

Table 1 – Point Repair Unit Costs

Point Repairs - Excavation

Table 2 provides the total count, length and the planning-level estimated costs of main sewer repairs requiring excavation, as well as the number of main sewer segments affected per overall Risk Category. Please note that an individual sewer segment (asset) may contain multiple Point Repairs.

Point Repairs - Excavation	Total Repair Count	Total Repair Footage	Total Repair Cost	Total Segment Count
Extreme	448	4,144	$ 3,312,788	114
High	1,054	9,576	$ 6,599,141	211
Medium	2,466	17,440	$ 11,633,188	726
Low	3,101	21,044	$ 13,603,192	934
Negligible	6,832	40,064	$ 24,976,448	2,757
Total	13,901	92,268	$ 60,124,757	4,742

Table 2 - Point Repairs Requiring Excavation

Point Repairs – Partial Lining

Table 3 provides the total count, length and planning-level estimated costs of main sewer point repairs to be completed using Partial Lining as well as the number of main sewer segments affected per Risk Category. Please note that an individual sewer segment (asset) may contain multiple Point Liners.

Partial lining provides a trenchless method to renew a portion of pipe at a lower cost than traditional excavation repairs in many locations. The unit price cost estimates for Partial Lining include materials and a conservative "adder" for crew and equipment time. Unit price estimates will be continuously refined as more data is gathered.

Point Repair - Partial Lining	Total Point Liner Count	Total Point LinerFootage	Total Point Liner Cost	Total Segment Count
Extreme	457	4,206	$ 2,516,494	283
High	1,420	12,922	$ 7,388,399	882
Medium	2,158	20,239	$ 11,369,060	1,197
Low	3,262	29,820	$ 16,849,134	2,083
Negligible	4,709	42,040	$ 23,257,196	3,085
Total	12,006	109,226	$ 61,380,284	7,530

Table 1 - Point Repairs Using Point Liners

Totals – Point Renewals

Figure 1 provides a summary of the total estimated cost to complete all Point Renewals within each risk category.

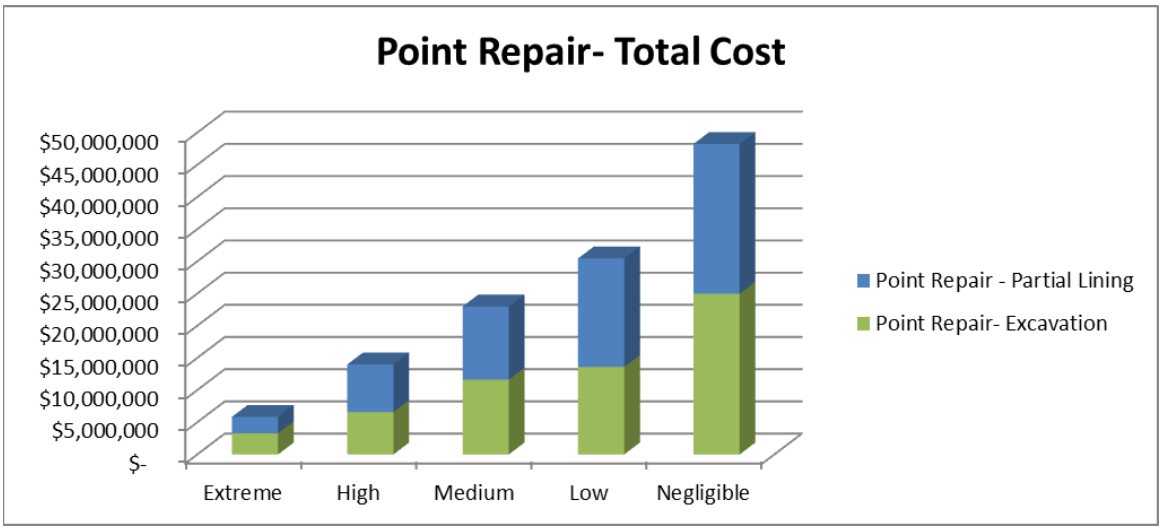

Figure 1- Total Estimated Point Repair Costs per Risk Bin

Full Asset Replacement

Table 4 provides the total count and footage of MSD main sewers recommended for Full Replacement per Risk Category. The method for establishing replacement cost estimates on a per asset basis through

an automated process is currently under development. As a result, planning-level Full Replacement estimated costs are not included at this time. Similar to Point Repairs requiring excavation, it will be necessary to programmatically assign an average asset depth, probable Method of Construction, and asset/location specific "adders" to assign reasonably accurate asset replacement costs.

Full Replacement	Total Replace Count	Total Replace Footage
Extreme	192	32,889
High	573	97,826
Medium	706	118,002
Low	928	155,768
Negligible	430	72,041
Total	2,829	476,526

Table 4 – Full Replacement Count and Footage

Totals – Point Renewals and Full Replacement

Figures 2 and **3** include the count and footage respectively of all MSD main sewer point repairs and replacements per Risk Category. Of the 44,492 main sewer segments that have been inspected using standardized PACP condition assessment 15,101 are in need of point repair or replacement.

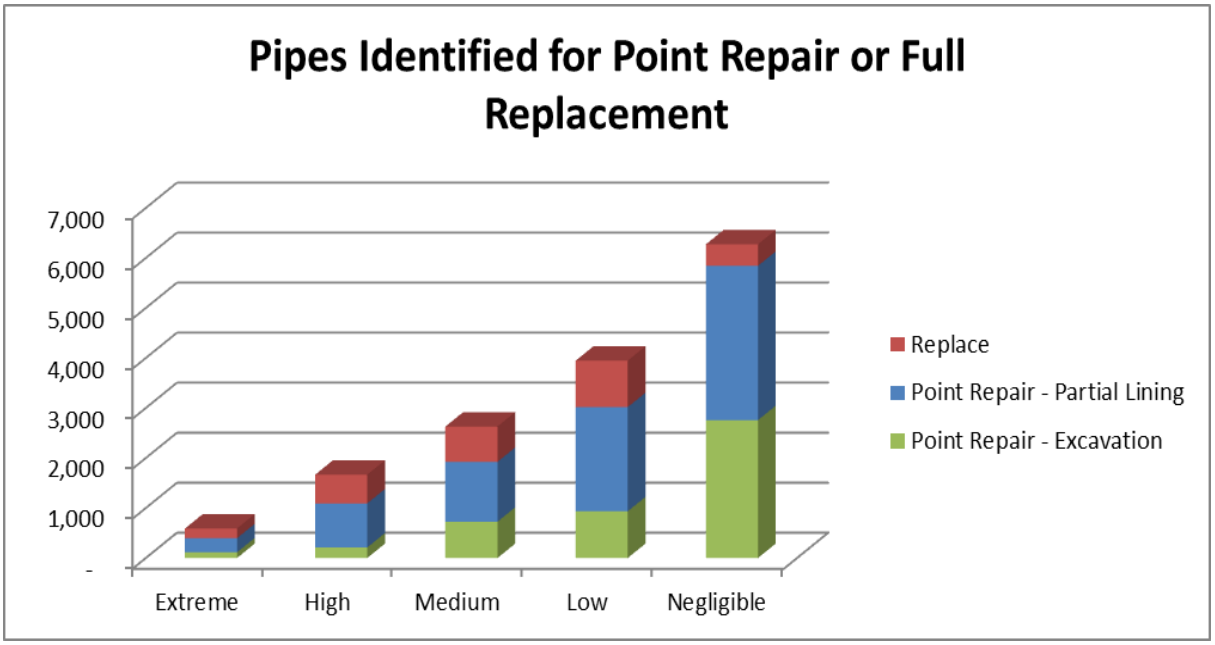

Figure 2

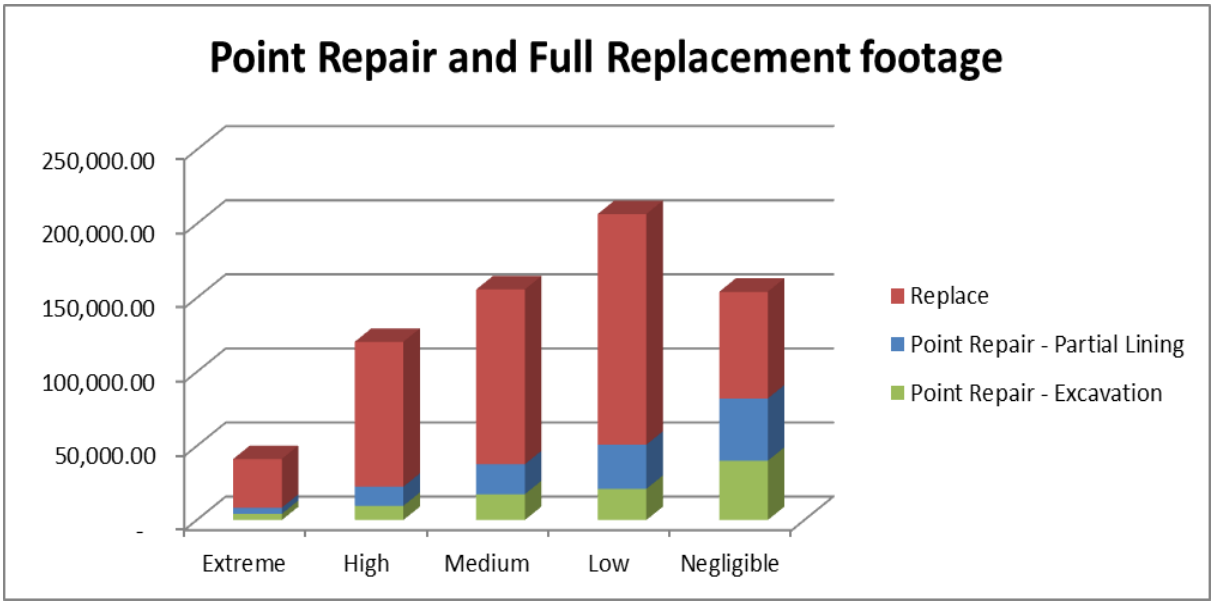
Point Repair and Full Replacement footage
250,000.00
200,000.00
150,000.00
100,000.00
50,000.00
-
Extreme
High
Medium
Low
Negligible
Replace
Point Repair - Partial Lining
Point Repair - Excavation

Figure 3