ENGINEERING SERVICES

ASSET SYSTEMS MANAGEMENT

Asset Management - System Planning ♦ Systems Analysis - Engineering/Modeling and Technical Support

CMOM SCIP Phase 1

TM 1 Cleaning and Inspection Drivers

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Date	April 24, 2012
Project	ESEN000021/ESEN000022, Functional Area PUENDEMS000000BE (Maintenance Support)

Revised By	Date	Reason
A. Lanier, A. Mandilag	4/18/2012	Initial Draft
A. Mandilag	4/19/2012	Incorporated Matt Marine's and Gary Irwin's comments
A. Lanier, A. Mandilag	4/19/2012	Incorporated additional comments from Gail Luthy
A. Mandilag	4/24/2012	Final changes, incorporated images for drivers
A. Mandilag	4/30/2012	Clarified root control for large diameter pipes; increased cost for large pipe condition inspections

Introduction

This TM was written under the CMOM SCIP MODELS PHASE 1 Project. The team has been asked by Gary Irwin to develop a tool that can be used to help manage the Maintenance Program's inspection and cleaning activities and the associated budgeting for those activities. The development of the model will assist the bureau in the development of a "needs-based" budget that incorporates business risk and priority into the cleaning and inspection programs. The results will also help meet DEQ permit reporting requirements due at the end of the year. This is phase 1 of a multi-year project.

This TM describes the drivers that trigger either a cleaning or inspection activity. Each driver is described in terms of Hansen Work Order Activity Code, frequency, cost, and source of information. The first meeting was held on April 10, 2012, with Gail Luthy, Matt Marine (PDOTMO-Cleaning), and John McGregor (Pollution Prevention-FOG) to discuss the process currently used to determine when a pipe is inspected or cleaned, and what variables will cause a frequency to be modified. The Root Program was also discussed. A follow-on meeting was held on April 17, 2012 to review the final list of drivers and the process diagram. The results from these meetings are summarized in this document, and will be

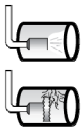
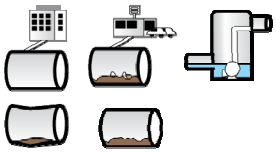
considered the basis for the Phase 1 model builds *[Note: at the end of Sprint One, Gary may request changes to these drivers. If so, amendments will be issued and the team will know as soon as possible].*

Drivers

Current Drivers

Each pipe will have multiple drivers associated with it, and the drivers will be categorized as inspection, cleaning, and root management. However, one driver per category is controlling for each pipe, and that driver is the one with the shortest frequency. See Table 1 for a list of the drivers by O&M Activity, the associated Hansen work order activity code, frequency of activity, cost, and source for information. Drivers that are grayed are considered unpredictable with the model, and therefore will not be used in determining controlling drivers for assets. It is also assumed that any of the frequencies that are considered variable will be maintained constant throughout two entire PM cycles when the model is run.

Table 1 Drivers Associated with BES Operations and Maintenance

O&M ACTIVITY	Drivers (Hansen Work Order Activity Code)	Frequency	Cost (Unit Cost/LF)	Source of Info
Inspection 	PM (*TVSEWS)* 	12 years	$0.80 $2.00 (>36 in. dia)	Hansen
	Root Control (*SPSWTV)* 	3 times treatment cycle: < 16 in. H = 6 yrs, M = 9 yrs >= 16 in. H = 9 yrs, M = 12 yrs	$1.25 $2.50 (>36 in. dia)	Hansen
	Condition (*SPSWTV*) 	Risk based – risk of not inspecting greater than cost of special sewer TV	$1.25 $2.50 (>36 in. dia)	Rehab model
	Grease (*SPSWTV)*	Experience-based; re-evaluate frequency after inspection	$1.25	Accelerated Areas List
	Post Repair (*REPTV)*	As needed	$1.25	
	SSO (*SPSWTV)*	Event-driven	$1.25	TRACKIT, TRACS
Cleaning 	PM *(SEWCLN)* 	6 years	$0.85	Hansen
	Accelerated Areas (*SPCLN)* 	Variable – Based on experience, anywhere from 3 mo to 5 yr; includes Sags, and Structural	$1.73	Accelerated Areas List
	Tractive Forces *(SPCLN)*[1] 	Variable	$1.73 $TBD (> 24 in. dia)	Tractive Forces Model (to be built)
	Post Repair (*REPCLN*) (for CCTV)	As needed	$1.73	Hansen

O&M ACTIVITY	Drivers (Hansen Work Order Activity Code)	Frequency	Cost (Unit Cost/LF)	Source of Info
	SSO (*SPCLN)*	Event-driven	$1.73	TRACKIT, TRACS
Root Management 	Root control (*RTCHEM)* 	Root Priority H and pipe dia <16in = 2 years Root Priority M and pipe dia <16in = 3 years Root Priority H and pipe dia >= 16in = 3 years Root Priority M and pipe dia >= 16in = 4 years	$1.20 for <16-in dia $2.93 for 16-in dia and larger	Hansen
	Post Root Treatment (*SPCLN)*	As needed (typically do not re-TV)	$1.73	Hansen
	Root Control/Grease[2] (*SEWSAW)*	As needed (for both roots and grease; although Matt seldom uses this code for grease)	$1.73	Hansen

[1]**Tractive Forces**: The sanitary and combined collection system will be analyzed for tractive forces to determine which pipes are more likely to drop sediment. Maintenance Engineering will work with ASM to partition the pipes according to this analysis into different degrees of cleaning, and Maintenance Engineering will decide on the frequencies that will be needed to address cleaning for each partition.

[2]**Grease Scores in Hansen**: These are currently not vetted and should not be used.

Process

The process diagram shows how the different drivers, activities, and lists prepared by Gail (Maintenance Engineer) and Matt (BOM) are related to each other. Depending on the driver and activities occurring, cascades of subsequent drivers and activities can be triggered; this leads to the conclusion that there are not two models to be developed (or even three when Gail indicated that Root Management needed to be separated from Cleaning), but only one with three different types of activities being spawned.

CMOM SCIP Phase 1 – Process – Sanitary and Combined Pipes

Inspection

List provided by BES/WG-ME to PBOT/MO-ES

BES/WG-ME prepares basin Inspection list

PBOT/MO-ES requests list when supervisors are starting to run low on work, usually giving a couple months for preparation

PM Inspection Due (for structural + operational defects)

Remaining Useful Life, Risk-based Inspection

Wide Areas of New or Rehab Pipe

See Roots? — N / Y

Check Roots

Check Sediment

Conduct Inspection

Check Grease

See Grease? — N / Y

Check Sag/Structural Design Defect

Root Management

Wait for next inspection or cleaning

Start

Permanently Place Asset in Root Program

Skip one treatment only (reduces cost yet preserves warranty when next treatment occurs)

H, M

Root Priority — N

Root Treatment Necessary? — Y

L, V, R, No Budget

No Root Treatment Necessary

Conduct Root Treatment

Cleaning

BES/WG-ME prepares basin mid-inspection cycle cleanings

PBOT/MO-ES combines BES/WG-ME's inspection and cleaning lists, and list of any new drivers; PBOT/MO-ES creates asset groups in Hansen, PBOT/MO-ES creates group project, PBOT/MO-ES creates hand delineations

PM Cleaning

Post Release (SSO)

Post Repair

Post Root Treatment (low priority)

Work Orders prepared by PBOT/MO-ES , with maps by subbasins

Usually for PBOT/MO-ES , sometimes to contractor via BES/WG-ME

Monthly Review

Conduct Cleaning

Accelerated Cleaning List

On accelerated cleaning list? — N / Y

On inspection list? — Y / N

Accelerated Cleaning

High-risk Groupings of Restaurants, Apartments

Requires accelerated cleaning scheduled? — N / Y

Conduct inspection to determine need for placement on Accelerated List

Visually, does grease affect operation? — N / Y

Sediment/ Debris

Tractive Force Model

Pump Stations in High Grease Areas

Sag or Structural Design Defect

Constraint
Assets that make the Root Control Program do not leave until Repair, Rehab, Reconstruction, or Abandonment

Constraint
Frequent pipe cleanings detriorate poor condition pipe

Legend

PBOT/MO-ES: Bureau of Transportation, Maintenance & Operations – Environment Services
BES/WG-ME: Bureau of Environmental Services, Wastewater Group – Maintenance Engineering

Predictable Drivers | Unpredictable Drivers | Documents | Activity | Decisions | Constraints

ASSET SYSTEMS MANAGEMENT
System Planning • Systems Analysis

Outstanding Issues

Post-repair CIP Rehab Inspection Data – neither Matt nor Gail receive this "acceptance inspection" data, and therefore this information is not available to determine that a pipe with an inspection that resulted in a rehabilitation has any follow-up inspection records to indicate the pipe now has a better structural and operational condition. This is an outstanding issue that has been on-going for years, and requires process improvements from Construction Engineering to address properly.

Grease Management Areas - Per John, the map layer for Grease Management Areas has not been updated for 8 years.

Summary of Meeting Notes

The following notes are from the April 10, 2012 and April 17, 2012 meetings and can be used for more information on the driver table and process diagram.

Scale of Reporting/ Work Orders

How do work orders get created and what do they look like?

- For PM inspections, Matt Marine notifies Gail when he needs next group of assets for Inspection. Gail lets Matt know which DRAINAGE BASIN is due for the district needing work (NORT (North and Northeast Portland, SOUT (Southeast Portland) or WEST (Northwest and Southwest Portland)). In addition, Gail may send Matt lists of specific assets needing inspection, sewers in specific basins that weren't done when the rest of the PM work was done and occasionally special projects that may are included in PM basin but need to be done on an accelerated schedule. The intent is to keep the overall DRAINAGE BASIN as tight as possible and meet needs beyond the PM program.
    - Please note: lists are only used for special requests that cannot be modeled or occasionally for cleanup of sewers in specific basins that weren't done when the rest of the PM work was done.
- Matt creates a map from that information, and breaks this down manually into SUBBASINS
    - Creates manageable work groups
    - Number of pipes limited to 150 to 200 maximum per SUBBASIN
    - Maps are given to crews
    - Currently, Matt hand delineates these subbasins. He will need access to the delineated catchments available through Systems Analysis. Catchment size may need to be expanded to account for the grouping Matt does (currently, catchment size is being controlled by placement of street inlets—he will need to roll this up to a coarser delineation)
- Matt also has a 'Matt's List', specific to Accelerated Areas, not in Hansen.
    - Reviewed monthly
    - Work orders for cleaning generated from this

- Refer to this for frequency

Why We Inspect (Inspection Drivers)

Why do we inspect?

- Current Preventive Maintenance
  - Determine structural condition of sewers
    - Are mainline repairs needed?
    - Are lateral (wyehead) repairs needed?
    - Is mainline whole pipe rehab needed?
  - Determine operational condition of sewers
    - Presence of roots?
    - Presence of grease?
    - Presence of debris?
    - I/I? (and amount)
    - Presence of sags (may trigger either operational –cleaning – or rehab response or no response)
  - Schedule for TV inspection for structural issues – Goal is 12 years, reality is often different
  - A scheduled inspection is a DRIVER for a CLEANING, since clean pipes are required for TV inspection

Inspection Drivers

What drives a TV inspection?

- Preventive/Planned Maintenance (12 year cycle)
- Root Control Program Management
  - Re-inspection to determine effectiveness of treatment and monitor regrowth of roots
  - Initially performed without pre-cleaning
- Grease Management
- Re-inspection to determine if cleaning frequency is appropriate; [GML: Check with Matt Marine about pre-cleaning when doing re-inspections.
- Post Repair
  - Re-inspection to update condition grade after repair
  - Pre-cleaning performed prior to post repair re-inspection; [GML Confirm with Matt Marine
  - NOTE: Neither Matt nor Gail receive the post repair rehab inspection data from construction (the 'acceptance inspection').
- Post Release (SSO)

- Affects pipes in vicinity, since the inspection is looking for more permanent type blockages as well as transitory. Usually the upstream and downstream pipes from the pipe generatin the release are marked for inspection as well.
- Enough pre-inspection cleaning performed to stop SSO. [GML: I'm not sure how much cleaning is generally performed but thought Matt indicated not a lot unless inspection indicates it is necessary.]

- Condition
  - Reinspection of pipes that have not been rehab'd in a timely manner
    - Resets Remaining Useful Life
- Accelerated Areas (Gary refers to these as 'hot spots'; preferred terminology by John McGregor is 'Accelerated Areas'). It does not refer to concentrations of any type of activity, but rather is anything on Matt's List. See \\OBERON\Hansen\Accelerated Cleaning Areas.
  - Groupings of restaurants (e.g. Mall 205 area)
  - Vulnerable PS design (e.g., 99th & Broadway – no wetwell except for influent pipe)
  - Apartments
  - Pipe design
    - Why is it falling in?
    - Sag
    - Defects
    - Flat Slope
    - Low flow
- CIP rehab and rebuild: these projects can trigger a pre-inspection, but that is paid for by the CIP. (this will not be part of the SCIP)

Why Do We Clean?

Primary mission – To Prevent SSO's

- Preventive (Planned) Maintenance – inspection depends on PM
  - Clean pipe so camera can get through for inspection
    - Remove rocks, etc that may impede camera progress
  - Remove excess sediment that may mask conditions in pipe
  - Remove paper, etc that may accumulate in sags or at offset joints.
  - Remove some roots and some grease if present so camera progress is not impeded
    - If grease and/or roots are present, at least trace amounts remain and are recorded. Generally sufficient to identify sewers for followup.
    - *[note: there are Grease Scores in Hansen, but these have not been vetted, per Gail. Do not use them at this time]*

    - If camera cannot progress through pipe due to accumulated materials (any of above) additional cleaning is performed so that inspection can be completed.
- Roots
- Grease – "accelerated areas"
- Sags
    - Because of loss of flow capacity
    - Because of grease settling
    - Because of sediment buildup
- Structural
    - Slope
    - Offset joints that can cause debris/sediment to accumulate
- Matching inverts (e.g. small diameter to large)

Cleaning Drivers

- Original TV Inspection request (for Preventive Maintenance)
    - Crew might see grease, add to the list to TV again in a year ---- GETS ON MATT's LIST
- Release Related (SSO's)
- Matt's List
    - Does not change that often
    - Reviewed monthly
    - Used to create work orders
    - Incorporates accelerated areas
    - Formulas to pre-determine what may get on list (e.g., certain proximities of restaurants) could be used in the future to assist in refining this acceleration list

Root Program

TV Inspection → Root Score → Root Priority in Hansen → Provide Root Treatment → Possible Root Clean

Once in this system, it never comes off until a repair, rehabilitation or replacement occurs on the pipe. The root priority never goes down, although it may go up.

e.g. A pipe gets a 2-yr treatment frequency; TV every 6 years to re-evaluate. If no roots found during inspection, skip one treatment cycle.

The cleaning referred to in this instance is generally NOT mechanical root removal. It is removal of dead roots using conventional cleaning (jet nozzle) methods. Root cleaning may also include the use of mechanical devices to remove roots from sewer, mostly performed by BOM with some contractors providing mechanical root removal. Mechanical root removal is used as infrequently as possible as mechanical root removal encourages root re-growth (pruning) and the devices used may damage the pipe.

Root Treatment Drivers – Chemical Application

- SSO (may trigger initial *mechanical root removal* to stop SSO followed by inclusion in *chemical root treatment program)*
- TV Inspection reveals roots (the amount of roots is identified by the score - see below - and thus the need to treatment).
    - The root score is generated, then Root Priority code in Hansen is assigned BASED ON THE ROOT SCORE
        - >75 score is a Root Priority of H
        - 26 to 75 = M
        - 6 to 25 = L
        - 1 to 5 = V
- Historical List (coded in Hansen as a priority for treatment, see Root Priority on a custom tab)
    - H = frequency is 2-years (<16-inch diam)
    - M = frequency is 3-years (<16- inch diam)
    - L, V = have no routine treatment frequency. May be treated if field check indicates treatment warranted
    - R = reported roots, no evidence, no routine treatment frequency.. Inspection may be triggered to confirm presence or absence of roots.
- For >16-inches, frequency varies according to funding and latest TV inspection as likelihood of SSO is less than for smaller diameter pipes and costs are substantially higher for treatment
- Root priority may be raised based on re-inspection (example from V to H). Root priority is not reduced but treatment may be skipped occassionally if re-inspection indicates.
- Never comes off the list unless repaired or rehab

Root Cleaning Drivers – Mechanical Root Removal

- SSO (see above)
- Does not happen unless necessary for capacity or to remove roots that are causing more damage to the pipe than the mechanical root removal is likely to cause (such as tap roots that can actually break the pipe) [GML Mechanical root removal encourages regrowth (pruning) and may damage pipe.]
- Removal of tap roots [GML Tap roots are killed by treatment. However, tap roots do not deteriorate readily remaining in the sewer, reducing capacity and possibly accumulating debris.]
- Removal of dead roots after treatment when heavy concentrations of roots were present prior to treatment

Rehab Module

TV Inspections need to account for the eventuality that the risk of not doing inspection is greater than cost of doing inspection.

Documents/ Sources

- Gail's CMOM Report
  - Categories
  - Root treatment process categories
- Hansen
  - inspection records
  - Root priority
  - Cleaning records (special clean, root chemical records)
- Matt's LIST [rename this to 'Accelerated List']: assume locations stay on the list for 20 years
- SP_Grease_View (Hansen) Asset Group
  - Not comprehensive
- TRACKIT – call intake locations of SSO's. Shows where every release is, duplication of TRACS; updated nightly)
- TRACS (SSO)
- LINKO FOG (database of grease activities- inspection, records of grease trucks) - Ali Dirks; uses data in MAPWORKS

Additional Notes on Grease Management

- FOG focuses on grease accumulation in line that team can act on
- No mechanism is available for John to ask owners to minimize grease
- City has changes to code, but conflicts with plumbing code (John may require certain fixtures that are overridden by the plumbing code)
- FOG is doing more cost recovery now
- John mentioned Sags and Structural deficiencies so that cleaning in those areas could be done more frequently. [most of the time the cleaning of these is related to grease]
- Matt's List is variable, but SSO drives overall
- Jantzen Beach is an accelerated area
- LINKOFOG tracks inspections

Outstanding Questions for Gary (from April 17, 2012)

How does Gary want to deal with SSOs? Eventually we would like to add some accounting for SSOs, but maybe that will have to be done later, since currently the available information is not at the asset level. We could use TRACKIT/TRACs to count events but these are address-based. Also, would need to separate SSO main and SSO lateral.

In order to get predictive SSO data, we would need operational data like roots and root growth