ASSESSMENT OF CONDITION
& RECOMMENDED REPAIR OPTIONS

ON

DRAIN (CULVERT) A
DRAIN (CULVERT) B

LOCATED

UNDER THE COMMERCIAL AREA
BETWEEN CENTER AVE AND W MARINE WAY
KODIAK, AK

PREPARED FOR

DOWL HKM
4041 B ST.
ANCHORAGE, AK 99503

BY

MILL CREEK MANAGEMENT
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SECTION 1: SYNOPSIS

SYNOPSIS

On April 1, 2014 Chris Pletnikoff (DOWL HKM) emailed a copy of an inspection report by Extreme Access Inc. on twin arched corrugated metal pipe (CMP) culverts under a commercial area in the City of Kodiak, AK and asked Mill Creek Management Technologies to assess culvert condition and make recommendations to repair or rehabilitate the culverts.

Based on information from the inspection report and general knowledge of the culvert construction materials, the author has concluded that both culverts were installed properly using durable pipe materials and that they are serviceable for the long-term in their present condition. The author recommends the following minor repair and stabilization work:

a. Basic, inexpensive cleaning, caulking and spot coatings at locations where there is exposed steel at separated and offset joints and along the pipe inverts;

b. Finding and then pressure grouting (cementitious and acrylamide or urethane) in a few places under the invert where cavities were detected during the inspection and in several joints that are infiltrating ground water.

SECTION 2: GENERAL INFORMATION

1. Culvert A (Drain A) and Culvert B (Drain B) are about 550 ft and 484 ft long, respectively. They run side by side over their entire lengths and discharge into St. Paul Harbor.

2. The culverts collect city surface runoff through grated manholes. The open grates allow sand, silt gravel and rocky debris to enter the system.

3. The culverts are made from 0.141 inch thick corrugated steel coated (likely dipped) with a 3/16" coal tar epoxy coating between 4:30-12-7:30 o'clock and a progressively thicker coating in the culvert inverts (about 1"- probably applied by hand).

4. The culverts have flat inverts, short-radius turns at the lower corners and arches that measure on average 73" wide by 41" high.

5. The culverts have nested joints. It is not known if the joints are gasketed.

SECTION 3: FIELD INSPECTION

In February 2014 DOWL HKM hired Extreme Access Inc., a company out of Bend, OR, to inspect both culverts for structural integrity. The culverts were checked for evidence of irregular loadings (bulges, joint separation, installation damage, etc.). Inspection techniques included cleaning, grinding, visual examination, ultrasonic testing, and sounding. Ultrasonic wall thickness testing was performed at the four cardinal points of the pipes where possible, with a spacing of roughly fifty feet where conditions allowed. Width and height pipe diameters were measured at these locations as well to assess ovality.

Sediment depth and composition were measured to provide information for possible future cleanup operations.

SECTION 4: CULVERT CONDITION ASSESSMENT

Pipe Structural Integrity

1. Arched culverts made from galvanized corrugated metal pipe (CMP) are designed to meet maximum drainage requirements and provide adequate structure while using cost-effective materials. The corrugated steel construction allows for strength and low cost. If coated properly inside and out and installed with care so as not to damage the coating, CMP culverts can provide reliable long-term service for surface runoff systems.

2. An optional bituminous asphalt coating was the traditional coating applied to galvanized CMP pipes before 2000. Culvert pipe sections were either dipped in bituminous coating at the factory or the coating was applied in the field. Well-designed culverts destined for abrasive service (mostly storm sewers) typically had thicker coatings applied to the inverts for better service life. Continuity of coatings is particularly important when the culverts are near marine environments.

3. The two culverts under study are made from 0.141 (3.5 mm) inch thick, galvanized and bituminous asphalt–coated CMP with thickened coating in the invert. This design is excellent for the storm service and marine environment requirements of these culverts.

4. Ultrasonic testing at 50 ft intervals throughout both lengths of pipe revealed clean galvanized surfaces under the asphalt coating. 104 readings were taken. 94 readings showed 3.5 mm or 3.6 mm thicknesses; there were five readings each at 3.4 mm and 3.7 mm, respectively. This suggests that the pipe is generally in pristine condition, with original wall thickness and effective internal and external coatings.

5. Measurements of the two diameters in each culvert showed average 73-1/2" wide by 41" high dimensions for Drain A and average 73" wide by 41" high dimensions for Drain B. Variations in the culvert **width** were 2" under to 1-1/2" above average for Drain A and 1" under to 1-1/2" above average for Drain B. Variations in the culvert **height** were 2" below the average and 2" above the average for Drain A and 3-1/2" below the average (in one spot only) and 2" above the average for Drain B. Vertical deviations noted are minor and attributable to compaction of soils around the culverts during installation and subsequent soil settling over years of service. Horizontal deviations are also minor and can be attributed in part to forced expansion by vertical compression of the culvert crown during installation and subsequent soil settling over years of service.

6. Indentations in the interior culvert wall of a CMP culvert can occur when soil presses down on corroded and weakened pipe surfaces or during pipe installation when soil compaction equipment gets too close to the pipe surface. There are three areas inside Drain A that have small indentations (about 4-8 sq. ft) of 2"-3-1/2". The wall thickness readings in those areas all registered at 3.6 mm. This eliminates corrosion as a possible cause for the indentations. The depth of the indentations and the limited size are not structurally significant, in my judgment.

7. Voids can form behind culvert pipe walls and under the inverts when groundwater infiltrates the pipes and flushes in backfill silt, sand and gravel. Voids can also form when storm water inside the pipe exfiltrates and finds a way under head pressure to drive backfill soil to a least resistance exhaust point. In the latter case, exfiltrated water can follow the backside of the culvert invert and exit from under the pipe at the discharge point if the pipe outlet is not sealed in a bulkhead structure. This mechanism can create a long continuous void under the pipe invert that will get

larger with time and undermine the structural integrity of the pipe. The inspection found a continuous void of unknown depth between 300 ft and 475 ft and one 12" deep horizontal void at 484 ft under the invert of Drain B. Both defective areas need to be grouted with cementitious grout to prevent potential future enlargement.

8. Three joints in a 40 ft section of Drain B have infiltrating joints (See Appendix Photo 14). One of the joints is leaking at an estimated rate of 2 gpm. All three joints are leaking from the 7 o'clock position and are close to or within the segment of drain where a continuous void was detected. These joints probably have voids behind them where soil fines have been washed into the pipe and need to be sealed with urethane grout to prevent future void enlargement. The pipe outlet end is encased in a concrete bulkhead but the presence of a long void near that outlet suggests a possibility that there is a void-forming channel flowing under the culvert invert. It needs to be grouted with cementitious grout.

9. Seams are important in maintaining flow integrity of a pipeline. When they separate or fail from corrosion, effluent exfiltrates or groundwater infiltrates, moving backfill soil fines in the process. Seams can separate when a pipe is installed and then settles over time or is subject to seasonal thermal expansion/contraction forces. This is particularly true where storm culverts have open ends and grated surface inlet manholes because of the chimney effect that causes cold or warm air to circulate through the culvert air space. If joints are gasketed, slight separations up to about 1" typically do not compromise their ability to remain watertight. We don't know if the joints in our culverts are gasketed or if they are all under water table. We know that many of them have vertical and horizontal separations up to 1-1/2" and do not show signs of leaking or staining caused by seasonal leaking (See Appendix Photos 1, 2 & 4). The three joints in Drain A that are infiltrating are all located near the lowest pipe elevation (discharge outlet).

Protection against Corrosion

1. If a CMP culvert is installed without being deformed, damaged or compressed excessively during installation, then the structural longevity of the pipe will be dependent on the quality and consistency of the coating(s) applied to its surfaces to protect against corrosion, the severity of weather conditions (freeze/thaw) and the aggressiveness of the effluents flowing inside the pipe.

2. In our case flow is not aggressive, consisting of seasonal storm water with traces of sand, silt and gravel and some rocks and tidal marine water that backflows into the pipe.

3. There is an element of weather severity in seasonal freeze/thaw cycles that would be expected to affect the inlet and outlet areas of the pipes. This seems to be the case for our culverts: corrosion is present in all of the inlet and outlet areas where severe weather conditions have caused peeling up of the bituminous coating and allowed corrosion of the underlying steel (See Appendix photos 6 & 7). Pipe deterioration is also present in areas where inlet openings exposed to severe weather were burned into the pipe crowns using a welding torch and the bituminous coating was not restored following the cutting (See Appendix photos 9 & 11). All of these corroded areas can be repaired and recoated to reestablish pipe longevity.

4. Reliability and permanence of the protective coatings (both metallic and bituminous) depend heavily on how the coatings were applied, how thick they are, how well the receiving pipe surfaces were prepared prior to application and how many holidays (defects) are present following application and. In our case the coatings appear to be well adhered throughout (with minor exceptions noted above). There are a few areas where coating adhesion has failed (See

Appendix photo 13) or where the coating was pulled apart when the joints separated, allowing exposed steel to become mildly corroded (See Appendix photo 5).

Pipe Deposits

1. There are deposits about 10" deep in the inverts of both culverts that consist mostly of heavy silt, sand, some gravel (See Appendix photo 3). About 180 ft of culvert B has a layer of small rocks mixed with silt (See Appendix photo 8). These deposits prevented inspection of the culvert inverts. While it is likely that the inverts are in excellent condition based on what the culverts look like at water's edge, it is recommended that they be sample-inspected to confirm their condition.

2. If the inverts are in good condition, the deposits should be left in place (especially the rocky deposits), as they will provide protection against abrasion caused by sand and silt carried down the pipe by seasonal flows.

SECTION 5: CONCLUSIONS & RECOMMENDATIONS

1. The structural integrity of both culverts is sound. I see no significant evidence of structural deformation, undermining, weakening from corrosion or mechanical damage. Both pipes are in good condition and, for the most part (see following paragraph), protected for the long-term by good design, good installation and stable soil and coating conditions.

2. There is a void of significant length (185 ft) but unknown size that needs to be confirmed and sealed with cementitious grout to prevent future pipe invert instability. This can be done by drilling small holes along the suspected void location and checking depth and continuity of void. The void can then be pressure-grouted using cementitious grout.

3. Many of the joints have separations of up to 1" but in all but three cases show no signs of infiltration or exfiltration. The exposed metal at these joints appears to be in pristine condition with very few exceptions. These joints need to be cleaned and treated with naval jelly where there is minor rust, then sealed with caulking and coated with a bituminous or coal tar epoxy coating to prevent future leaking and/or corrosion.

4. The areas inside both pipes where there is some serious but limited-scope corrosion (mostly around the inlet flame-cut manhole/pipe openings and the outlets) need to be cleaned carefully by wire brushing, repaired with an epoxy-resin coating and finished with a thick bituminous coating like the original coating.

5. The invert on each culvert needs to be sample-inspected for coating integrity and corrosion. While I don't expect that there are any major issues, inspection will confirm condition so that timely repairs can be performed if damage is uncovered. The deposits should be left in place to protect the pipe from erosion/abrasion.

George Vernon, P. E.
Mill Creek Management
Technologies, Inc.

SECTION 6: APPENDIX

FIELD INSPECTION PICTURES

Photo 1 - **Drain A** - Separated joint showing no corrosion or signs of leakage

Photo 2 - **Drain A** – Separated joint showing minor incipient corrosion

Photo 3 - **Drain A** – typical 10" deep silt/sand deposit

Photo 4 - **Drain A** – Joint with 1" separation and 1-1/2" offset

Photo 5 - **Drain A** – occasional flaking off of coating with minor Corrosion

Photo 6 - **Drain A** – Outlet steel is exposed and needs to be cleaned and recoated

Photo 7 - **Drain A -** Corroded outlet where coating is missing

Photo 8 - **Drain B** – Rocky invert debris

Photo 9 - **Drain B** - Flame cut inlet opening

Photo 10 - **Drain B** – Separated joint with 1" offset

Photo 11 - **Drain B** – Flame cut manhole opening with serious Corrosion needs to be cleaned and recoated

Photo 12 - **Drain B** – 12" horizontal void that needs to be filled

Photo 13 - **Drain B** – outlet has lost some coating and is corroded. Needs to be cleaned and recoated

Photo 14 - **Drain B** – One of two infiltrating joints that needs to Be sealed and recoated