2024 Spring Conference at Great Wolf Lodge
Perryville, Maryland

County Standardization of Manhole Frames and Covers

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BIOGRAPHY

- Region Engineer with Neenah Enterprises Inc.
- Mechanical Engineer
- Saint Marys, PA

ABSTRACT

County Standardization of Manhole Frames and Covers

1. Reasons to Standardize
2. Quality Control, Weight Requirements, Green Footprint and BABA
3. Lettering
4. Surface Design
5. Pick Styles
6. Frame Design

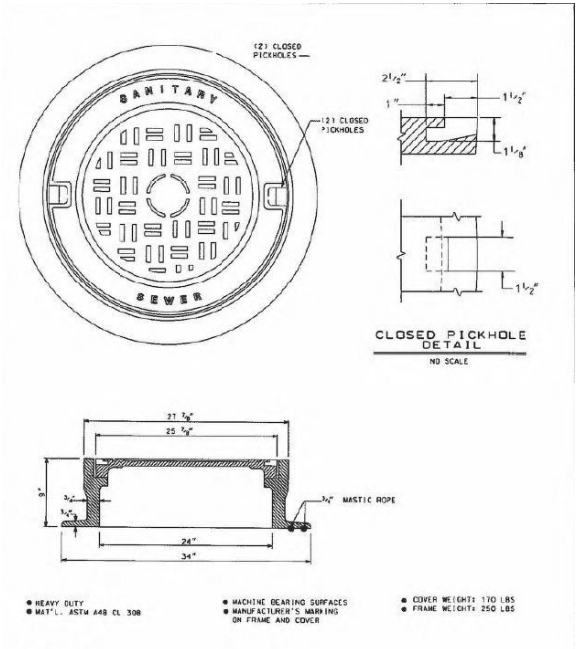
- 1.0 PDH

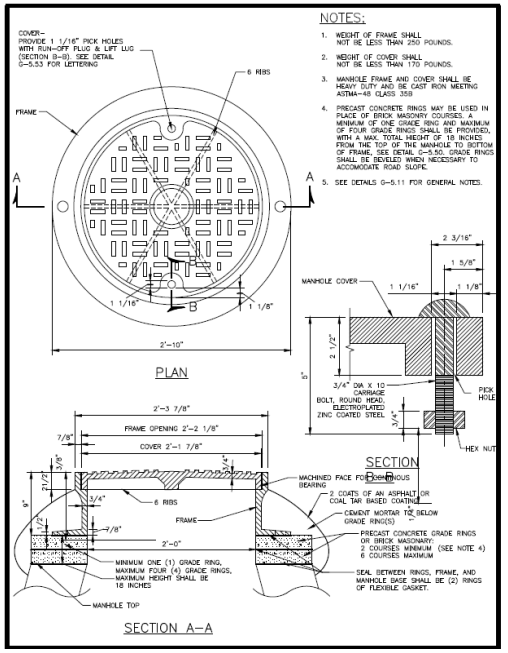
Standardization of Castings for CEAM

- **Why Standardize?**
  - Increase interchangeability
  - Increase manufacturing efficiency
  - Reduce chance for mistakes
  - Decrease lead time
  - Decrease complexity in the field

Standardization of Castings for CEAM

- **Review of all County Standards**
  - Inlet Grates and Frames are generally the same for each County
  - Manhole frames and covers are consistent in critical dimensions, but vary widely in:
    - Weight
    - Surface Design
    - Pick Style
    - Lettering
    - Rib Location and Design





Recommendation 1: Remove Weight Requirements

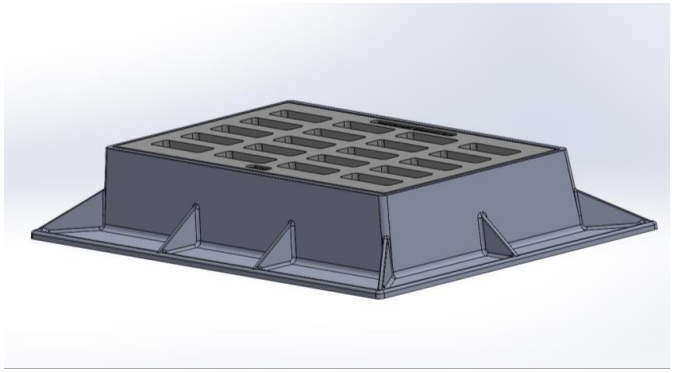
- **Remove weight requirement for frames and lids**
  - Optimize weight & Strength via Performance Based Design - Weight does not equate to strength
  - Removing weight reduces energy consumption
  - Increased ergonomics and reduced worker compensation claims
  - Switch to load rating versus weight requirement
- **Implement Build America Buy America (BABA)**

Performance Based Design

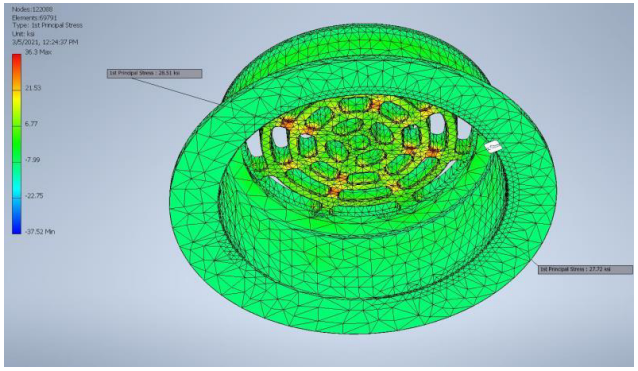
- **Historical Casting Design**
  - Castings were designed with thick walls this helped with:
    - Molding – thin sections of sand can be difficult to mold
    - Casting – thin sections can freeze off during pouring
    - Iron Chemistry Variations
    - Ensuring Safety
  - Tooling is expensive – Much easier to overdesign than to try and push the boundaries
  - Manufacturing was more manual and in general subject to more variation

Remove Weight Requirements

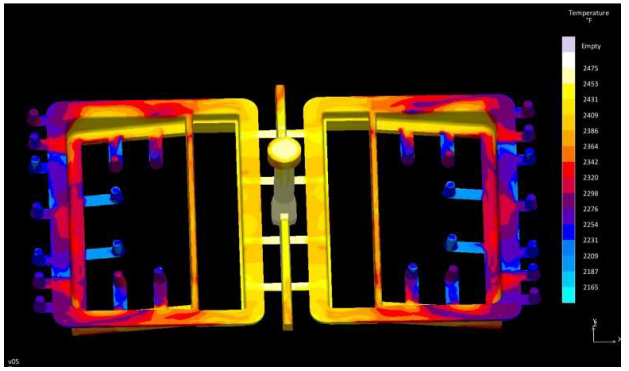
- **Modern Casting Design**
  - Conform with Federal, State, Local or customer specifications
  - Software used:
    - 3D Modeling
    - Finite Element Analysis
    - Computational Fluid Dynamics



3D Model of Infrastructure Product



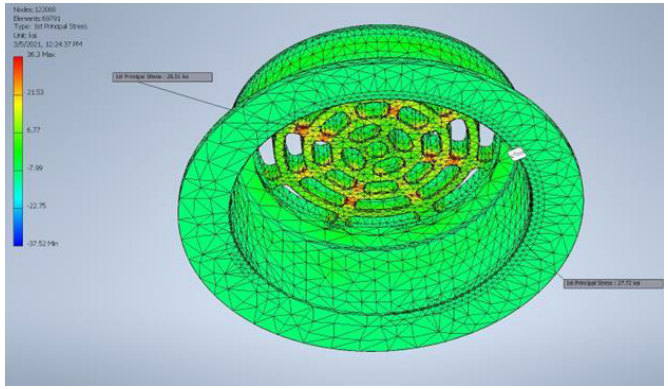
Finite Element Analysis



Computational Fluid Dynamics Software

Remove Weight Requirements

- **Performance Based Design**
  - Over Designed Castings – The Past
    - Tooling costs
    - Design calculations took time
    - Consistency was less controlled
    - Raw materials & energy were inexpensive
  - Less Material in Castings - New Design
    - Saves raw material costs and reduces energy consumption
    - Reduces shipping costs
    - Increases ergonomics



Performance Based Design

- **Example Results of Performance Based Design**

Product Type	Previous Weight (lbs)	New Weight (lbs)	Weight Savings (lbs)	Manufacturing CO_2 Emission Reduction (lb/casting)	Transportation CO_2 Emission Reduction (lb/casting/mile)
MH Frame (24" CO)	154	126	28	57.12	0.0026
MH Cover (26" Ø)	162	120	42	85.68	0.0039
MH Frame (21" CO)	162	140	22	44.88	0.0021
MH Cover (22.75" Ø)	143	122	21	42.84	0.0020
MH Frame (30" CO)	367	245	122	248.88	0.0114
Inlet Frame (24"x36")	344	164	180	367.20	0.0168

Notes:

1) CO_2 Emissions are based on an average emission rate of (2.04 lb CO_2 / lb gray iron shipped).
   source: Shifo, J.F., Radia, J.T., KERAMIDA Environmental, Inc. "Theoretical/Best Practice Energy Use In Metalcasting Operations" U.S. Department of Energy, Industrial Technologies Program, 2004.
2) Transportation CO_2 emission reduction assumes 22.42 lb CO_2 / gallon of diesel fuel, and an average fuel economy of 6 miles/gallon

Benefits of Performance Based Design (reducing weight)

Optimizing the amount of metal, reducing the weight of manhole frames & covers, gains efficiencies at every stage of the creation and delivery process, reducing cost and environmental impacts.

- **Mining of Iron Ore:**
  - Less raw material excavated and less trips required to ship
- **Iron Smelting and Processing:**
  - Less fuel & heat required to smelt and lower emissions
- **Manufacturing:**
  - Less fuel & heat required to mold and lower emissions including shipping to distribution centers and end users
- **Delivery to Public Works Department:**
  - Less trips and emissions required to ship; lighter materials are easier to handle and require less energy for transportation to public works departments, contributing to efficiency and reducing the risk of injuries during delivery

Quality Control

- **Load Rating Standards**
  - **AASHTO M306, Standard Specification for Drainage, Sewer, Utility and Related Castings**
    - Grey Iron ASTM A48 Class 35B
    - Load Rating: Must meet 40,000 lbs proof load on a 9” x 9” load test area.
    - Quality Control: Test Bars checked every 4 hours to meet ASTM requirements

AASHTO

FEDERAL AVIATION ADMINISTRATION

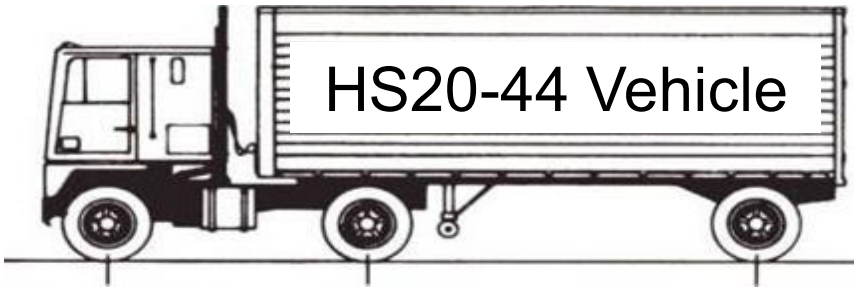
GSA

cen

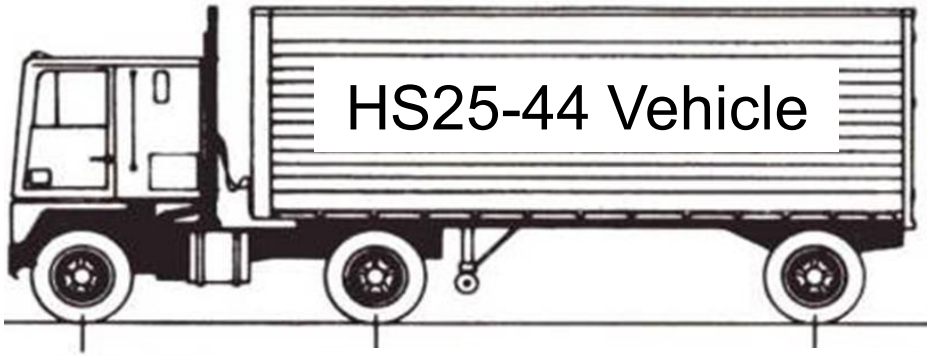
EUROPEAN COMMITTEE FOR STANDARDIZATION

AASHTO M306 - Design Vehicles and Load Rating

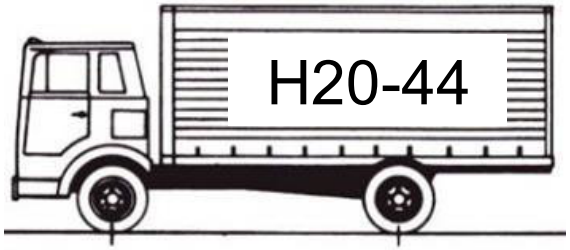
- **Standard for Highway and Vehicle Loading Requirements of Castings**



8,000 lbs 32,000 lbs 32,000 lbs



10,000 lbs 40,000 lbs 40,000 lbs



8,000 lbs 32,000 lbs

*Values are Axel Loads

Load Ratings – Proof Load

- **AASHTO M306 Load Testing and Casting Performance Requirements**
  - 2.5 times the rated load (H20 - 40,000lb or H25 - 50,000lb)
    1. The proof load used, simulating a tire, 9” x 9”
    2. Loading rate: 100 and 1,000 lbs/sec
    3. The load is held for 1 minute and then released
    4. Inspection to determine if cracking or damage occurred
    5. Permanent deformation after loading may not exceed 1/8”

AASHTO M306 (Load Test) Hydraulic Press

Grate and Frame
Pre-Test Setup

SECTION III (TEST DATA)

DATE OF TEST
Apr 2, 2019

CAST DATES
03-27-2019

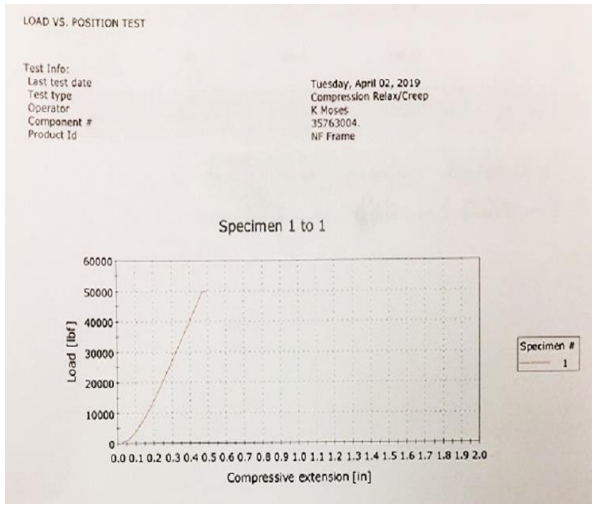
DID THE CASTING BREAK BEFORE PROOF LOAD?
NO

MEASURED DEFORMATION (IN INCHES):
.071

COMMENTS

APPROVED LOAD RATING
AASHTO M306 H-25

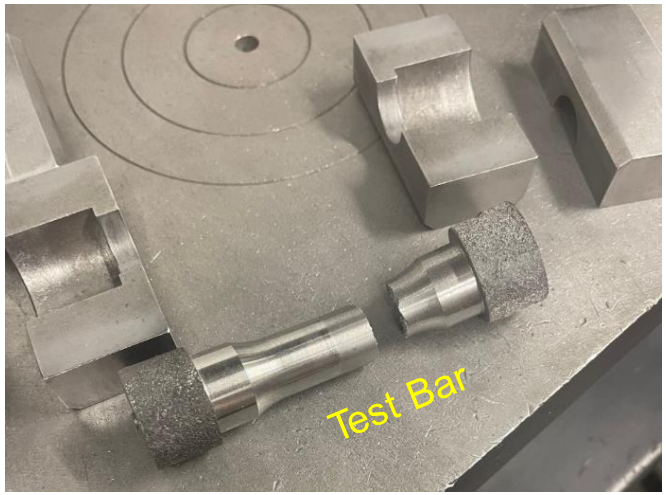
COMMENTS
Casting Failed at 56,531 lb



Failure Location
Marked

Quality Control

- **Manufacturing Quality Control**
  - Test Bars
    - Every 4 hours
    - Tensile properties meet ASTM requirements
  - Iron Chemistry
    - Elements within the iron are acceptable, mass spectrometer
  - Part Conformance
    - X-ray, Soundness testing, Hardness testing and Dimensional accuracy



Build America Buy America Act

- Build America Buy America Act (BABA)
- For ALL Federal Financial Assistance Infrastructure Projects after May 14, 2022
- All iron and steel items must be produced in the United States. This includes all manufacturing process from initial melting through final processing. It also includes coatings.
- Manufactured products must be produced in the United States. 55% of the product's cost must come from US made products.

Recommendation 1: Remove Weight Requirements Summary

- **Control of Import Casting Quality Issues**
  - Institute Buy America requirement for iron and steel
  - Follow AASHTO M306 Section 8 “Inspection”
    - Import castings require proof load test and cast-on test bars
    - Domestic castings require proof load test and separately cast test bars
      - Done through certifications
  - Implement a no-paint policy
    - Importers can hide defects by painting

Recommendation 2: Lettering

- **Current Lettering**
  - Raised lettering in a recessed pocket
  - Several different fonts
  - Multiple sizes
  - Varying Locations
- **Recommendations**
  - High volume castings continue casting lettering
  - Low volume (less than 10 per order) allow engraved lettering
  - Standardize lettering location
  - Standardize font type and size

Lettering Options

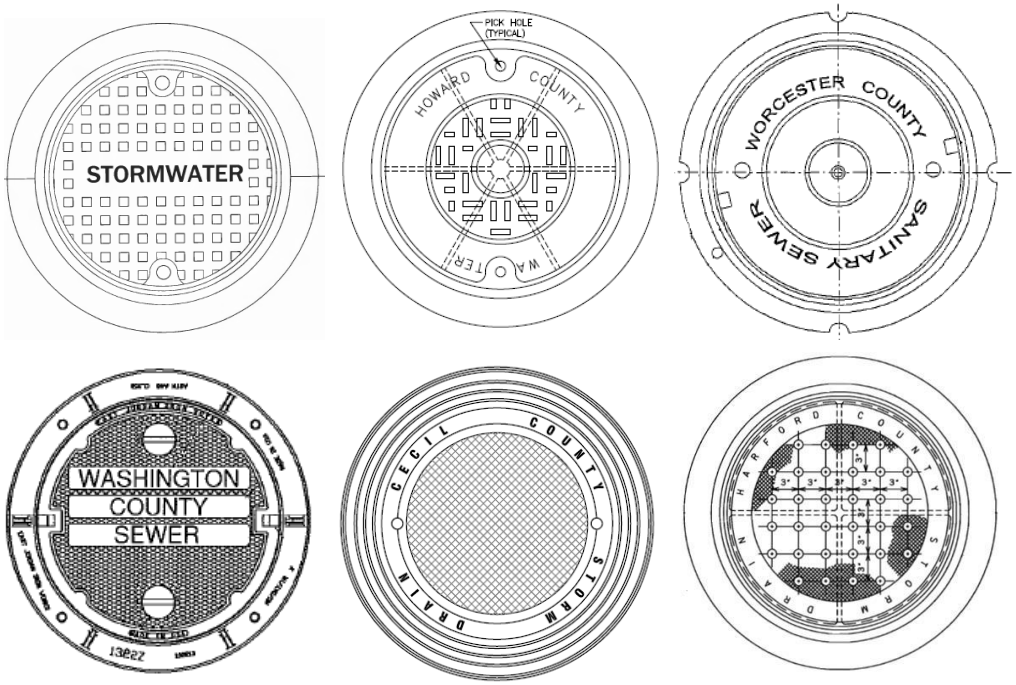
- **Two to three Lines of Text**
  - County Name with _____
    - Drain
    - Sewer
    - Reclaimed Water
    - Water

Recommendation 2: Lettering Summary

- **Recommendations**
  - High volume castings continue casting lettering
  - Low volume (less than 10 per order) allow engraved lettering
  - Standardize lettering location
  - Standardize font type and size

Recommendation 3: Manhole Cover Surface Design

- **Standardize Surface Design**
  - Currently 6+ designs
  - Pick locations vary
  - Lettering height and location vary
- **Recommendations**
  - One design per size
  - Standardize lettering
  - Standardize picks and locations



Manhole Surface Design

Diamond - Utilized 41%

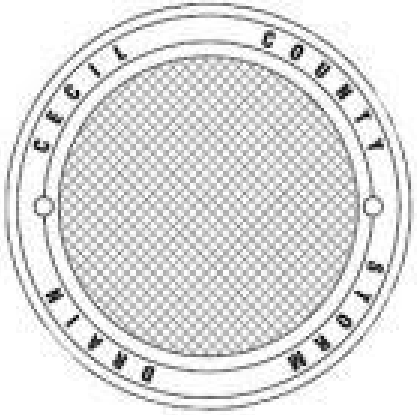


Figure 4.1
Diamond Pattern meets
<1/4” tall requirement

Raised - Utilized 52%

Figure 4.2
Raised Line Design
is 3/8” tall

Raised Square - Utilized 7%

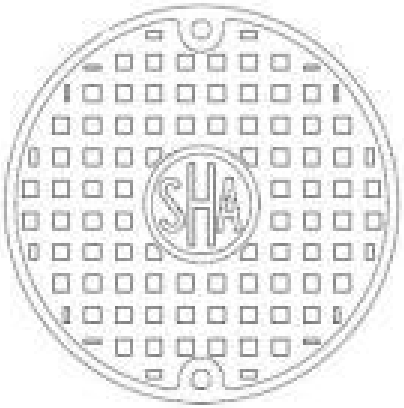
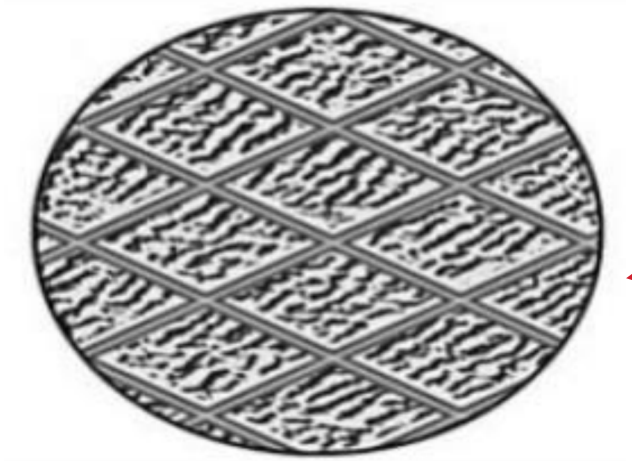


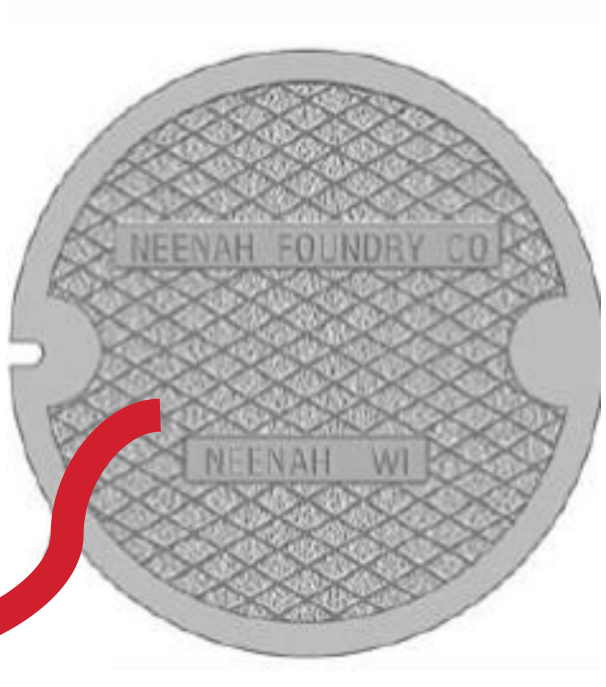
Figure 4.3
Raised Square Design
is 3/8” tall

Recommendation 3: Manhole Cover Surface Design Summary

- **Diamond Pattern**
  - ADA Compliant – Required ¼” or less elevation change
  - Weight Reduction by 3-5 lbs

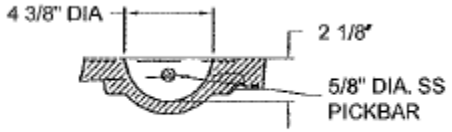
Perma Grip Surface



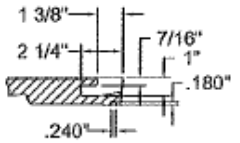


Recommendation 4: Standardization of Pick Style

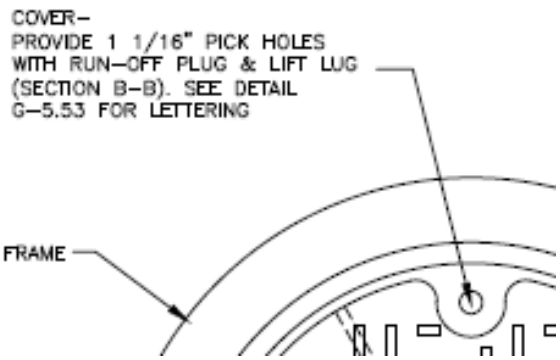
- **Standardize manhole pick styles**
  - Currently 5 different styles
  - 2 different hole diameters
  - Varying locations
- **Recommend two styles**
  - One open pick
  - One concealed pick
- **Recommend standard locations**
  - Based on style chosen

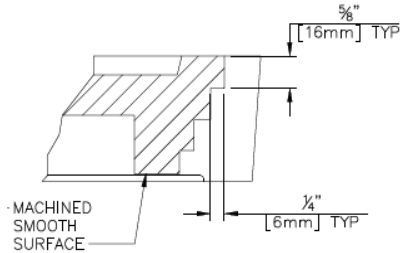


PICKBAR DETAIL

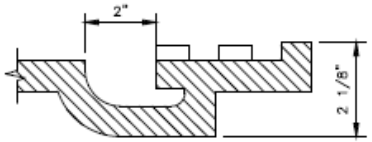


PICKHOLE & GASKET DETAIL





DETAIL OF PICKHOLE



WATERTIGHT PICKHOLE

Pick Style Categories

- **Open Pick**
  - Holes, Slots and Other openings
  - Penetrate through the entire casting
  - 3 Different Styles utilized across MD Counties

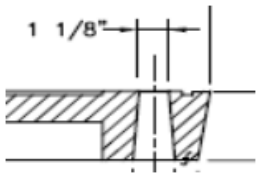


FIG. 3.4
PICK HOLE

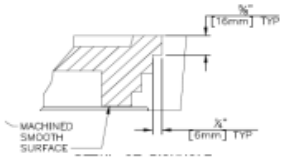


FIG. 3.5
EDGE OPEN NOTCHED PICK

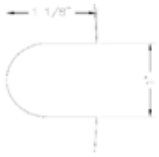


FIG. 3.6
EDGE OPEN PICK

- **Concealed Pick**
  - Edge Concealed, Pick Slot, Pick Bar
  - Do not penetrate through casting
  - 3 different styles utilized across MD Counties

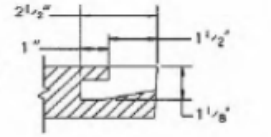


FIG. 3.1
EDGE CONCEALED PICK

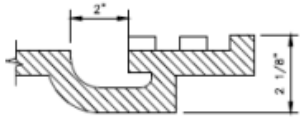


FIG. 3.2
PICK SLOT

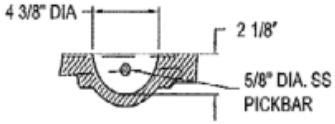


FIG. 3.2
PICK BAR

Open Pick Styles Utilized in MD

Table 3.2 – Open Pick Styles

Pick Style	Percent Specified	Number of Variations	Comments
Pick Hole	80%	1	All pick holes are approx. 1 1/8" in diameter
Edge Open Notched Pick	15%	1	
Edge Open Pick	5%	1	

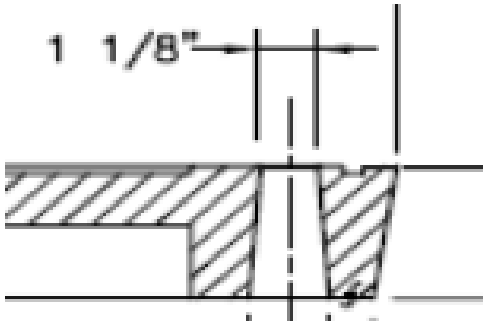


FIG. 3.4
PICK HOLE

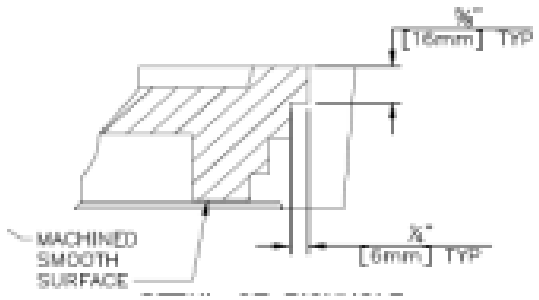


FIG. 3.5
EDGE OPEN NOTCHED PICK

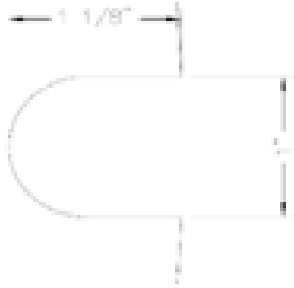


FIG. 3.6
EDGE OPEN PICK

Concealed Pick Styles utilized in MD

Table 3.1 – Concealed Pick Styles

Pick Style	Percent Specified	Number of Variations	Comments
Edge Concealed Pick	60%	2	80% are the same or similar in size
Pick Slot	33%	1	
Pick Bar	7%	1	

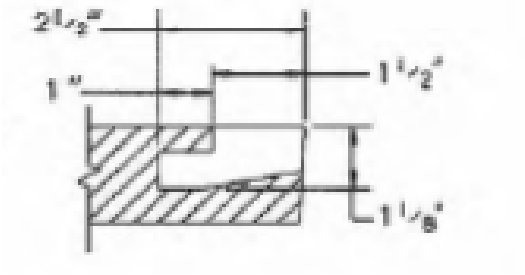


FIG. 3.1
EDGE CONCEALED PICK

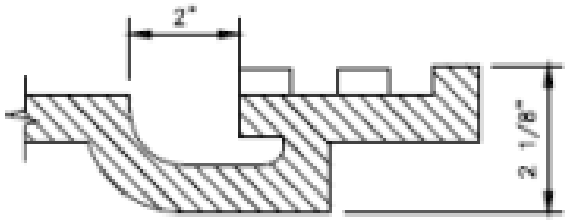


FIG. 3.2
PICK SLOT

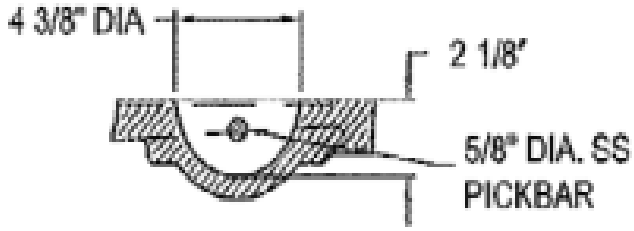


FIG. 3.2
PICK BAR

Recommendation 4: Standardization of Pick Style Summary

- **Concealed Pick**
  - Edge Concealed Pick
  - Allows for maximum leverage if the cover needs to be pried open

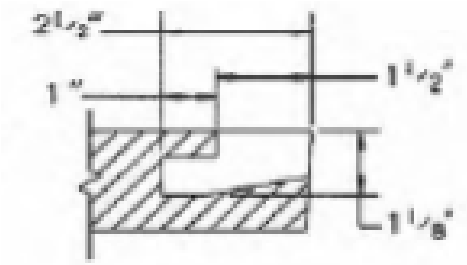


FIG. 3.1
EDGE CONCEALED PICK

- **Open Style Pick**
  - 1-1/8” diameter hole
  - Most Common Option in Use

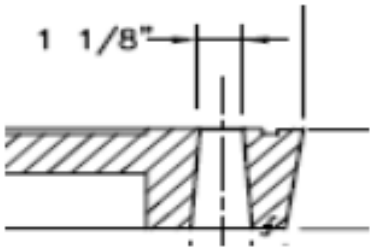


FIG. 3.4
PICK HOLE

Recommendation 5: Standardize Frame Style

Two most common types are Straight Wall & Cantilever Seat

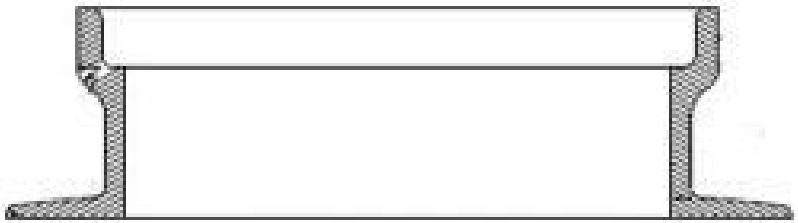


FIG. 5.1
STRAIGHT WALL FRAME

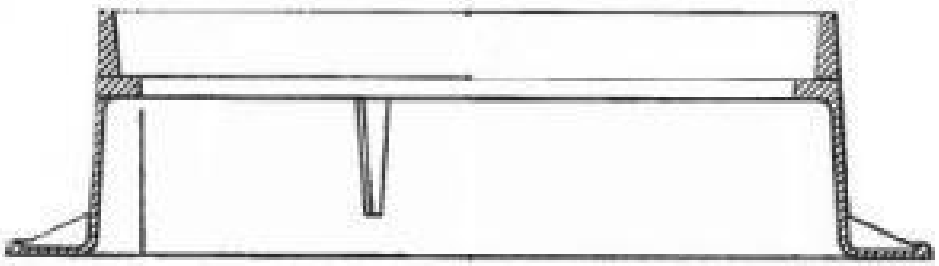


FIG. 5.2
CANTILEVER SEAT FRAME

Straight Wall Frame

- **Utilized 56% of the time in MD**
  - Metal walls need to be thicker which increases weight.
  - Increased weight results in shipping inefficiencies
  - More difficult to handle in the field

FIG. 5.1
STRAIGHT WALL FRAME

Recommendation 5: Cantilever Seat Frame

- **Utilized 44% of the time in MD**
  - Allows for weight reduction through design features
  - Allows for frames to be nested during shipping (efficiency)
    - More castings are able to ship on the same truck
  - Allows for addition of manhole technology
    - CPR2
    - Infralock

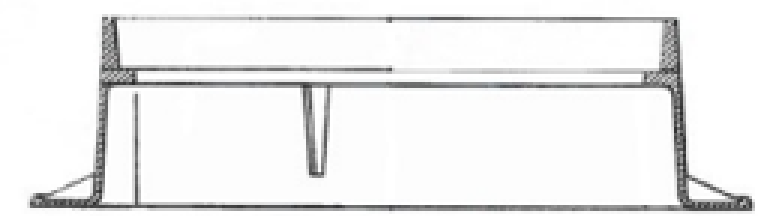


FIG. 5.2
CANTILEVER SEAT FRAME

Standardization of Castings for CEAM

- **Recap of Neenah Proposed Standardization Items**
  - Implement Buy America Clause
    - Remove weight requirements for frames and lids
    - Follow AASHTO M306 Section 8 “Inspection”
  - Allowance for engraved lettering versus cast in place lettering
  - Reduce to one surface design per manhole cover
  - Reduce pick styles to two types, one open, one concealed
  - Standardized one frame design

Menu of County Choices to Inform Statewide Collaboration

1) Weight Requirement Removal
   a) Remove Weight Requirement (recommended)
   b) Institute BABA requirement (recommended)
   c) Retain Existing Weight Requirement
2) Lettering
   a) Center Lettering to facilitate engraving of up to 10 covers per order (recommendation)
   b) Retain Existing Casting Lettering
3) Manhole Surface Design Pattern
   a) Diamond (recommended, ADA Compliant)
   b) Raised Line
   c) Raised Square
4) Open Pick Style
   a) Pick Hole (recommended)
   b) Open Edge Pick
   c) Open Edge Notch
5) Concealed Pick Style
   a) Edge Concealed (recommended)
   b) Pick Slot
   c) Pick Bar
6) Frame
   a) Cantilever (recommended)
   b) Straight Wall

QUESTIONS?

Technical Question:

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CEAM Statewide Collaboration Question:

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APPENDIX

1. Performance Based Design Calculations
2. Infralock
3. CIR-II
4. Hydrovent
5. Maryland Counties Cover Matrix
6. Maryland Counties Frame Matrix

Performance Based Design

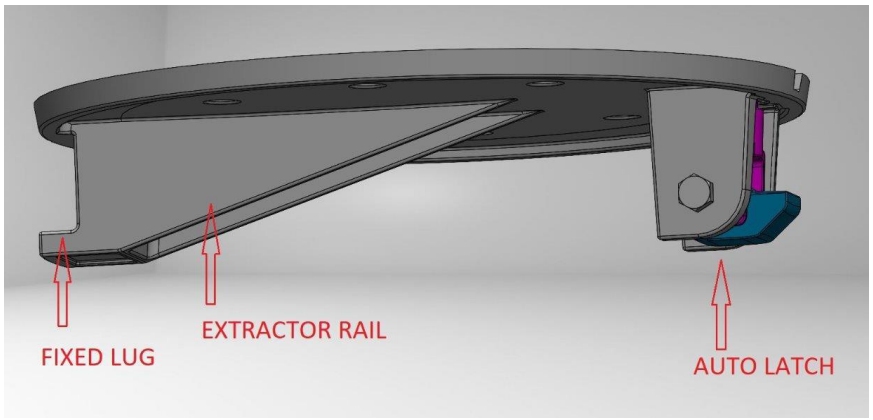
- **Performance Based Design – Environmental Impact Example – 26" Diameter MH Cover**
  - Objective: Determine the total amount of CO_2 emissions reduced by reducing the weight of the 26" diameter manhole cover by 42 pounds and shipping a full truckload of castings 500 miles. Equate this value to the average car.
  - Given:
    - Casting Weight = 120 lb
    - Weight Reduction = 42 lb
    - Manufacturing CO_2 Reduction = 85.68 lb CO_2/casting
    - Transportation CO_2 Reduction = 0.0039 lb CO_2/casting/mile
    - Castings / Truck = 40,000 lb / 120 lb/casting = 333 castings
    - Average car emits 0.89 lb CO_2/mile
  - Analysis:
    - CO_2 Reduction = [(85.68 lb CO_2 / Casting)*333 Castings] + [333 Castings*(0.0039 lb CO_2/casting/mile)*(500 miles)]
      CO_2 Reduction = 29,181 lb
    - Comparison to Average Car: 29,181 lb CO_2 / 0.89 lb CO_2/mile = **32,788 miles**

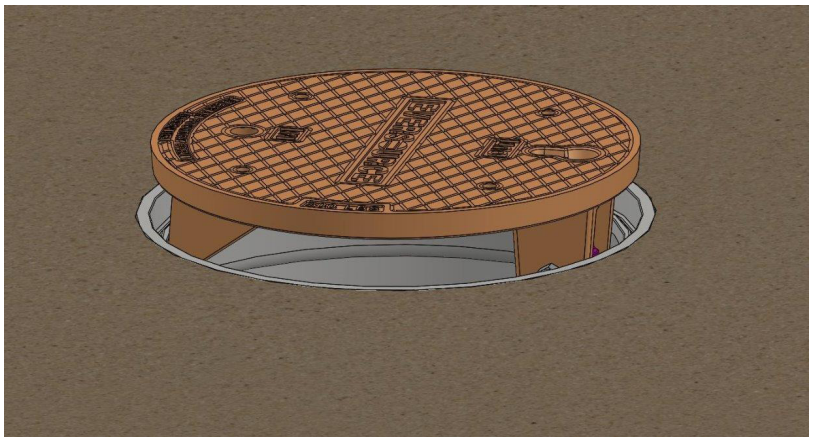
Manhole Technology – Infralock

- **Maximize Security**
  - Protects underground infrastructure systems from theft, destruction and unauthorized access.

Manhole Technology – CPR-II

- **Controlled Pressure Release Cover**
  - Designed to protect the public and lessen the severity of the damage caused by an underground manhole explosion





Manhole Technology – Hydrovent

- **Water surcharge events**
  - Designed to allow water surcharge events to safely occur while manhole cover remains in place

Cover Matrix (Page 1 of 4)

County Name	Standard	Lid Diameter (in)	Lid Seat Depth (in)	Lid Weight Listed (lbs)	Lid Surface Design	Lid Type	Lettering	Lettering Location	Open or Concealed Pick	Pick Style	Number of Picks	Pick Size (in)	Pick Location	Vents (Y/N)	Bolted (Y/N)	Gasket (Y/N)	Inner Lid Option	Comments
Montgomery	WSSC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Follows WSSC Standards
Prince George's	WSSC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Follows WSSC Standards
Baltimore County	S-8	25.75	2.50	150	Raised Line	Ribbed	Baltimore County Sanitary Sewer	Radial	Open	Open Notched	2	1.50	Same Side	N	N	N	N	
Baltimore County	S-8B	25.88	2.50	177	Raised Line	Platen	Baltimore County Sanitary Sewer	Radial	Open	Open Notched	2	1.50	Same Side	N	N	N	N	
Baltimore County	S-8	31.75	2.50	215	Raised Line	Ribbed	Baltimore County Sanitary Sewer	Radial	Open	Open Notched	2	1.50	Same Side	N	N	N	N	
Baltimore County	S-13	27.88	2.50	NA	Raised Line	Ribbed	Baltimore County Sanitary Sewer	Radial	Open	Pick Hole	2	1.00	180 degrees	N	Y	Y	Y	
Baltimore County	D-3.05	25.88	2.50	135	Diamond	Ribbed	Baltimore County Storm Drain	Radial	Open	Open Notched	4	1.50	180 degrees	Y	N	N	N	
Baltimore County	D-3.06	22.00	1.50	NA	Diamond	Ribbed	Baltimore County Storm Drain	Radial	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	20.00	NA	NA	Raised Line	NA	Water Valve	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	20.00	NA	NA	Raised Line	NA	Water Division	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	20.00	NA	NA	Raised Line	NA	Water Meter	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	26.25	NA	NA	Raised Line	NA	Water Valve Main Vault	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	26.25	NA	NA	Raised Line	NA	Water Valve Division	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	26.25	NA	NA	Raised Line	NA	Water Meter	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	32.00	NA	NA	Raised Line	NA	Water Valve Main Vault	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	32.00	NA	NA	Raised Line	NA	Water Valve Division	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore County	W-18	32.00	NA	NA	Raised Line	NA	Water Meter	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	

Cover Matrix (Page 2 of 4)

County Name	Standard	Lid Diameter (in)	Lid Seat Depth (in)	Lid Weight Listed (lbs)	Lid Surface Design	Lid Type	Lettering	Lettering Location	Open or Concealed Pick	Pick Style	Number of Picks	Pick Size (in)	Pick Location	Vents (Y/N)	Bolted (Y/N)	Gasket (Y/N)	Inner Lid Option	Comments
Baltimore City	BC 376.93	19.75	1.63	NA	Diamond	Platen	DPW	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore City	BC 383.21	25.88	2.50	NA	Diamond	Ribbed	Storm Drain	Radial	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Baltimore City	BC 383.23	32.00	2.50	NA	Diamond	Ribbed	Storm Drain	Radial	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	
Baltimore City	BC 831.40	25.88	2.50	NA	Diamond	Platen	Baltimore City Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	N	N	N	N	
Baltimore City	BC 831.42	32.00	2.50	NA	Diamond	Platen	Baltimore City Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	N	N	N	N	
Baltimore City	BC 831.44	26.00	2.50	NA	Diamond	Platen	Baltimore City Sanitary Sewer	Radial	Concealed	Concealed Pick	2	2.00	Same Side	N	Y	Y	N	Uses NF G-Lock
Baltimore City	BC 831.46	32.00	2.50	NA	Diamond	Platen	Baltimore City Sanitary Sewer	Radial	Concealed	Concealed Pick	2	2.00	Same Side	N	Y	Y	N	Uses NF G-Lock
Baltimore City	BC 875.01	20.00	2.19	NA	Diamond	Ribbed	Water Meter	Radial	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	
Baltimore City	BC 876.01	25.88	2.50	NA	Diamond	Ribbed	Water Valve Main Vault	Radial	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	
Baltimore City	BC 877.01	31.88	2.50	NA	Diamond	Ribbed	Water Valve Main Vault	Radial	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	
Anne Arundel	D-16	25.88	2.50	NA	Diamond	Ribbed	Anne Arundel County Dept of Public Works Storm Drain	Radial/Center	Open	Open	2	NA	180 degrees	N	N	N	N	
Anne Arundel	D-17	22.00	1.50	NA	Diamond	Ribbed	Anne Arundel County Dept of Public Works Storm Drain	Radial/Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Anne Arundel	S-17	25.75	2.50	150	Raised Line	Ribbed	Anne Arundel County Sanitary Sewer	Radial	Concealed	Pick Slot	2	2.00	180 degrees	N	N	N	N	
Anne Aumdel	S-18	23.88	1.13	123	Raised Line	Ribbed	S	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	
Howard	G-5.51	25.88	2.50	170	Raised Line	Ribbed	NA	NA	Open	Pick Hole	2	1.06	180 degrees	N	N	N	N	
Howard	G-5.52	23.88	1.13	170	Raised Line	Ribbed	S	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	N	N	
Howard	G-5.53	25.88	2.50	170	Raised Line	Ribbed	Howard County Water	Radial	Open	Pick Hole	2	1.06	180 degrees	N	N	N	N	
Howard	G-5.53	25.88	2.50	170	Raised Line	Ribbed	Howard County Storm Drain	Radial	Open	Pick Hole	2	1.06	180 degrees	N	N	N	N	
Howard	G-5.53	25.88	2.50	170	Raised Line	Ribbed	Howard County Sanitary Sewer	Radial	Open	Pick Hole	2	1.06	180 degrees	N	N	N	N	
Howard	G-5.53	25.88	2.50	170	Raised Line	Ribbed	Howard County Reclaimed Water Do Not Enter	Radial	Open	Pick Hole	2	1.06	180 degrees	N	N	N	N	
Frederick	5.1	25.88	2.50	NA	Raised Line	Platen	Frederick County Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	N	Y	Y	Y	
Harford	D-48	22.00	1.50	NA	Diamond	Ribbed	Harford County Storm Drain	Radial	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Harford	D-49	25.88	2.50	134	Diamond	Ribbed	Harford County Storm Drain	Radial	NA	NA	NA	NA	NA	Y	N	N	N	
Harford	D-50	25.88	2.50	170	Raised Square	Ribbed	Harford County	Center	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	Lid is domed

Cover Matrix (Page 3 of 4)

County Name	Standard	Lid Diameter (in)	Lid Seat Depth (in)	Lid Weight Listed (lbs)	Lid Surface Design	Lid Type	Lettering	Lettering Location	Open or Concealed Pick	Pick Style	Number of Picks	Pick Size (in)	Pick Location	Vents (Y/N)	Bolted (Y/N)	Gasket (Y/N)	Inner Lid Option	Comments
Carroll	S-6	25.75	2.50	NA	Raised Line	Ribbed	Carroll County Sanitary Sewer	Radial	Open	Open Notched	2	1.50	Same Side	N	N	N	N	
Carroll	S-7	27.88	2.50	NA	Raised Line	Ribbed	Carroll County Sanitary Sewer	Radial	Open	Pick Hole	2	1.13	180 degrees	N	N	N	Y	
Carroll	88	25.88	2.50	NA	Raised Line	Platen	Storm Drain	Center	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	
Charles	S-3.00	25.88	2.50	150	Raised Line	Ribbed	Charles County Sanitary Sewer	Radial	Open	Open Notched	2	1.50	Same Side	N	Y	N	N	Bolting is optional according to S-3.01
Washington	SW-2.6	32.00	1.50	NA	Diamond	Platen	Washington County Sewer	Center	Concealed	Concealed & Pick Bar	4	See Dwg	90 degrees	N	N	Y	N	Lid has both concealed pick hole and bar
Washington	SW-2.7	32.00	1.44	NA	Diamond	Ribbed	Washington County Sewer	Center	Concealed	Pick Bar	2	3.75	180 degrees	N	Y	Y	N	Uses Cam / G-Lock
Washington	SW-2.8	29.75	0.75	NA	Diamond	Platen	Washington County Sewer	Radial	Concealed	None	0	NA	NA	N	Y	N	N	Uses Single Lock, lid has handle
St. Mary's	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Cecil	R-32	32.00	1.50	NA	Diamond	Ribbed	Cecil County Storm Drain	Radial	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	
Cecil	R-33	25.88	2.50	134	Diamond	Ribbed	Cecil County Storm Drain	Radial	Open	Open	?	?	?	Y	N	N	N	
Cecil	S-14	25.88	2.50	170	Raised Line	Platen	Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	N	N	N	N	
Cecil	S-15	25.88	2.50	170	Raised Line	Platen	Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	N	Y	N	N	
Cecil	S-16	25.88	2.50	170	Raised Line	Platen	Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	N	N	N	Y	
Cecil	S-17	23.88	1.25	NA	Raised Line	Platen	S	Center	Concealed	Concealed Pick	2	1.50	180 degrees	N	Y	N	N	
Wicomico	WI-383.03	25.88	2.50	NA	Raised Square	Ribbed	Stormwater	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	Lid is domed
Calvert	CA-383.03	25.88	2.50	NA	Raised Square	Ribbed	Stormwater	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	Lid is domed
Calvert	CA-383.61	19.50	1.63	107	Diamond	Platen	SD	Center	Open	Pick Hole	2	1.00	180 degrees	N	N	N	N	Lid is domed
Allegany	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Worcester	S-5	25.81	2.50	NA	Plain	Ribbed	Worcester County Sanitary Sewer	Radial	Concealed	Concealed Pick	2	1.50	180 degrees	Y	N	N	N	Lid has two concealed picks with two 1" picks
Queen Anne's	RD-106.05	22.00	1.50	NA	Diamond	Ribbed	Storm Drain	Center	NA	NA	NA	NA	NA	N	N	N	N	
Talbot	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line

Cover Matrix (Page 4 of 4)

County Name	Standard	Lid Diameter (in)	Lid Seat Depth (in)	Lid Weight Listed (lbs)	Lid Surface Design	Lid Type	Lettering	Lettering Location	Open or Concealed Pick	Pick Style	Number of Picks	Pick Size (in)	Pick Location	Vents (Y/N)	Bolted (Y/N)	Gasket (Y/N)	Inner Lid Option	Comments
Caroline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Dorchester	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Garrett	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Somerset	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Kent	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
WSSC	P&M-6.2	23.75	1.00	NA	Raised Line	Ribbed	S	Center	Concealed	Concealed Pick	2	1.50	Same Side	N	N	N	N	
WSSC	P&M-6.2	23.75	1.00	NA	Raised Line	Ribbed	W	Center	Concealed	Concealed Pick	2	1.50	Same Side	N	N	N	N	
WSSC	P&M 10.1b	31.88	1.13	310	Raised Line	Ribbed	S	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	Seat Depth = 1.31 w/gasket
WSSC	P&M 10.1b	31.88	1.13	310	Raised Line	Ribbed	W	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	Seat Depth = 1.31 w/gasket
WSSC	P&M 10.2b	37.88	1.13	410	Raised Line	Ribbed	S	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	
WSSC	P&M 10.2b	37.88	1.13	410	Raised Line	Ribbed	W	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	
WSSC	P&M 10.4a	22.00	1.50	NA	Raised Line	Ribbed	S	Center	Concealed	Concealed Pick	2	1.50	180 degrees	N	N	N	N	
WSSC	P&M 10.4a	22.00	1.50	NA	Raised Line	Ribbed	W	Center	Concealed	Concealed Pick	2	1.50	180 degrees	N	N	N	N	
WSSC	P&M 10.5a	23.75	2.50	145	Raised Line	Ribbed	S	Center	Concealed	Concealed Pick	2	1.50	Same Side	N	N	N	N	
WSSC	P&M 10.5a	23.75	2.50	145	Raised Line	Ribbed	W	Center	Concealed	Concealed Pick	2	1.50	Same Side	N	N	N	N	
WSSC	P&M 10.7a	23.88	1.13	NA	Raised Line	Platen	S	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	
WSSC	P&M 10.7a	23.88	1.13	NA	Raised Line	Platen	W	Center	Concealed	Pick Slot	2	2.00	180 degrees	N	Y	Y	N	
MDSHA	MD 383.32	25.88	2.50	170	Raised Square	Ribbed	SHA	Center	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	
MDSHA	MD 383.61	19.50	1.63	107	Diamond	Platen	SHA	Center	Open	Pick Hole	2	1.13	180 degrees	N	N	N	N	

Frame Matrix (Page 1 of 2)

County Name	Standard	Frame Opening (in)	Lid Seat Depth (in)	Frame Clear Opening (in)	Frame Height (in)	Frame OD (in)	Frame Weight (lbs)	Frame Design	Comments
Montgomery	WSSC	NA	NA	NA	NA	NA	NA	NA	Follows WSSC Standards
Prince George's	WSSC	NA	NA	NA	NA	NA	NA	NA	Follows WSSC Standards
Baltimore County	S-8	26.00	2.50	24.00	9.00	34.00	250	Straight Wall	
Baltimore County	S-8	32.00	2.50	30.00	9.00	40.00	310	Straight Wall	
Baltimore County	S-13	28.00	2.50	24.00	9.00	36.00	NA	Straight Wall	Water tight frame with innner cover
Baltimore County	D-3.05	26.00	2.50	24.00	9.00	34.00	250	Straight Wall	
Baltimore County	D-3.05	26.00	2.50	24.00	4.00	34.00	165	Straight Wall	
Baltimore County	D-3.06	22.25	1.50	20.00	4.00	28.00	NA	Cantilever - Flange Up	
Baltimore County	W-18	22.25	NA	NA	4.00	NA	NA	Straight Wall	
Baltimore County	W-18	24.25	NA	NA	4.00	NA	NA	Straight Wall	
Baltimore County	W-18	34.25	NA	NA	4.00	NA	NA	Straight Wall	
Baltimore City	BC 376.93	19.81	1.63	18.00	4.50	21.81	NA	Cantilever	Flange is not present
Baltimore City	BC 383.22	26.06	2.50	24.00	9.00	34.00	NA	Cantilever	Option for Locking frame on 383.25
Baltimore City	BC 383.24	32.25	2.50	29.75	9.00	40.00	NA	Cantilever	Option for Locking frame on 383.25
Baltimore City	BC 831.41	26.00	2.50	24.00	9.00	34.00	NA	Cantilever	
Baltimore City	BC 831.42	32.00	2.50	30.00	9.00	40.00	NA	Cantilever	
Baltimore City	BC 831.45	26.00	2.50	24.00	9.00	34.00	NA	Cantilever	
Baltimore City	BC 831.47	32.00	2.50	30.00	9.00	40.00	NA	Cantilever	
Baltimore City	BC 875.01	20.13	2.19	18.00	4.00	29.00	NA	Straight Wall	
Baltimore City	BC 876.01	26.00	2.50	24.00	9.00	34.00	NA	Straight Wall	
Baltimore City	BC 877.01	32.00	2.50	30.00	9.00	40.00	NA	Straight Wall	
Anne Arundel	D-16	26.13	2.50	24.00	9.00	34.00	NA	Straight Wall	
Anne Arundel	D-17	22.25	1.50	20.00	4.00	28.00	NA	Cantilever - Flange Up	
Anne Arundel	S-17	26.00	2.50	24.00	9.00	34.00	280	Straight Wall	
Anne Aurndel	S-18	24.00	1.25	21.00	8.00	39.00	NA	Tapered Wall	
Howard	G-5.51	26.13	2.50	24.00	9.00	34.00	250	Straight Wall	
Howard	G-5.52	24.00	1.25	21.00	8.00	35.00	215	Tapered Wall	
Frederick	5.1	26.00	2.50	NA	9.00	NA	NA	Straight Wall	Frame has inner cover option
Frederick	5.2	26.00	2.50	24.00	9.00	34.00	NA	Cantilever	

Frame Matrix (Page 2 of 2)

County Name	Standard	Frame Opening (in)	Lid Seat Depth (in)	Frame Clear Opening (in)	Frame Height (in)	Frame OD (in)	Frame Weight (lbs)	Frame Design	Comments
Harford	D-48	22.25	1.50	20.00	4.00	25.00	NA	Cantilever - Flange Up	
Harford	D-49	26.13	2.50	24.00	9.00	34.00	NA	Straight Wall	
Carroll	S-5	26.00	2.50	23.88	Varies	32.00	NA	Straight Wall	
Carroll	S-7	27.13	2.50	24.00	Varies	36.00	NA	Straight Wall	Frame has inner cover option
Carroll	88	26.13	2.50	24.00	9.00	34.00	NA	Straight Wall	
Charles	S-3.00	26.13	2.50	24.00	9.00	34.00	250	Straight Wall	
Washington	SW-2.6	32.25	1.50	30.25	6.50	40.00	NA	Cantilever	
Washington	SW-2.8	30.00	0.75	28.00	5.00	37.25	NA	Cantilever	
St. Mary's	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Cecil	R-32	22.25	1.50	20.00	4.00	28.00	185	Cantilever - Flange Up	
Cecil	R-33	26.25	2.50	24.00	9.00	34.00	250	Straight Wall	
Cecil	S-14	26.25	2.50	NA	9.00	34.00	250	Cantilever	Verify if the reduced open area is due to bolt pads
Cecil	S-15	26.25	2.50	NA	9.00	34.00	250	Cantilever	Verify if the reduced open area is due to bolt pads
Cecil	S-16	26.13	2.50	22.00	9.00	34.00	NA	Straight Wall	Frame has inner cover option
Cecil	S-17	24.13	1.25	21.75	8.00	39.00	NA	Cantilever	
Wicomico	WI-383.03	26.25	2.50	24.00	9.00	34.00	NA	Straight Wall	
Calvert	CA-383.03	26.13	2.50	24.00	9.00	34.00	NA	Straight Wall	
Calvert	CA-383.61	19.75	1.63	18.00	4.50	21.75	66	Cantilever	Flange is not present
Allegany	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Worcester	S-5	26.06	2.50	24.00	9.00	34.00	NA	Cantilever	
Queen Anne's	RD-106.05	22.25	1.50	20.00	4.00	28.00	NA	Cantilever - Flange Up	
Talbot	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Caroline	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Dorchester	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Garrett	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Somerset	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
Kent	NA	NA	NA	NA	NA	NA	NA	NA	Standards are not found on-line
WSSC	P&M 10.1b	32.00	1.31	30.00	8.00	44.00	340	Cantilever	
WSSC	P&M 10.2b	38.00	1.31	36.00	8.00	50.00	420	Cantilever	
WSSC	P&M 10.4a	22.38	1.50	20.00	4.00	28.25	130	Cantilever	
WSSC	P&M 10.5a	24.00	2.50	22.00	8.00	31.00	227	Straight Wall	
WSSC	P&M 10.7b	24.00	1.31	21.75	8.00	39.00	305	Cantilever	
MDSHA	MD 383.31	26.25	2.50	24.00	9.00	34.00	250	Straight Wall	
MDSHA	MD 383.61	19.75	1.63	18.00	4.50	21.75	66	Cantilever	Flange is not present