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4-1 GENERAL

This chapter provides the design criteria for the stormwater system, including pipes, culverts, catch basins, and open channels. Each of the sections references applicable standard details for the various types of systems or facilities.

Stormwater conveyance systems, flow control, water quality treatment, and low impact development best management practices shall be provided for all projects within the City of Snohomish (City) as required by these Standards, City adopted Department of Ecology (Ecology) Stormwater Management Manual for Western Washington (SWMM) and the City's Land Use Code.

4-2 STORMWATER CONVEYANCE SYSTEM

4-2.1 OVERVIEW

For the purposes of this section, the stormwater conveyance system includes all portions of the stormwater system (pipes, culverts, outfalls, and open channels) that transports stormwater runoff, either natural or man-made, except those features protected as environmentally sensitive areas under the City's land use code. Environmentally sensitive areas may only be modified as allowed under the City Land use Code. Stormwater must generally be treated and detained prior to discharge to an environmentally sensitive area, including those features created for mitigation.

4-2.2 DESIGN FLOW

All existing and proposed conveyance systems shall be designed to convey stormwater runoff from the 25-year storm event. The latest version of Ecology's Western Washington Hydrology Model (WWHM) will be used to determine the design flow for the stormwater conveyance system. Any other methodology must be requested in writing and receive written approval from the City prior to use.

A backwater analysis may be required for a proposed or existing pipe system if the ability of the pipe system to convey the peak rate of runoff from the 25-year design storm event may be effected by tail water conditions (outlet control) anywhere in the pipe system.

Structures such as catch basins and manholes for proposed pipe systems, such as catch basins and manholes, must provide a minimum of 0.5 feet of freeboard between the headwater surface (hydraulic grade line) and the top of the structure for flow from a 25-year storm. However, structures may overtop for flow resulting from a 100-year storm. When overtopping occurs for the 100-year storm, the additional flow over the ground surface is analyzed using the methods described in Section 1-6 and is added to the flow capacity of the

pipe system.

4-2.3 PIPE SYSTEMS

Pipe systems are networks of pipes, catch basins, manholes, inlets, and outfalls designed and constructed to convey stormwater. The hydraulic analysis of flow in pipes is typically limited to “gravity flow”. The following subsections give design criteria for different components and aspects of pipe systems.

4-2.3.1 PIPE MATERIALS

Pipe material, joints, and protective treatment shall conform to the requirements set forth in Section 9-05 of the WSDOT/APWA Standard Specifications. The following pipe materials are allowed for use in pipe systems in the City:

- (a) Plain Concrete Pipe (12-inches in diameter, used only for driveway culvert)
- (b) Reinforced Concrete Pipe
- (c) Ductile Iron Pipe
- (d) PVC Pipe (SDR35, ASTM D3034 with 3-feet of cover, minimum)
- (e) Profile wall PVC, culvert pipe, profile wall PVC storm sewer pipe (AASHTO M304, or ASTM F794 Series 46).
- (f) Pipe material not listed must receive City approval prior to use.

Coupling bands shall be of the same material as the pipe. Materials for concrete, rubber gaskets, metal castings, reinforcing steel, and masonry units shall meet the requirements of the appropriate sections of the WSDOT/APWA Standard Specifications.

4-2.3.2 PIPE SIZES, SLOPES, AND VELOCITIES

1. No storm drain pipe between catch basins or manholes in the public right-of-way shall be less than 12-inches in diameter; with the exception that 8-inch pipe may be used between inlets and catch basins in runs of 50-feet or less, as approved by the City.
2. Minimum velocity in any pipe or culvert carrying the design storm flow shall be two feet per second.
3. Maximum allowable velocity in concrete pipe shall be 30 feet per second.
4. Change of pipe size, material and direction are allowed only at structures.
5. Downstream decrease in pipe size is not a recommended practice and will only be allowed under special conditions, as approved by the City.

4-2.3.3 STRUCTURES

1. Catch basins, and inlets shall be constructed of pre-cast units in accordance with the following Standard Detail:

<u>Item</u>	<u>Detail</u>
Inlets	401
Catch Basins	402 through 404
Frames, Grates and Cover	405A through 409
Steps and Ladder	609 and 610 (Sanitary Sewer Details)

2. Catch basin (or manhole) diameter shall be determined by pipe size and orientation at the junction structure. A plan view of the junction structure, drawn to scale, will be required when more than four pipes enter the structure on the same plane, or if angles of approach and clearance between pipes is of concern. The plan view (and sections if necessary) must insure a minimum solid concrete wall distance between pipe openings of 8-inches for 48-inch and 54-inch catch basins and 12-inches for 72-inch and 96-inch catch basins.
3. Catch basin evaluation of structural integrity for H-20 loading may be required for multiple junction catch basins and other structures.
4. Catch basins shall be provided within 50-feet of the entrance to a pipe system to provide for silt and debris removal.
5. HDPE pipe systems longer than 100-feet must be secured at the upstream end and the downstream end must be placed in a four foot section of the next larger pipe size. This sliding sleeve connection accounts for the high thermal expansion/contraction coefficient of this pipe material.
6. The maximum slope of the ground surface for a radius of five feet around a catch basin grate shall be 3:1.
7. A Type II catch basin or a manhole shall be required when the depth to the flow-line exceeds 5-feet, regardless of the pipe size.
8. All Type II catch basins and all manholes shall be equipped with ladders per Standard Detail 609 and 610 (Sanitary Sewer Details).
9. A Type II catch basin shall be installed as the last collector in the public right-of-way prior to discharge to the combined sanitary sewer.
10. Concrete inlets shall not be used where the discharge goes directly into the main storm drain system.

4-2.3.4 PIPE ALIGNMENT/CONNECTIONS/COVER

1. Pipes must be laid true to line and grade with no curves, bends, or deflections in any direction, except for HDPE and ductile iron with flanged restrained mechanical joint

bends (not greater than 30 degrees) on steep slopes.

2. A catch basin or manhole will be required at all changes in pipe diameter and changes in grade or alignment.
3. Connections to a pipe system shall be made only at catch basins or manholes. No wyes or tees are allowed except on roof, footing, or yard drain systems on pipes eight inches in diameter or less, with clean-outs upstream of each wye or tee.
4. Six-inches minimum vertical and three-feet minimum horizontal clearance (between outside surfaces) shall be provided between storm drain pipes and other utility pipes and conduits.
5. Any closed storm drainage system collecting runoff from paved areas in the public right-of-way or private property shall provide for floatable material separation (see Standard Detail 410) prior to discharge to the main storm drainage system in the public right-of-way, unless otherwise approved by the City Engineer.
6. All PVC connections to catch basins or manholes shall be made by grouting in an approved manhole adapter into which the PVC pipe is inserted.
7. Activities such as trench excavation, tunneling or boring, pipe embedment, backfilling, compaction, all required testing, safety and pavement patching, whether for public or private utilities, shall conform to the requirements set forth in other sections of the City Standards.

4-2.3.5 FRAMES/LIDS/GRATES/COVERS

1. In general, frames and grates shall be furnished and installed per Standard Details 405A through 409.
2. The cover or grating of catch basins shall not be grouted to final grade until the final elevation of the pavement, gutter, ditch, or sidewalk in which it is to be placed has been established, and until permission thereafter is given by the City Inspector to grout the cover or grating in place.
3. Lids, grates, and covers shall be seated properly to prevent rocking.
4. All catch basins in unpaved areas shall be equipped with locking frames and lids or grates per Standard Detail 405A through 409.
5. Type II catch basins shall be supplied with bolt or locking lids or grates per Standard Detail 405A.
6. Type II catch basins functioning exclusively as access structures shall be equipped with round 24-inch covers and frames per Standard Details 405A.
7. Round lids on all storm drain structures shall have “DRAIN” or “STORM” cast into the lid.
8. In conditions when the effectiveness of a normal grate installation would be limited, an open curb face frame and grate shall be furnished and installed per Standard Details 408 and 409. These conditions include high likelihood of clogging from leaf fall, especially in

sag vertical curves; when the inlet is a surface drainage end point, such as a cul-de-sac; and when normal inlet grates may be passed over due to the road grade. The use of open curb face frame and grates must be approved by the City Engineer.

4-2.3.6 RESTRICTOR DEVICES

1. Minimum orifice size diameter allowed for use in the City is one (1) inch.
2. Restrictor devices shall be constructed and installed in accordance with Standard Details 412A through 412C.

4-2.3.7 DEBRIS BARRIERS

Debris barriers (trash racks) are required on all pipes entering or leaving a closed pipe system, including pipes entering or leaving a control/restrictor manhole or catch basin from a surface-type BMP (detention pond, infiltration basin, wet pond, biofiltration swale, etc.).

4-2.3.8 DRAINAGE EASEMENTS

1. Public drainage easements shall be a minimum of 20-feet wide for maintenance and access of pipes located outside of the public right-of-way which convey runoff from public streets or other facilities, unless otherwise approved by the City.
2. Where possible, pipes shall be located within the center of the drainage easement, but in no case shall a pipe be closer than five feet to a property line. If the pipe is not centered within the easement, the easement width will be adjusted to maintain a 10-foot minimum clearance from the outer edge of the pipe.
3. Where possible, drainage easements shall be contained on one lot, and not bisected by a lot line.
4. Shared private pipes must be located within private drainage easements.
5. Easements for downspout roof drains, yard drains, and footing drains are not required unless these systems are shared by more than one property owner.

4-2.4 CULVERT DESIGN CRITERIA

4-2.4.1 HEADWATER

1. For new culverts 18-inches in diameter or less, the maximum allowable 25-year design storm headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter/arch culvert height used and shall be one foot or more below the road or parking lot sub-grade.
2. For new culverts larger than 18-inches in diameter, the maximum 25-year design storm headwater elevation for the new culvert shall be one foot or more below the road or

parking lot sub-grade.

4-2.4.2 INLET

1. For culverts 18-inches in diameter and larger, the embankment around the culvert inlet shall be protected from erosion by rock lining or riprap as specified in Table 4-2.1, except the length shall be a minimum of five (5) feet (upstream of the culvert), and the height shall be at the design headwater elevation.
2. Trash racks/debris barriers are required on culverts that are over 60-feet in length and that are 12-inches to 36-inches in diameter. Exceptions are culverts on fish-bearing streams.
3. In order to maintain the stability of roadway embankments, concrete headwalls, wing walls, or tapered inlets and outlets may be required if right-of-way and/or easement constraints prohibit the culvert from extending to the toe of the embankment slope. Normally concrete inlet structures/headwalls installed in or near roadway embankments must be flush with and conform to the slope of the embankment.

4-2.4.3 OUTLETS

The receiving channel at the outlet shall be protected from erosion by rock lining, as specified in Table 4-2.1, except the height shall be one foot above the maximum tail water elevation or one foot above the crown of the pipe, whichever is higher.

4-2.5 OPEN CHANNEL DESIGN CRITERIA

Open channels, either natural or artificial, may be used to convey storm water on and from a site. In general, however, natural channels are protected as environmentally sensitive areas under the City's Land Use Code and may not be used to convey untreated, undetained storm water. Alteration of these channels, including bank stabilization projects, requires special permits. Artificial channels are those constructed from upland areas specifically to convey storm and surface water. In general, the criteria in this section do not apply to biofiltration swales, which are primarily designed to treat storm water runoff.

When constructing artificial channels, vegetation-lined channels are preferred when properly designed and constructed. Rock-lining may be necessary along the length of channels or at specific locations (such as bends and outfalls) when a vegetative lining will not provide adequate protection from erosive velocities.

4-2.5.1 ARTIFICIAL CHANNELS

1. Channel section geometry shall be trapezoidal. Side slopes shall not be steeper than 3H:1V for vegetation-lined channels and 2H:1V for rock-lined channels, unless the channel is engineered specifically for steeper slopes.

2. A minimum 0.5-foot freeboard above design flows must be provided.
3. Vegetation-lined channels shall have bottom slope gradients of five percent or less and a maximum average velocity at the design flow of five feet per second.
4. Rock-lined channels shall be used when design flow velocities exceed five feet per second. Rock lining shall be in accordance with Table 4-2.2.
5. A maintenance access easement shall be a minimum width of the channel top width plus ten (10) feet on both sides is required along all publicly maintained constructed channels located on private property. A minimum 15-foot setback must be provided between any structures and the top of the bank of the channel. However, required easement widths and building setback lines may vary with channel top width.

4-2.5.2 ROCK-LINING

In rock-lined channels, stone (riprap) is placed on the channel sides and bottom to protect the underlying material from erosion. Proper riprap design requires the determination of the median size of stone, the thickness of the riprap layer, the gradation of stone sizes, and the selection of angular stone which will interlock when placed.

Research by the U.S. Army Corps of Engineers has provided criteria for selecting the median stone size, W_{50} (Figure 4-2.1). If the riprap is to be used in a highly turbulent zone, such as a culvert outfall, downstream of a stilling basin, at sharp changes in channel geometry, etc., the median stone (W_{50}) should be increased from 200 percent to 600 percent depending on the severity of the locally high turbulence. The thickness of the riprap layer should generally be twice the median stone diameter (D_{50}) or at least that of the maximum stone. The riprap should have a reasonably well-graded assortment of stone sizes within the following gradation:

$$1.25^3 (D_{\max}/D_{50})^3 \leq 1.50, (D_{15}/D_{50}) = 0.50, (D_{\min}/D_{50}) = 0.25$$

4-2.5.3 RIPRAP FILTERS

Riprap should be underlain by a sand and gravel filter (or filter fabric) to keep the fine materials in the natural or artificial channel from being washed through the voids in the riprap. Likewise, the filter material must be selected so that it is not washed through the voids in the riprap. Adequate filters can usually be provided by a reasonably well-graded sand and gravel material with $D_{15} < 5d_{85}$, where d refers to the sieve opening through which 85 percent of the material being protected will pass and D_{15} has the same interpretation for the filter material. A filter with a D_{50} of 0.5 mm will protect any finer material including clay. Where very large riprap is used, it is sometimes necessary to use two filter layers between the material being protected and the riprap.

For additional information and procedures for specifying filters for riprap and general guidance,

refer to the Army Corps of Engineers Manual EM 1110-2-1601 (1970) “Hydraulic Design of Flood Control Channels”, paragraph 14, Riprap Protection.

4-2.6 FISH PASSAGE

Guidance for designing culverts for fish passage must be obtained from the Washington State Department of Fish and Wildlife.

4-3 OUTFALL DESIGN CRITERIA

4-3.1 GENERAL

1. All outfalls (at a minimum) shall be provided with rock protection per Table 4-2.1. For outfalls with a velocity at the design flow greater than ten feet per second, a gabion dissipater or engineered energy dissipater shall be required.
2. Mechanisms which reduce velocity prior to discharge from an outfall are encouraged.
3. Engineered energy dissipaters, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with velocity at design flow greater than 20 feet per second.
4. Inlet control will usually dictate outfall pipe system capacity. The inlet conditions should be carefully examined, as well as the consequences should the inlet to the pipe system become plugged or capacity exceeded.

4-3.2 OUTFALL SYSTEMS TRAVERSING STEEP SLOPES

1. Outfall systems constructed of pipe segments which are banded and/or gasketed are not acceptable for traversing steep slopes.
2. Continuously fused, welded or flange bolted mechanical joint pipe systems (such as high density polyethylene pipe (HDPEP) or ductile iron pipe with flange-bolted mechanical joints) with proper anchoring shall be used for outfall systems traversing steep slopes.
3. In general, outfall pipes systems shall be installed in trenches with standard bedding on slopes up to 20 percent. On slopes greater than 20 percent, outfall pipe systems shall be placed on the ground surface with proper pipe anchorage.
4. HDPEP outfall systems must be designed to address the material limitations as specified by the manufacturer, in particular thermal expansion/contraction and pressure design. Sliding sleeve connections to address thermal expansion and contraction shall be used. These sleeve connections consist of a section of the appropriate length of the next larger size diameter of pipe into which the outfall pipe is fitted. These sleeve connections must be located as close to the discharge end of the outfall system as is practical.
5. Flows of very high energy will require a specifically engineered energy dissipation

structure as described above.

4-4 OPEN CHANNEL DESIGN CRITERIA

Open channels, either natural or artificial, may be used to convey storm water on and from a site. In general, however, natural channels are protected as environmentally sensitive areas under the City's Land Use Code and may not be used to convey untreated, undetained storm water. Alteration of these channels, including bank stabilization projects, requires special permits. Artificial channels are those constructed from upland areas specifically to convey storm and surface water. In general, the criteria in this section do not apply to biofiltration swales, which are primarily designed to treat storm water runoff.

When constructing artificial channels, vegetation-lined channels are preferred when properly designed and constructed. Rock-lining may be necessary along the length of channels or at specific locations (such as bends and outfalls) when a vegetative lining will not provide adequate protection from erosive velocities.

4-4.1 ARTIFICIAL CHANNELS

1. Channel section geometry shall be trapezoidal. Side slopes shall not be steeper than 3H:1V for vegetation-lined channels and 2H:1V for rock-lined channels, unless the channel is engineered specifically for steeper slopes.
2. A minimum 0.5-foot freeboard above design flows must be provided.
3. Vegetation-lined channels shall have bottom slope gradients of five percent or less and a maximum average velocity at the design flow of five feet per second.
4. Rock-lined channels shall be used when design flow velocities exceed five feet per second. Rock lining shall be in accordance with Table 4-2.2.
5. A maintenance access easement shall be a minimum width of the channel top width plus ten (10) feet on both sides is required along all publicly maintained constructed channels located on private property. A minimum 15-foot setback must be provided between any structures and the top of the bank of the channel. However, required easement widths and building setback lines may vary with channel top width.

4-4.2 ROCK-LINING

In rock-lined channels, stone (riprap) is placed on the channel sides and bottom to protect the underlying material from erosion. Proper riprap design requires the determination of the median size of stone, the thickness of the riprap layer, the gradation of stone sizes, and the selection of angular stone which will interlock when placed.

Research by the U.S. Army Corps of Engineers has provided criteria for selecting the median stone size, W_{50} (Figure 4-2.1). If the riprap is to be used in a highly turbulent zone, such as a culvert outfall, downstream of a stilling basin, at sharp changes in channel geometry, etc., the median stone (W_{50}) should be increased from 200 percent to 600 percent depending on the severity of the locally high turbulence. The thickness of the riprap layer should generally be twice the median stone diameter (D_{50}) or at least that of the maximum stone. The riprap should have a reasonably well-graded assortment of stone sizes within the following gradation:

$$1.25^3 (D_{\max}/D_{50})^3 \leq 1.50, (D_{15}/D_{50}) = 0.50, (D_{\min}/D_{50}) = 0.25$$

4-4.3 RIPRAP FILTERS

Riprap should be underlain by a sand and gravel filter (or filter fabric) to keep the fine materials in the natural or artificial channel from being washed through the voids in the riprap. Likewise, the filter material must be selected so that it is not washed through the voids in the riprap. Adequate filters can usually be provided by a reasonably well-graded sand and gravel material with $D_{15} < 5d_{85}$, where d refers to the sieve opening through which 85 percent of the material being protected will pass and D_{15} has the same interpretation for the filter material. A filter with a D_{50} of 0.5 mm will protect any finer material including clay. Where very large riprap is used, it is sometimes necessary to use two filter layers between the material being protected and the riprap.

For additional information and procedures for specifying filters for riprap and general guidance, refer to the Army Corps of Engineers Manual EM 1110-2-1601 (1970) “Hydraulic Design of Flood Control Channels”, paragraph 14, Riprap Protection.

4-5 INSPECTION AND TESTING

All testing costs shall be paid by the party responsible for the work. The City Engineer shall have access to the project site for the purpose of inspections and testing at all times. Proper facilities, labor, materials and equipment shall be provided for such access, inspection, and testing.

If any work is covered without approval or consent of the City Engineer, it must be uncovered for inspection if required by the City Engineer.

All required tests are to be observed by the City Engineer. Copies of the test results must be provided to the City. Party responsible for the project shall ensure all necessary tests and re-tests are done and successfully completed to ensure that the material and/or equipment are in accordance with the plans and these Standards.

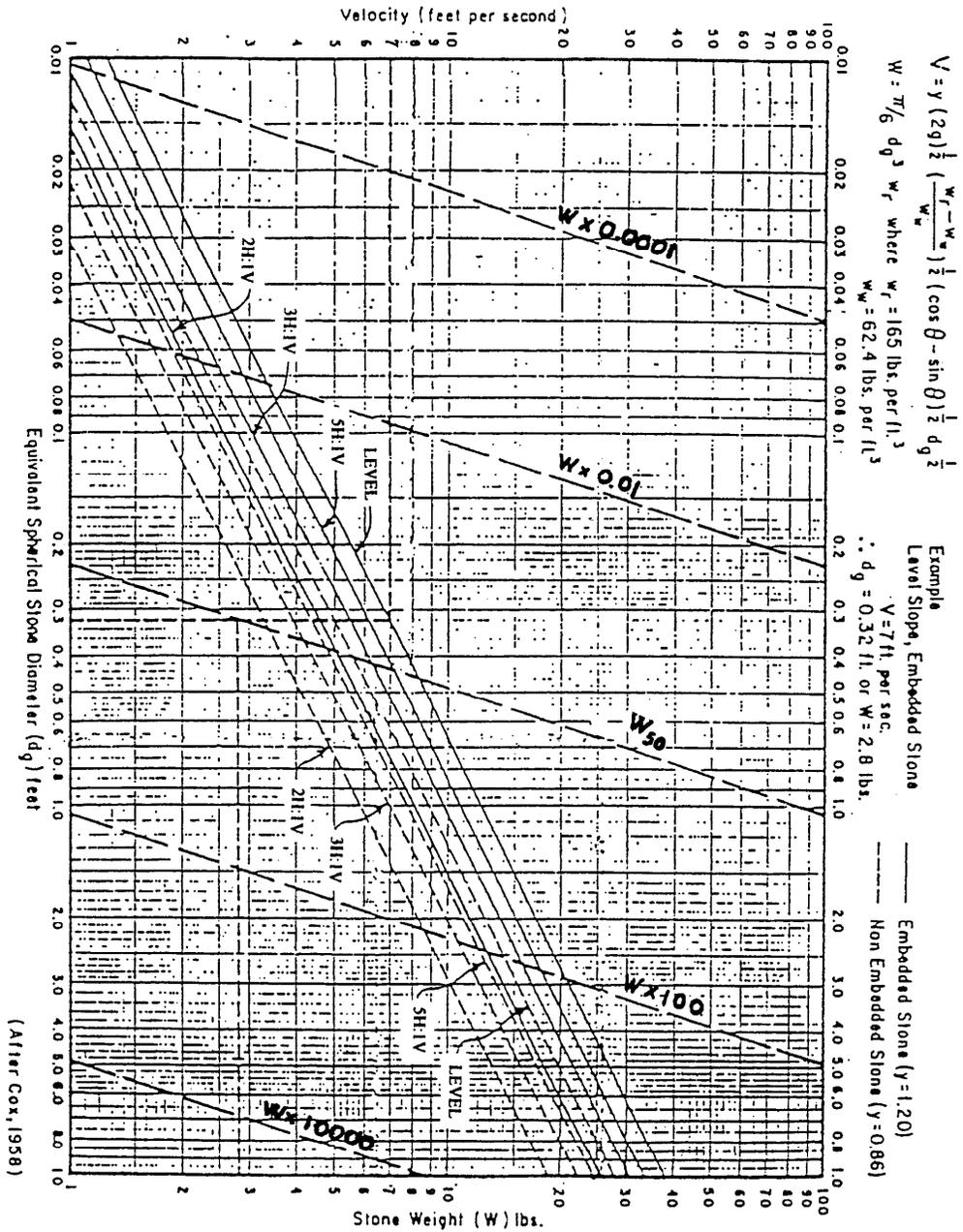
Written and verbal notices of deficiency shall be given to the party responsible for the work. Party responsible for the project shall correct such deficiencies and repeat tests as required before final inspection by the City Engineer. Party responsible for the project shall be responsible for all costs related to the tests and any repeat tests that are necessary.

All required tests must successfully pass before final project inspection by the City Engineer.

Figure 4-2. 1 Median Stone Size Selection for Riprap Design

STORM AND SURFACE WATER

Figure 4-2. 1 Median Stone Size Selection for Riprap Design



Rev. 4/02

Table 4-2. 1 Outfall Protection

STORM AND SURFACE WATER

Table 4-2.1 Outlet Protection

Design Flow Discharge Velocity (fps)	REQUIRED PROTECTION (Minimum Dimensions)				
	Type	Thickness	Width	Length	Height
0 - 5	Riprap*	1 ft	Diameter + 6 ft	8 ft or 4x diameter, whichever is greater	Crown + 1 ft
>5 - 10	Riprap**	1 ft	Diameter + 6 ft or 3x diameter, whichever is greater	12 ft of 3X diameter, whichever is greater	Crown + 1 ft
>10 - 20	Gabion	1 ft	As required	As required	Crown + 1 ft

Note: The stone for riprap shall be hard, sound, and durable and free of rock fines, soil, or other extraneous material. It shall also be free of segregation, seams, cracks, and other defects which would tend to destroy its resistance to weather.

* Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

- 100 % passing an 8 inch square sieve (maximum stone size = 8 inches)
- 40 - 60% passing a 6 inch square sieve (median stone size = 6 inches)
- 0 - 10% passing a 2 inch square sieve (minimum stone size = 2 inches)

** Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

- 100% passing a 24 inch square sieve (maximum stone size = 24 inches)
- 40 - 60% passing a 16 inch square sieve (median stone size = 16 inches)
- 0 - 10% passing a 4 inch square sieve (minimum stone size = 4 inches)

Note: The above riprap sizing assumes 3H:1V side slopes on the outlet channel.

Table 4-2. 2 Channel Protection

STORM AND SURFACE WATER

Table 4-2.2 Channel Protection

Velocity at Design Flow	Required Protection	Thickness	Min. Height Above Design Water Surface
0 - 5 fps	Grass Lining/Bioengineering	Not applicable	0.5 feet
>5 - 8 fps	Riprap*/Bioengineering	1 ft	1 ft
>8 - 12 fps	Riprap**	2 ft	2 ft
>12 - 20 fps	Slope Mattress	varies	2 ft
>20 fps	Gabion, etc.	varies	varies

Note: The stone for riprap shall be hard, sound, and durable and free of rock fines, soil, or other extraneous material. It shall also be free of segregation, seams, cracks, and other defects which would tend to destroy its resistance to weather.

* Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

- 100 % passing an 8 inch square sieve (maximum stone size = 8 inches)
- 40 - 60% passing a 6 inch square sieve (median stone size = 6 inches)
- 0 - 10% passing a 2 inch square sieve (minimum stone size = 2 inches)

** Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

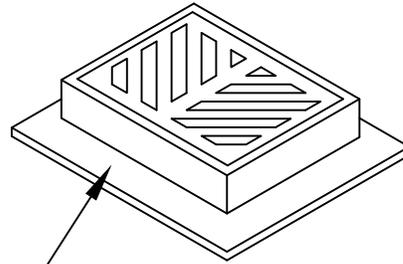
- 100% passing a 24 inch square sieve (maximum stone size = 24 inches)
- 40 - 60% passing a 16 inch square sieve (median stone size = 16 inches)
- 0 - 10% passing a 4 inch square sieve (minimum stone size = 4 inches)

**CITY OF SNOHOMISH
ENGINEERING DESIGN AND CONSTRUCTION STANDARDS**

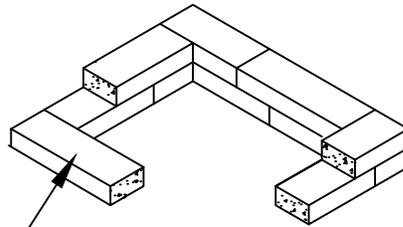
STORMWATER STANDARD DETAILS		
DETAIL NO.	TITLE	REVISED
401	Precast Concrete Inlet	April 2021
402	Catch Basin Type 1	April 2021
403	Catch Basin Type 1L	April 2021
404	Catch Basin Type 2 (48" or 54")	April 2021
405A	Hinged Manhole Cover	April 2021
405B	Grate Or Solid Cover Frame	April 2021
406A	Catch Basin Or Inlet Grate	April 2021
406B	Solid Cover For Catch Basin Or Inlet	April 2021
406C	Vaned Grate For Catch Basin Or Inlet	April 2021
407	Typical Frame And Grate Installation	April 2021
408	Open Curb Face Frame And Grate Installation	April 2021
409	Open Curb Face Frame & Grate Details	NOT USED
410	Floatable Material Separator And/or Gas Trap (6" or 8")	April 2021
411	Floatable Material Separator And/or Gas Trap (12" And Larger)	April 2021
412A	Typical Restrictor Installation	April 2021
412B	Typical Restrictor Installation	April 2021
412C	Lift Gate Assembly And Secondary Orifice	April 2021
413	NOT USED	NOT USED
414	NOT USED	NOT USED
415	NOT USED	NOT USED
416	NOT USED	NOT USED

STORMWATER STANDARD DETAILS		
DETAIL NO.	TITLE	REVISED
417	NOT USED	NOT USED
418	NOT USED	NOT USED
419	NOT USED	NOT USED
420	NOT USED	NOT USED
421	Oil/ Water Separator and Grit Removal Vault	April 2021
422A	Bypass Structure Type 1	April 2021
422B	Bypass Structure Type 2	April 2021
422C	Bypass Structure Type 3	April 2021
422D	Bypass Structure Type 4	April 2021
422E	Multiple Restrictor Structure	April 2021

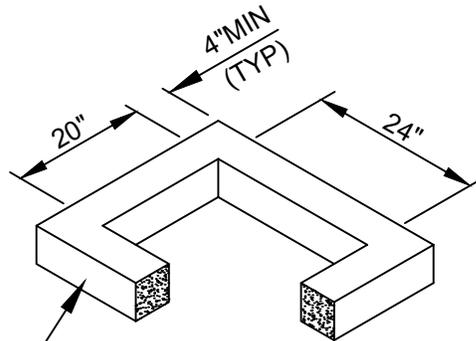
NOTE:
 INLET TO CONFORM TO
 WSDOT STANDARD PLAN B-26.



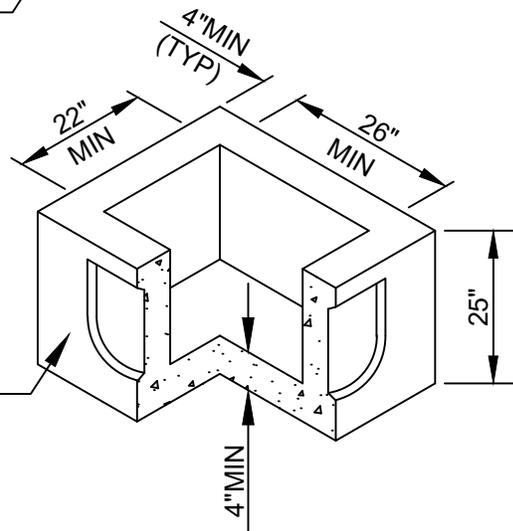
FRAME AND GRATE PER
 STD DETAILS 405A TO 406C



2"x4"x8" SOLID BRICK
 USED FOR FINAL ADJUSTMENT
 TO GRADE. 6" HIGH MAXIMUM.



6" OR 12" CONCRETE
 RISER SECTION
 CLASS 4000 CONCRETE



PRECAST CONCRETE BASE
 SECTION WITH MAXIMUM OF ONE
 17"Ø KNOCKOUT PER SIDE.
 ENTRANCE ANGLE TO BE LIMITED
 BY KNOCKOUTS CLASS 4000
 CONCRETE PIPE OUTER DIAMETER
 PLUS INLET WALL THICKNESS
 SHALL NOT EXCEED 17".



PRECAST CONCRETE INLET

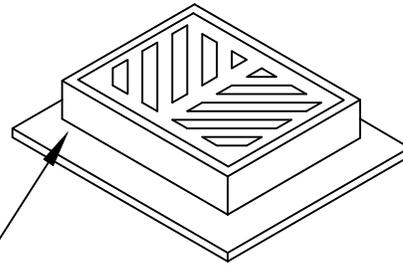
Approved By:
 Y. Monzaki
 City Engineer
 Date: APRIL 2021

401
 Number

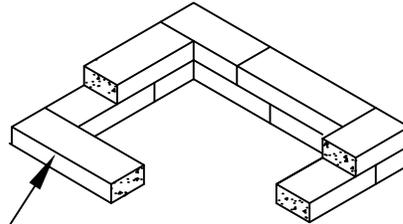
City of Snohomish Public Works Department

NOTE:
CATCH BASIN TO CONFORM TO
WSDOT STANDARD PLAN B-1.

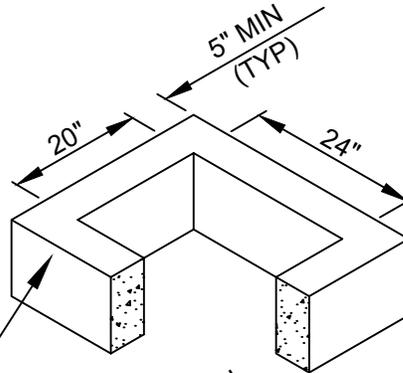
FRAME AND GRATE PER
STD DETAILS 405A TO 406C



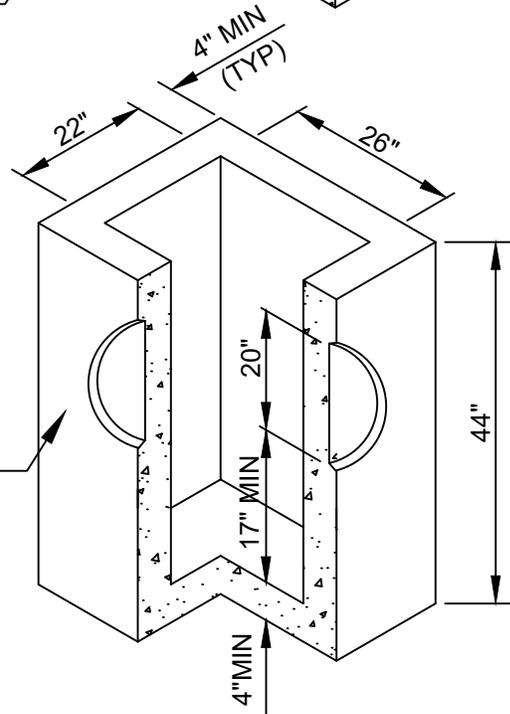
2"x4"x8" SOLID BRICK
USED FOR FINAL ADJUSTMENT
TO GRADE. 6" HIGH MAXIMUM.



6" OR 12" CONCRETE
RISER SECTION
CLASS 4000 CONCRETE



PRECAST CONCRETE BASE SECTION
WITH MAXIMUM OF ONE 20"Ø
KNOCKOUT PER SIDE. ENTRANCE
ANGLE TO BE LIMITED BY KNOCKOUTS
CLASS 4000 CONCRETE PIPE OUTER
DIAMETER PLUS CATCH BASIN WALL
THICKNESS SHALL NOT EXCEED 20".



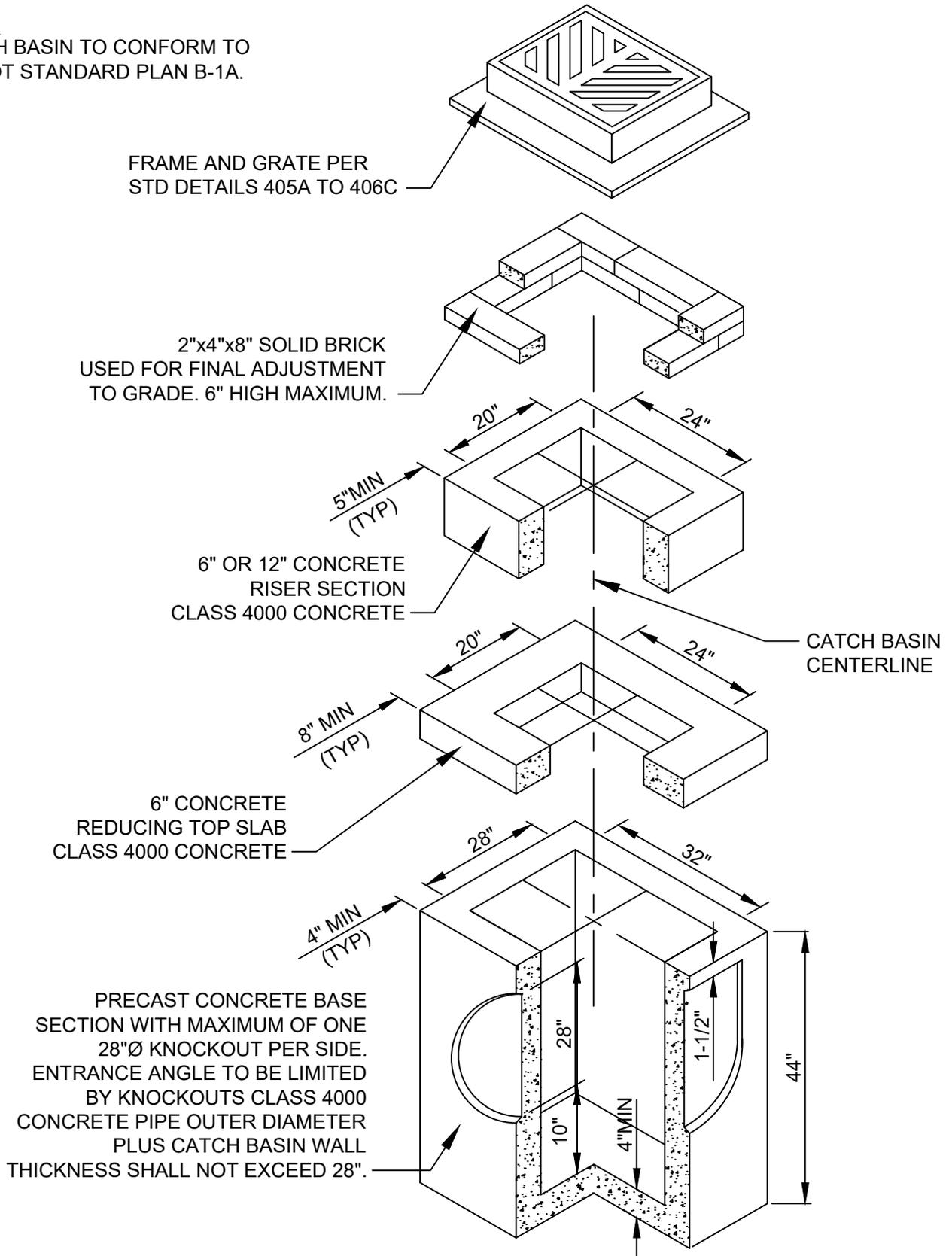
CATCH BASIN TYPE 1

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

402
Number

City of Snohomish Public Works Department

NOTE:
CATCH BASIN TO CONFORM TO
WSDOT STANDARD PLAN B-1A.



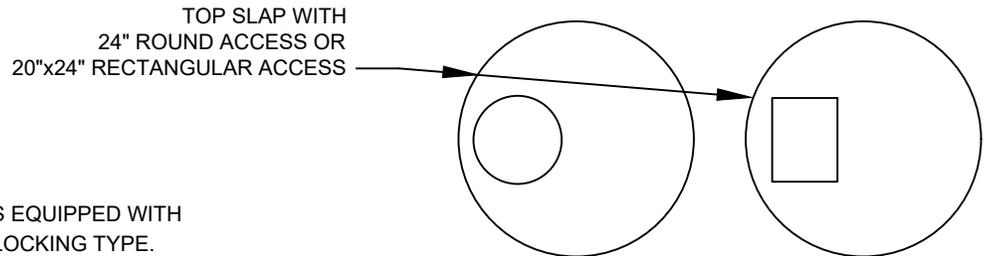
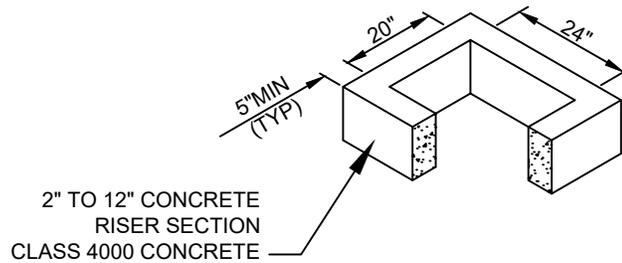
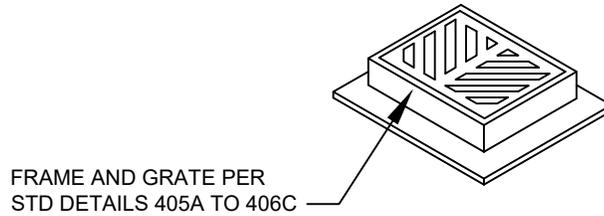
CATCH BASIN TYPE 1L

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

403
Number

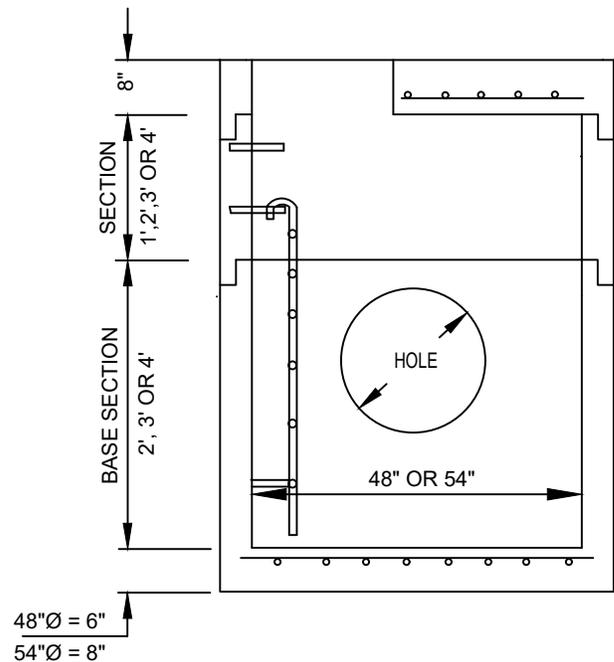
City of Snohomish Public Works Department

NOTE:
CATCH BASIN TO CONFORM TO
WSDOT STANDARD PLAN B-1E.



NOTES:

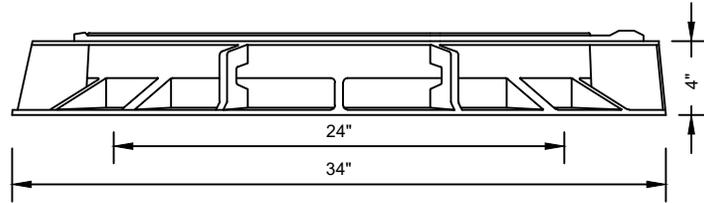
1. ALL TYPE 2 CATCH BASINS EQUIPPED WITH OPEN GRATES SHALL BE LOCKING TYPE.
2. ALL TYPE 2 CATCH BASINS NOT IN PAVED AREAS SHALL BE EQUIPPED WITH LOCKING LIDS.
3. CATCH BASINS SHALL BE SET SO THAT STEPS ARE DIRECTLY UNDER OPENING.
4. ALL TYPE 2 CATCH BASINS SHALL BE EQUIPPED WITH STEPS AND LADDER PER STD DETAIL 609 AND 610.
5. CONCRETE SHALL BE CLASS 4000.
6. MINIMUM DISTANCE FROM INVERT TO CATCH BASIN BOTTOM SHALL BE 24".
7. CATCH BASIN SECTIONS AND LID WILL BE HS20 TRAFFIC LOAD CERTIFIED BY MANUFACTURER.
8. HOLE SIZE = PIPE OD + 5" MAX
MAX HOLE SIZE = 36" (48" CB)
MAX HOLE SIZE = 42" (54" CB)



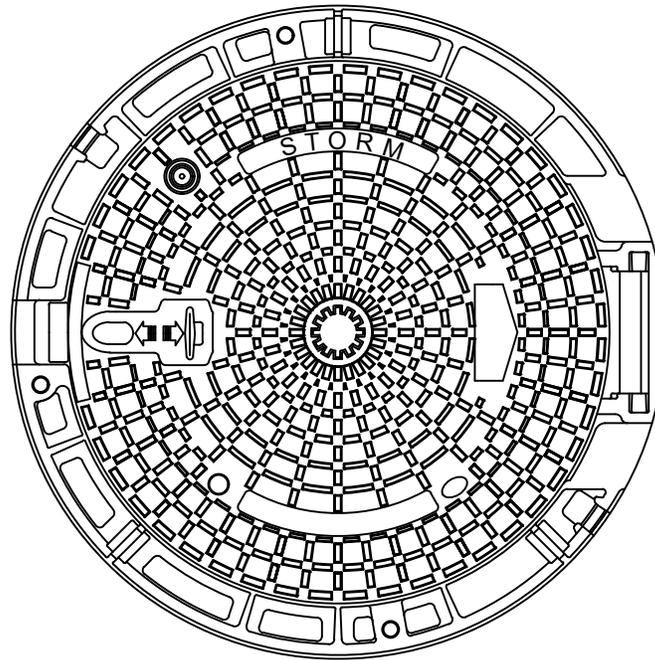
**CATCH BASIN TYPE 2
(48-INCH OR 54-INCH)**

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

404
Number



ELEVATION



PLAN

NOTES:

1. MANHOLE FRAME AND COVER SHALL BE DUCTILE IRON AND MANUFACTURED BY EJ (EAST JORDAN IRON WORKS) OR APPROVED EQUAL.
2. COVER SHALL BE STAMPED STORM AND HAVE A NON-SLIP 4L TREAD PATTERN.
3. COVER SHALL BE HINGED AND INCORPORATE A 90° SAFETY CATCH BLOCKING SYSTEM TO PREVENT ACCIDENTAL CLOSURE AND REMOVAL AT 120° OPEN.
4. COVER SHALL BE ONE PERSON OPERABLE USING STANDARD TOOLS.
5. FRAME AND COVER SHALL EXCEED AASHTO H20, M306 OR M105 LOADINGS.
6. FRAMES SHALL BE CIRCULAR, INCORPORATE A SEATING RING AND A FITTED PLUG IN EACH HINGE HOUSING.
7. FLANGE SHALL INCORPORATE BEDDING SLOTS, BOLT HOLES AND LIFTING EYES.
8. LOCKING COVER SHALL BE REQUIRED OUTSIDE OF PAVED TRAFFIC AREAS AND IN LOCATIONS AS DIRECTED BY CITY ENGINEER.

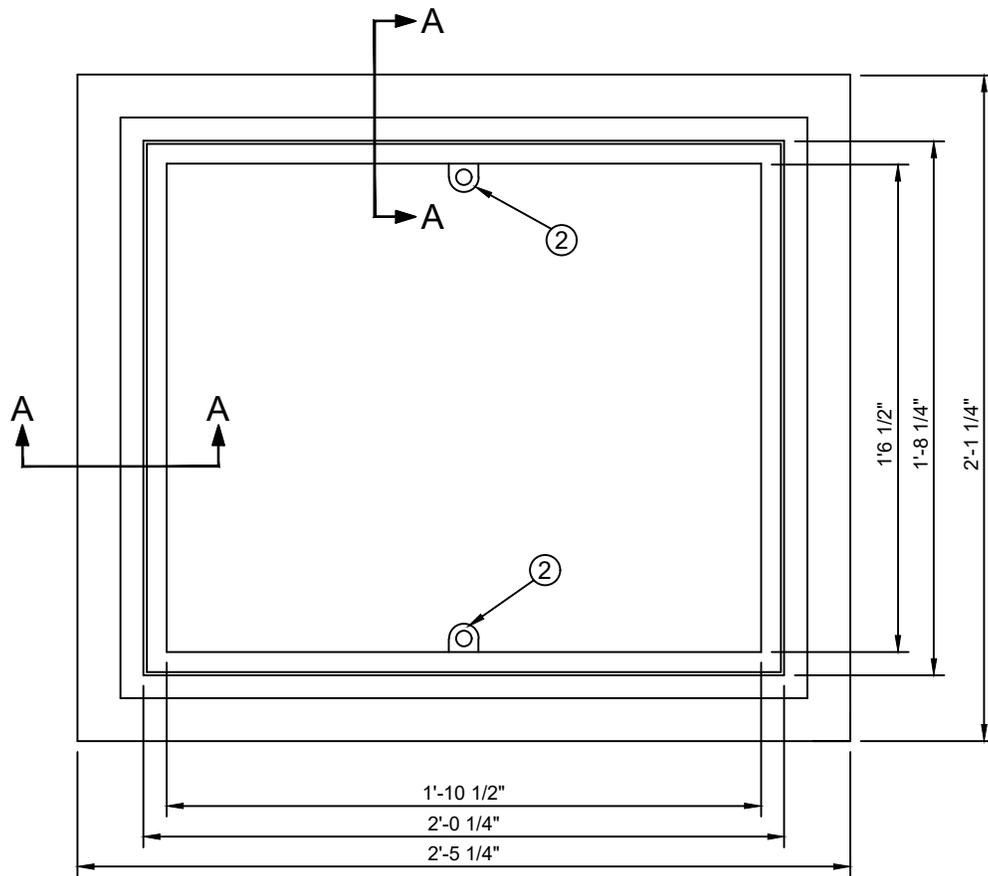


HINGED MANHOLE COVER

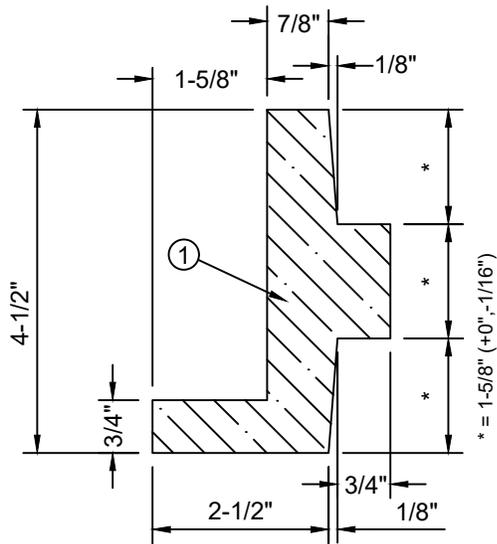
Approved By:
Y. Monzaki
City Engineer
Date: MARCH 2021

405A
Number

City of Snohomish Public Works Department



TOP VIEW



SECTION A-A

NOTE:

- ① MATERIAL USED SHALL BE CAST IRON PER ASTM-A48, CLASS 30.
- ② WHEN A LOCKING GRATE OR COVER IS REQUIRED THE FRAME SHALL BE FABRICATED TO ACCEPT TWO (2) 5/8" STAINLESS STEEL SOCKET HEAD CAP SCREWS OF GRATE OR COVER.

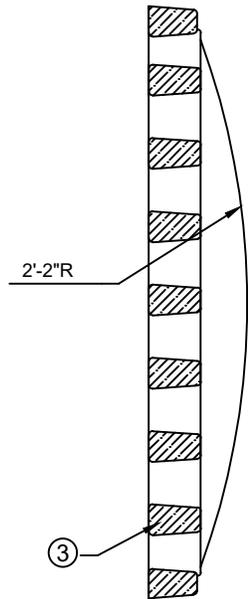
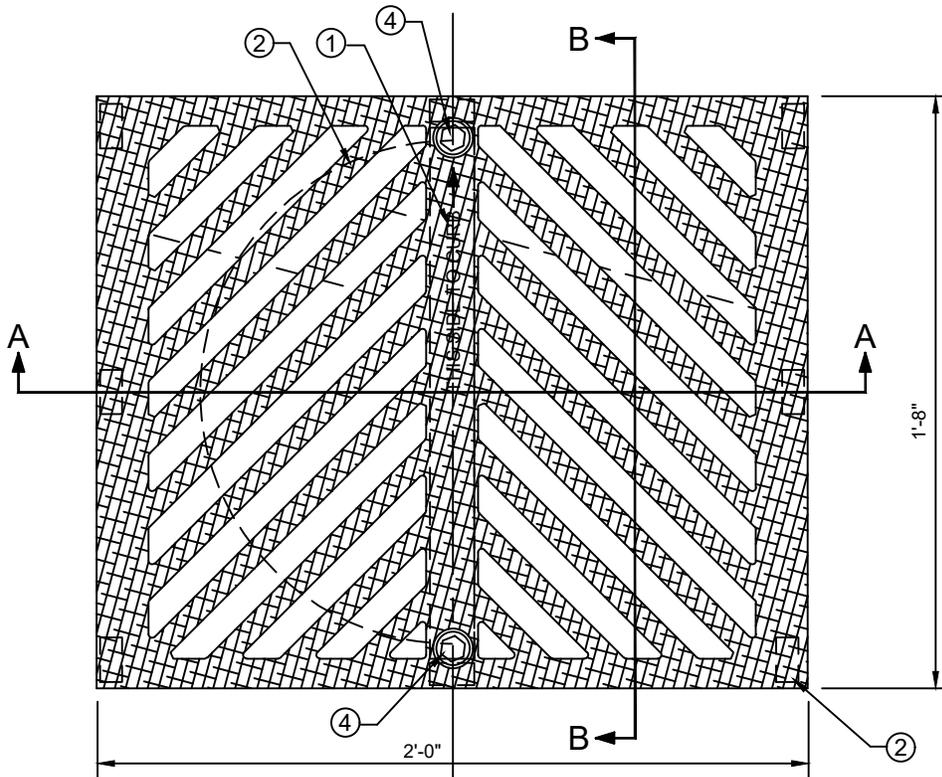


GRATE OR SOLID COVER FRAME

City of Snohomish Public Works Department

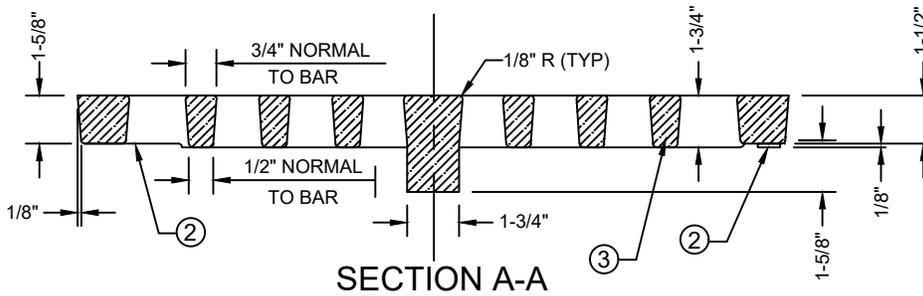
Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

405B
Number



PLAN

SECTION B-B



SECTION A-A

NOTES:

- ① FOUNDRY NAME, "THIS SIDE TO CURB" WITH ARROW AND "DI" FOR DUCTILE IRON SHALL BE EMBOSSED ON TOP OF GRATE WITH 1/16" RECESSED LETTERS.
- ② SEATING OF GRATE SHALL BE ACCOMPLISHED BY ONE OF THE FOLLOWING:
 - A. EIGHT INTEGRALLY CAST PADS (1-1/2"x3/4"x1/8").
 - B. MACHINE BOTTOM SURFACE OUTSIDE A 17" DIAMETER.
- ③ MATERIAL USED SHALL BE DUCTILE IRON PER ASTM-A536, GRADE 80-55-06.
- ④ WHEN LOCKING GRATE REQUIRED, HOLES WILL BE PROVIDED IN CASTING TO ALLOW FOR TWO 5/8" DIAMETER STAINLESS STEEL SOCKET HEAD CAP SCREWS. NO PART OF HEAD WILL PROTRUDE ABOVE TOP OF CASTING.

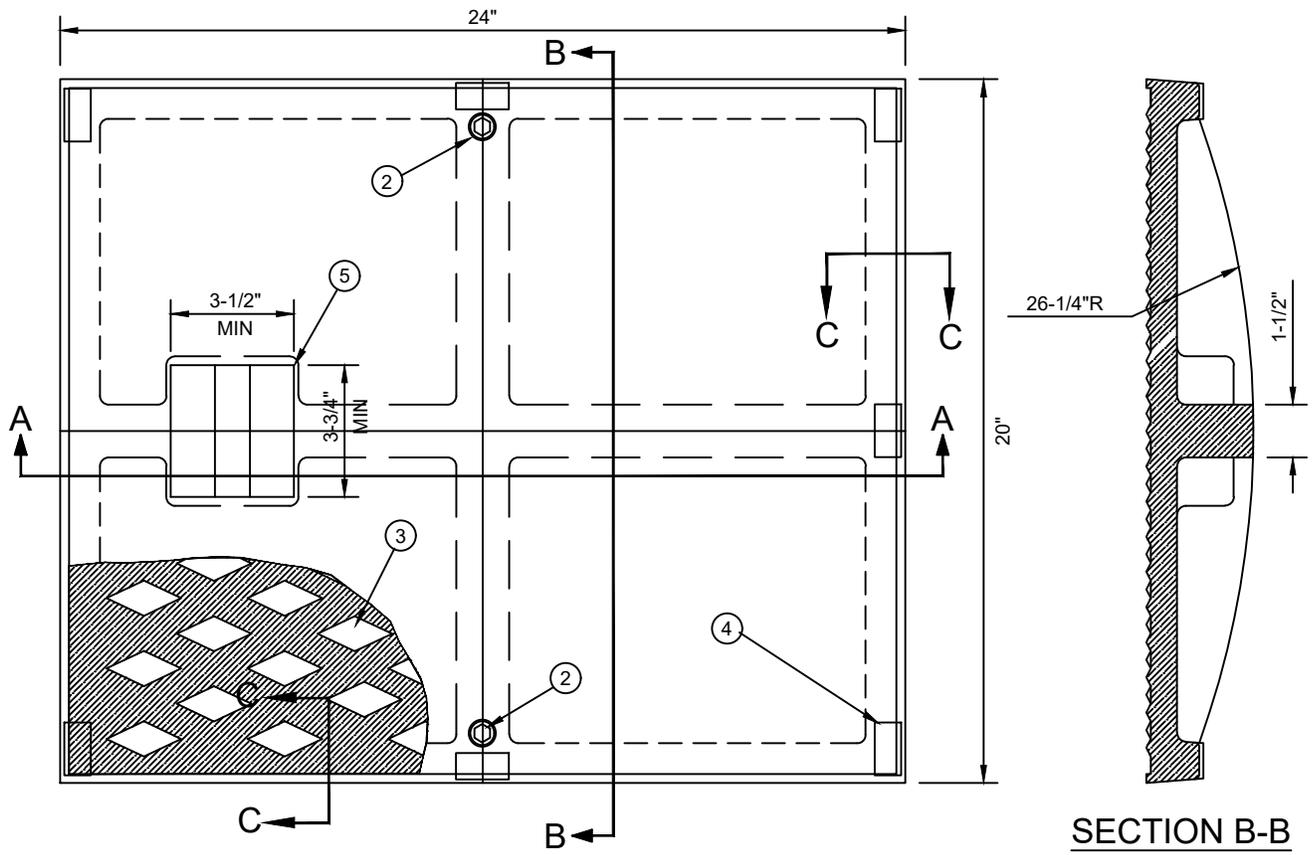


CATCH BASIN OR INLET GRATE

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

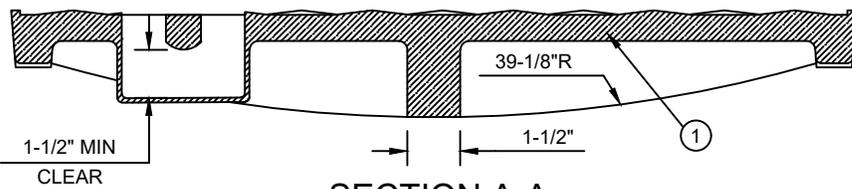
406A
Number

City of Snohomish Public Works Department

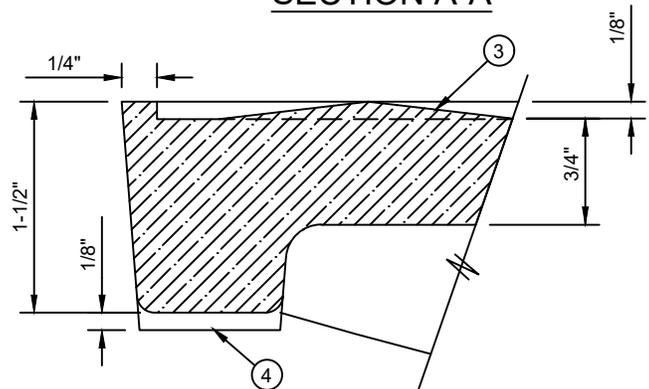


TOP VIEW

SECTION B-B



SECTION A-A



SECTION C-C

NOTE:

- ① MATERIAL USED SHALL BE DUCTILE IRON PER ASTM-A536, GRADE 80-55-06.
- ② WHEN LOCKING GRATE REQUIRED HOLES WILL BE PROVIDED IN CASTING TO ALLOW FOR TWO 5/8" DIA STAINLESS STEEL, SOCKET HEAD CAP SCREWS. NO PART OF SCREW WILL PROTRUDE ABOVE GRATE.
- ③ NON-SKID DIAMOND PATTERN APPROXIMATE 2-1/2"x1"x1/8" HIGH.
- ④ GRATE SEATING: EIGHT INTEGRALLY CAST PADS.
- ⑤ CAST POCKET LIFT HANDLE.

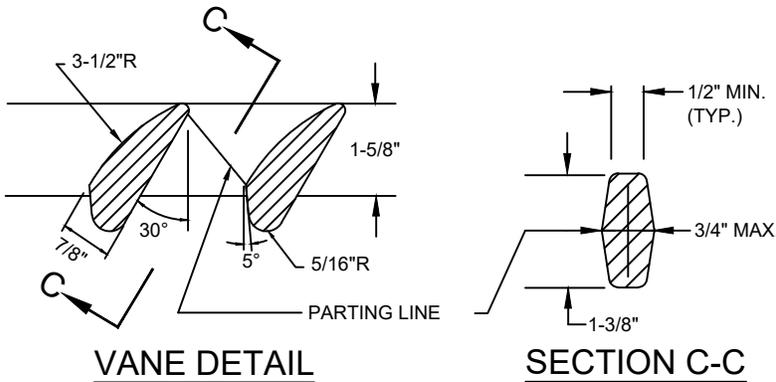
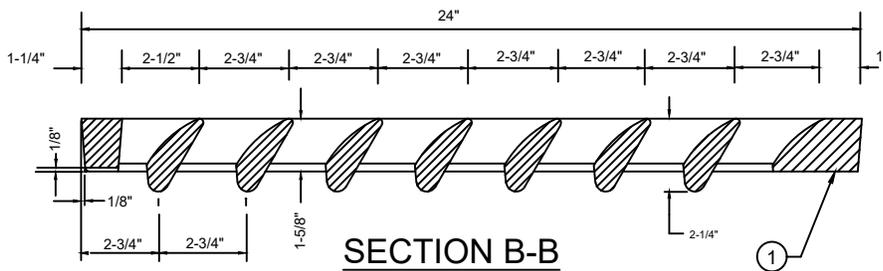
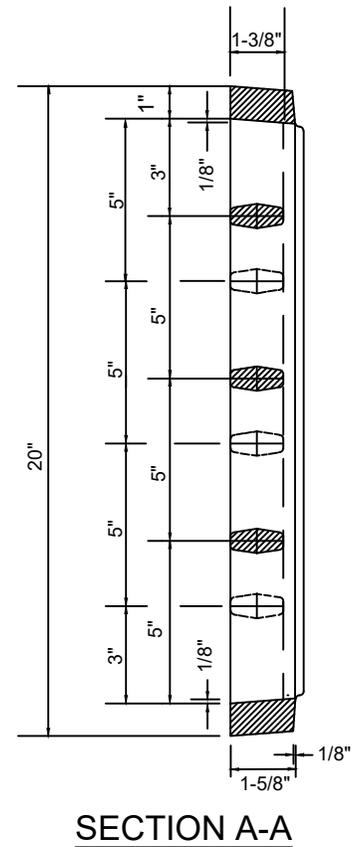
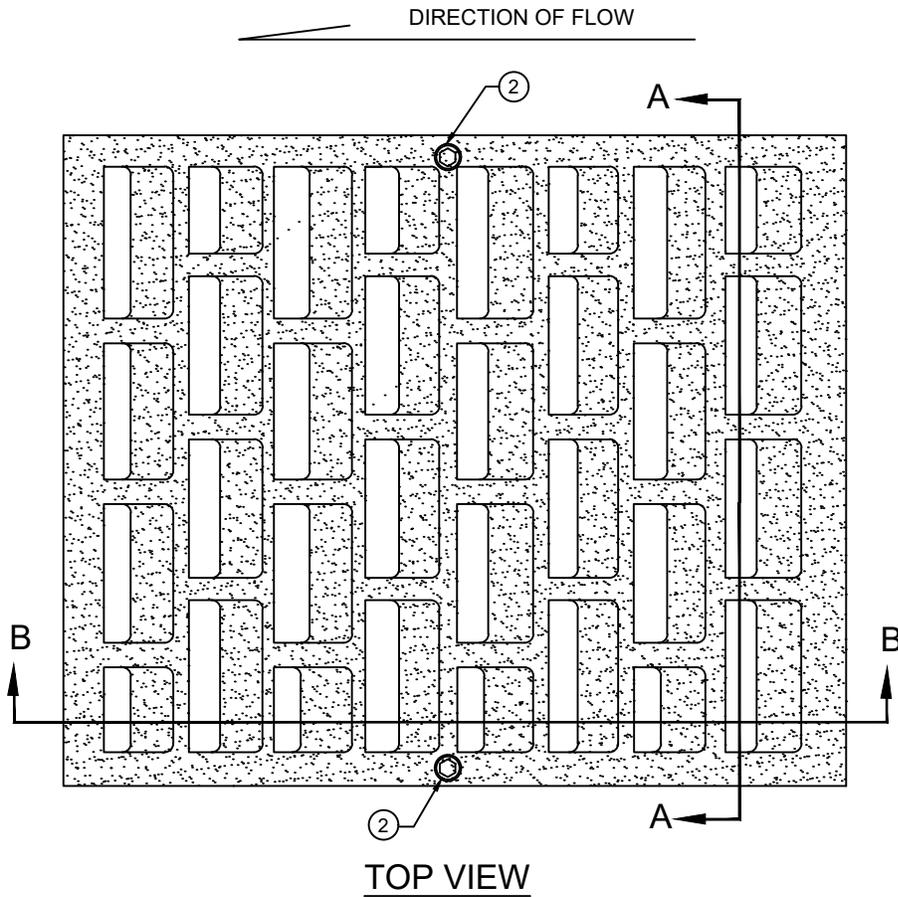


SOLID LID COVER FOR CATCH BASIN OR INLET

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

406B
Number

City of Snohomish Public Works Department



NOTE:

- ① MATERIAL USED SHALL BE DUCTILE IRON PER ASTM-A536, GRADE 80-55-06.
- ② WHEN LOCKING GRATE REQUIRED HOLES WILL BE PROVIDED IN CASTING TO ALLOW FOR TWO 5/8" DIAMETER STAINLESS STEEL, SOCKET HEAD CAP SCREWS. NO PART OF SCREW WILL PROTRUDE ABOVE GRATE.

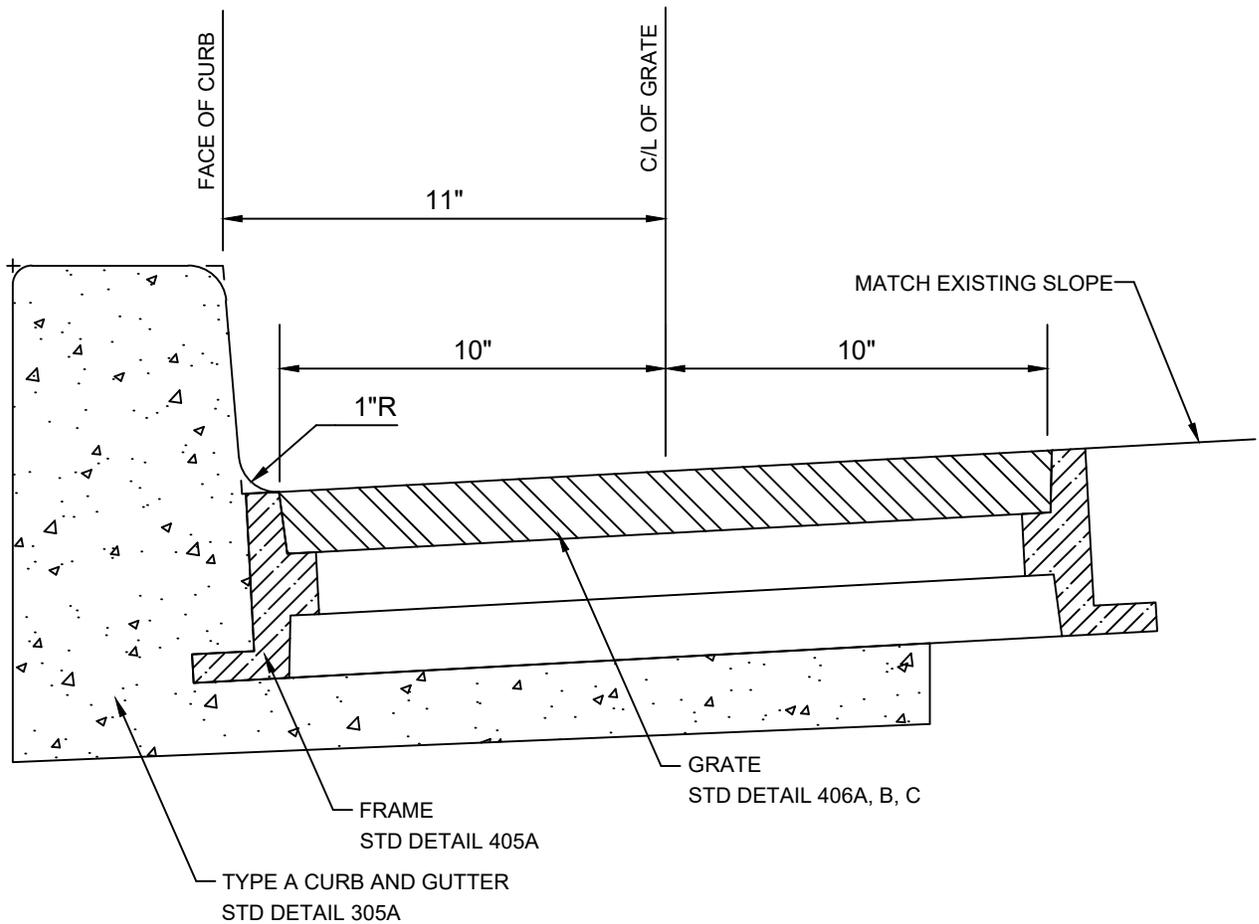


VANED GRATE FOR CATCH BASIN OR INLET

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

406C
Number

City of Snohomish Public Works Department

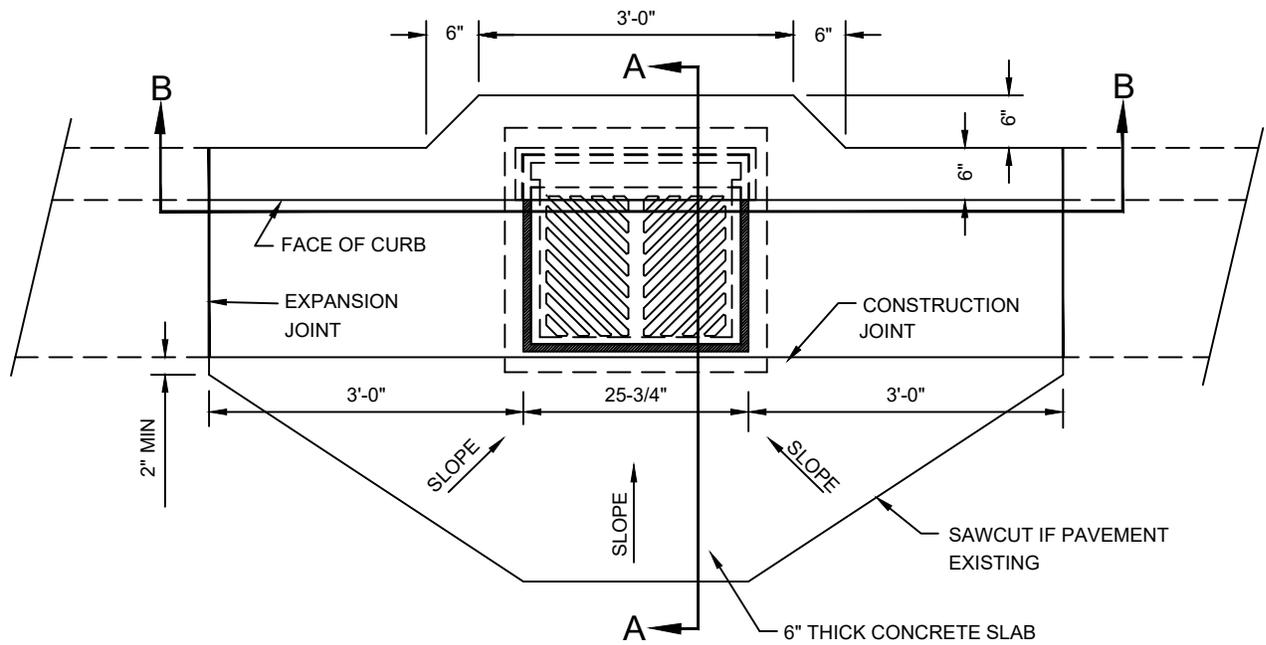


TYPICAL FRAME AND GRATE INSTALLATION

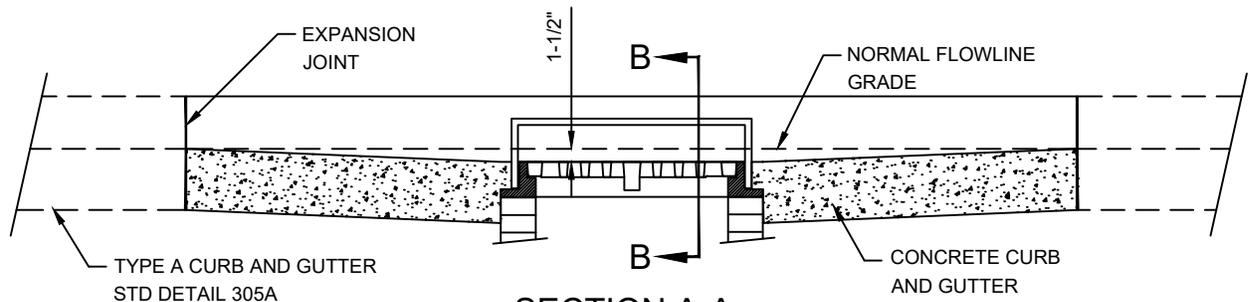
Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

407
Number

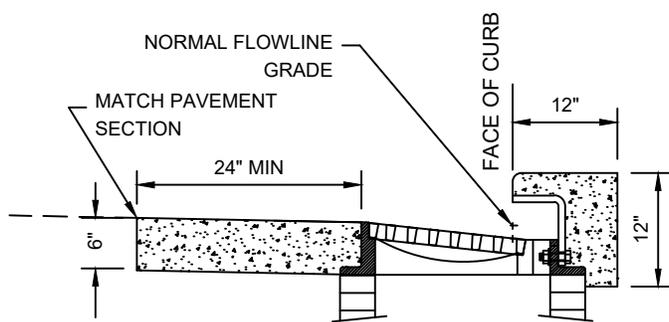
City of Snohomish Public Works Department



TOP VIEW



SECTION A-A



SECTION B-B

NOTES:

1. INSTALLATION OF OPEN CURB FACE FRAME AND GRATE MUST BE APPROVED BY CITY ENGINEER ON A CASE BY CASE BASIS.
2. PROBLEMS OF FLOATABLE MATERIAL ENTERING STORM DRAINAGE SYSTEM BY USE OF THIS INSTALLATION MUST BE ADDRESSED.
3. SEE STD DETAIL 409 FOR FRAME AND GRATE DETAILS.

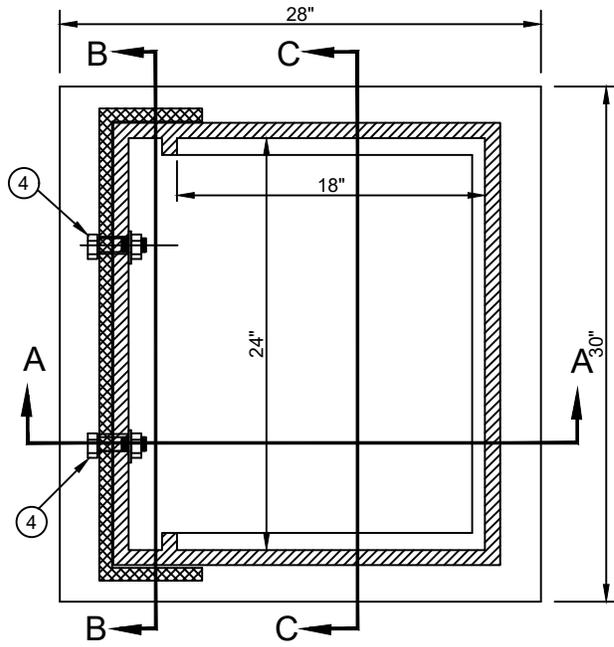


**OPEN CURB FACE FRAME AND GRATE
INSTALLATION**

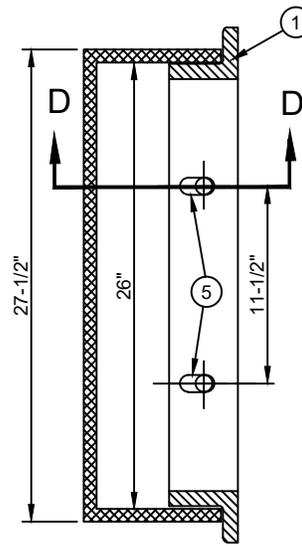
Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

408
Number

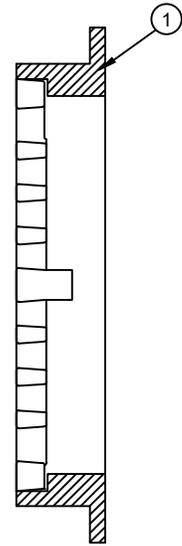
City of Snohomish Public Works Department



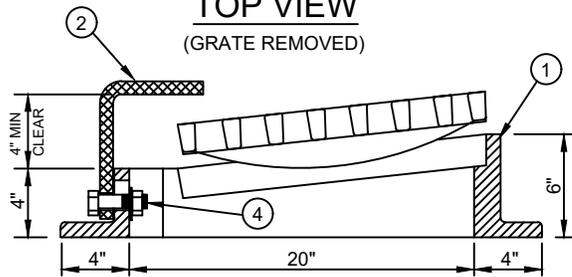
TOP VIEW
(GRATE REMOVED)



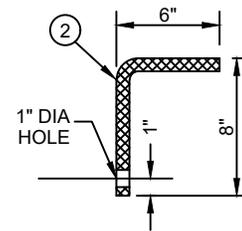
SECTION B-B



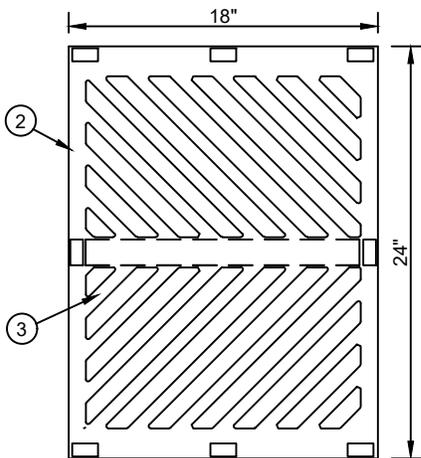
SECTION C-C



SECTION A-A
(GRATE RAISED)



SECTION D-D



GRATE TOP VIEW

NOTES:

- ① FRAME MATERIAL SHALL BE CAST IRON ASTM A48, CLASS 30.
- ② GRATE AND COVER MATERIAL SHALL BE DUCTILE IRON ASTM A536, GRADE 80-55-06.
- ③ GRATE TO BE FABRICATED PER STD DETAIL 406A WITH OVER ALL DIMENSIONS OF 24" x 18".
- ④ PROVIDE 3/4" BOLT, NUT AND WASHERS.
- ⑤ ADJUSTMENT SLOT IN FRAME CASTING APPROXIMATELY 1" x 2". VERTICAL PLACEMENT TO PROVIDE MINIMUM CLEARANCE BETWEEN GRATE AND COVER PLATE.
- ⑥ SEE STD DETAIL 408 FOR INSTALLATION DETAILS.

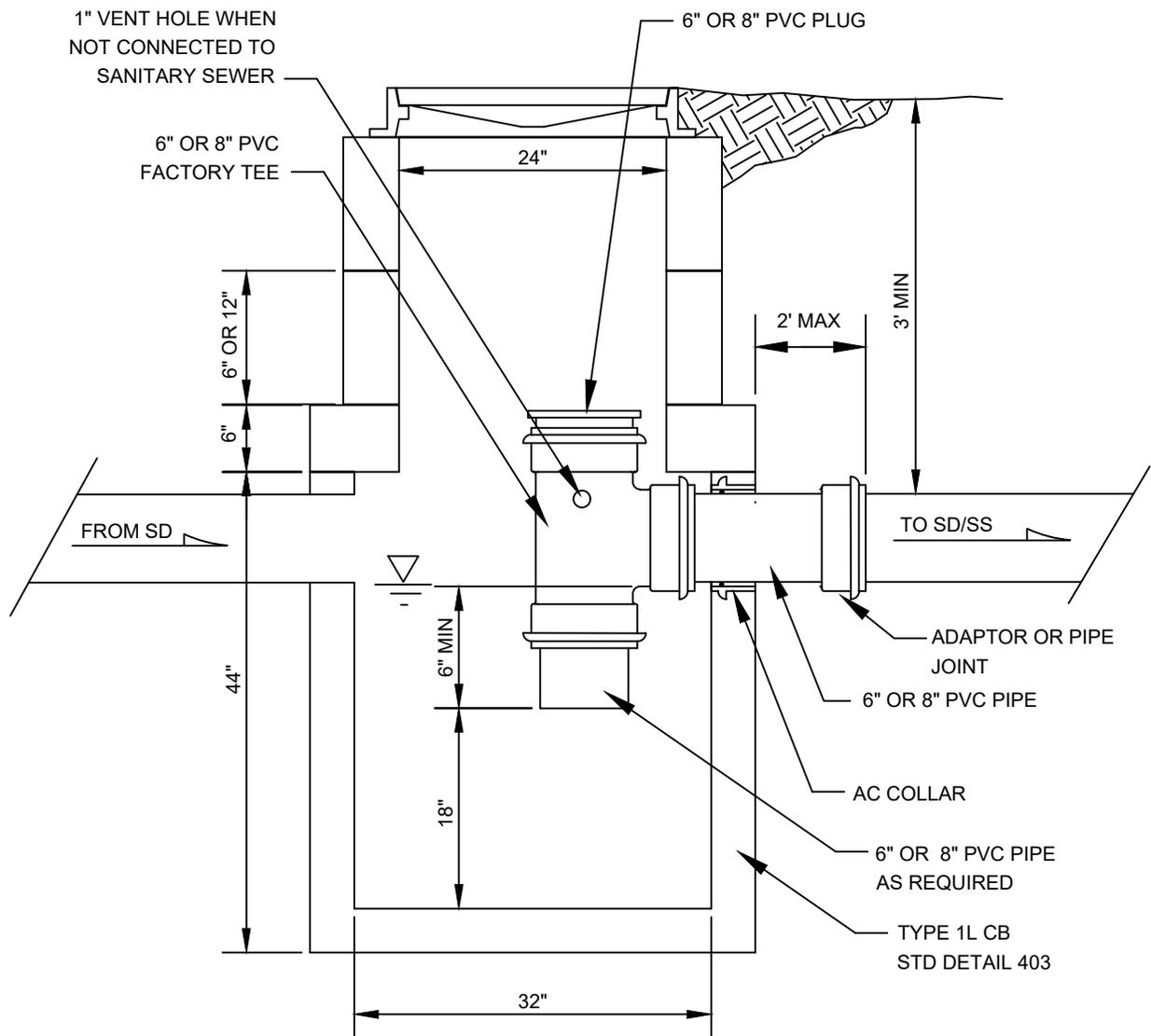


**OPEN CURB FACE FRAME AND GRATE
INSTALLATION**

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

409
Number

City of Snohomish Public Works Department

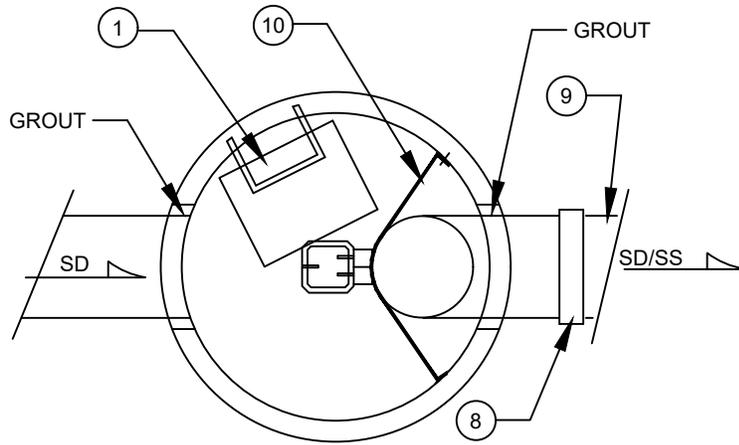


**FLOATABLE MATERIAL SEPARATOR
AND/OR GAS TRAP (6" OR 8")**

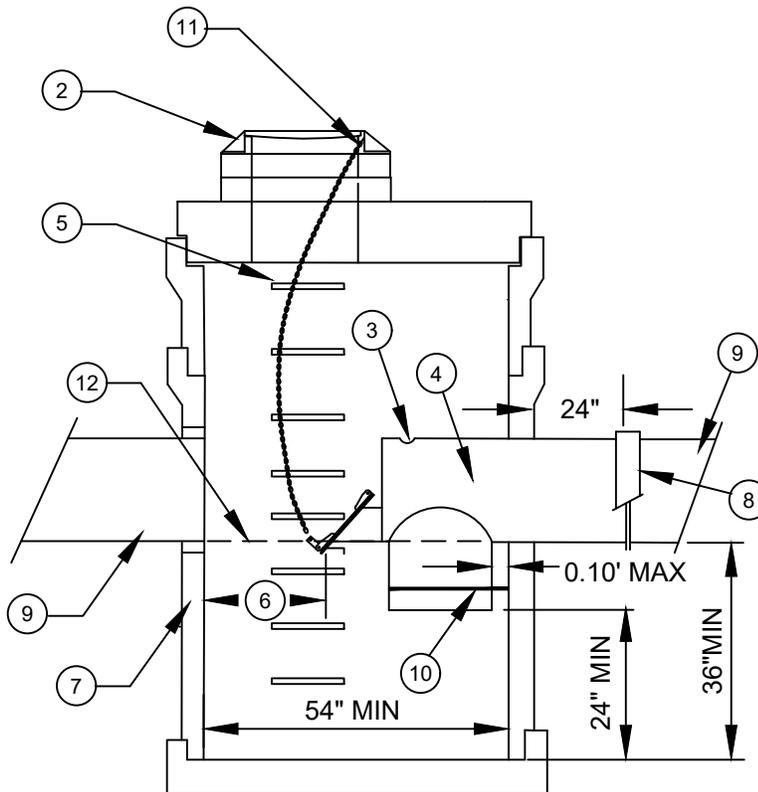
Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

410
Number

City of Snohomish Public Works Department



PLAN



ELEVATION

NOTES:

- ① INSTALL CATCH BASIN TOP, FRAME, GRATE AND SECTIONS SO THAT LIFT GATE IS VISIBLE THROUGH OPENING AND STEPS CLEAR INLET AND RESTRICTOR UNIT.
- ② INSTALL LOCKING FRAME AND GRATE OR LID PER STD DETAIL 405. FRAME AND LID PER STD DETAIL 405 IS REQUIRED IF INSTALLATION IS NOT IN PAVED AREA OR IS NOT TO FUNCTION AS A CATCH BASIN.
- ③ 1" VENT HOLE WHEN NOT CONNECTED TO TO COMBINED SANITARY SEWER SYSTEM.
- ④ SEPARATOR ASSEMBLY SEE STD DETAIL 412B AND 412C AS APPLICABLE.
- ⑤ STEPS PER STD DETAIL 606.
- ⑥ MINIMUM CLEARANCE:
36" FOR OUTLETS OF 24" AND LARGER
18" FOR OUTLETS OF 18" AND SMALLER
- ⑦ 54" TYPE 2 CB OR LARGER.
- ⑧ BAND STRAP WITH GASKET.
- ⑨ SEE PLAN AND SPECIFICATIONS FOR SIZE AND TYPE OF PIPE ENTERING AND EXITING CATCH BASIN.
- ⑩ SECURE SEPARATOR TO CATCH BASIN WITH 8 GAGE ALUMINUM STRAP. BOLT TO CATCH BASIN WALL WITH STAINLESS STEEL ANCHOR BOLTS AND TACK WELD TO SEPARATOR UNIT.
- ⑪ BOLT OR WELD CHAIN TO FRAME.
- ⑫ INVERT ELEVATION: SEE PLANS AND SPECIFICATIONS.

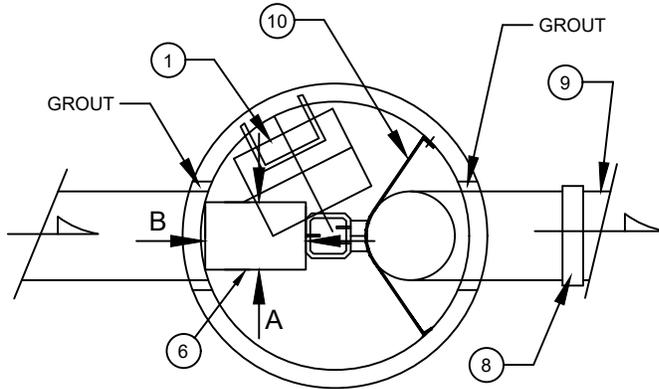


FLOATABLE MATERIAL SEPARATOR AND/OR GAS TRAP (12" AND LARGER)

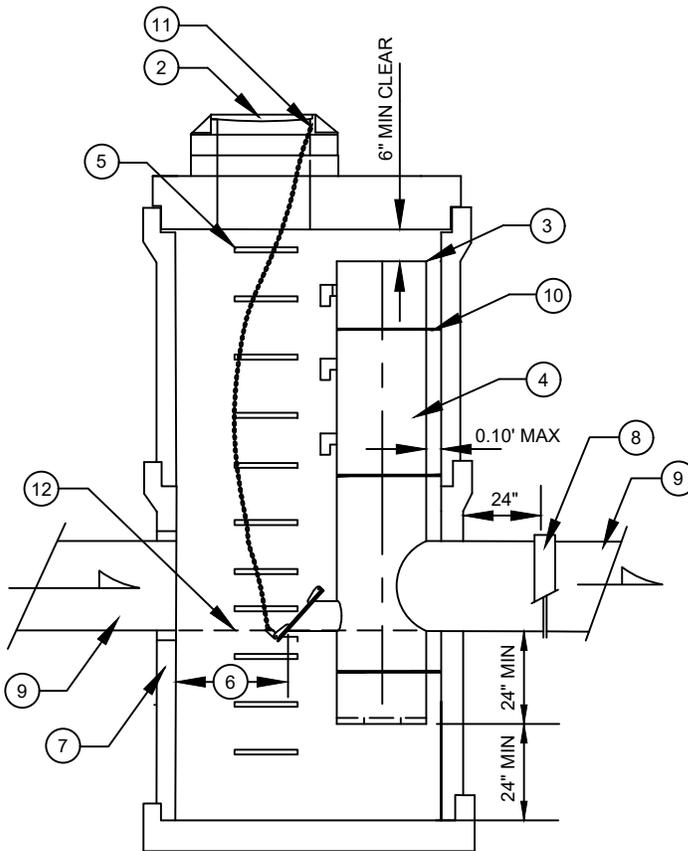
Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

411
Number

City of Snohomish Public Works Department



PLAN



ELEVATION

NOTES:

- ① INSTALL CATCH BASIN TOP, FRAME, GRATE AND SECTIONS SO THAT LIFT GATE IS VISIBLE THROUGH OPENING AND STEPS CLEAR INLET AND RESTRICTOR UNIT.
- ② INSTALL LOCKING FRAME AND GRATE OR LID PER STD DETAIL 405. FRAME AND LID PER STD DETAIL 405 IS REQUIRED IF INSTALLATION IS NOT IN PAVED AREA OR IS NOT TO FUNCTION AS A CATCH BASIN.
- ③ OVERFLOW ELEVATION.
- ④ RESTRICTOR ASSEMBLY SEE STD DETAIL 412B AND 412C.
- ⑤ STEPS PER STD DETAIL 606.
- ⑥ MIN CLEARANCE:
 36" FOR OUTLETS OF 24" AND LARGER
 18" FOR OUTLETS OF 18" AND SMALLER
 MAINTENANCE CLEAR ZONE: THIS AREA IS REQUIRED FOR CLEANING AND WILL BE FREE OF OBSTRUCTIONS FROM GATE TO TOP OF STRUCTURE.

DIM	OUTLET SIZE	
	18" AND SMALLER	24" AND LARGER
A	18"	36"
B	18"	24"

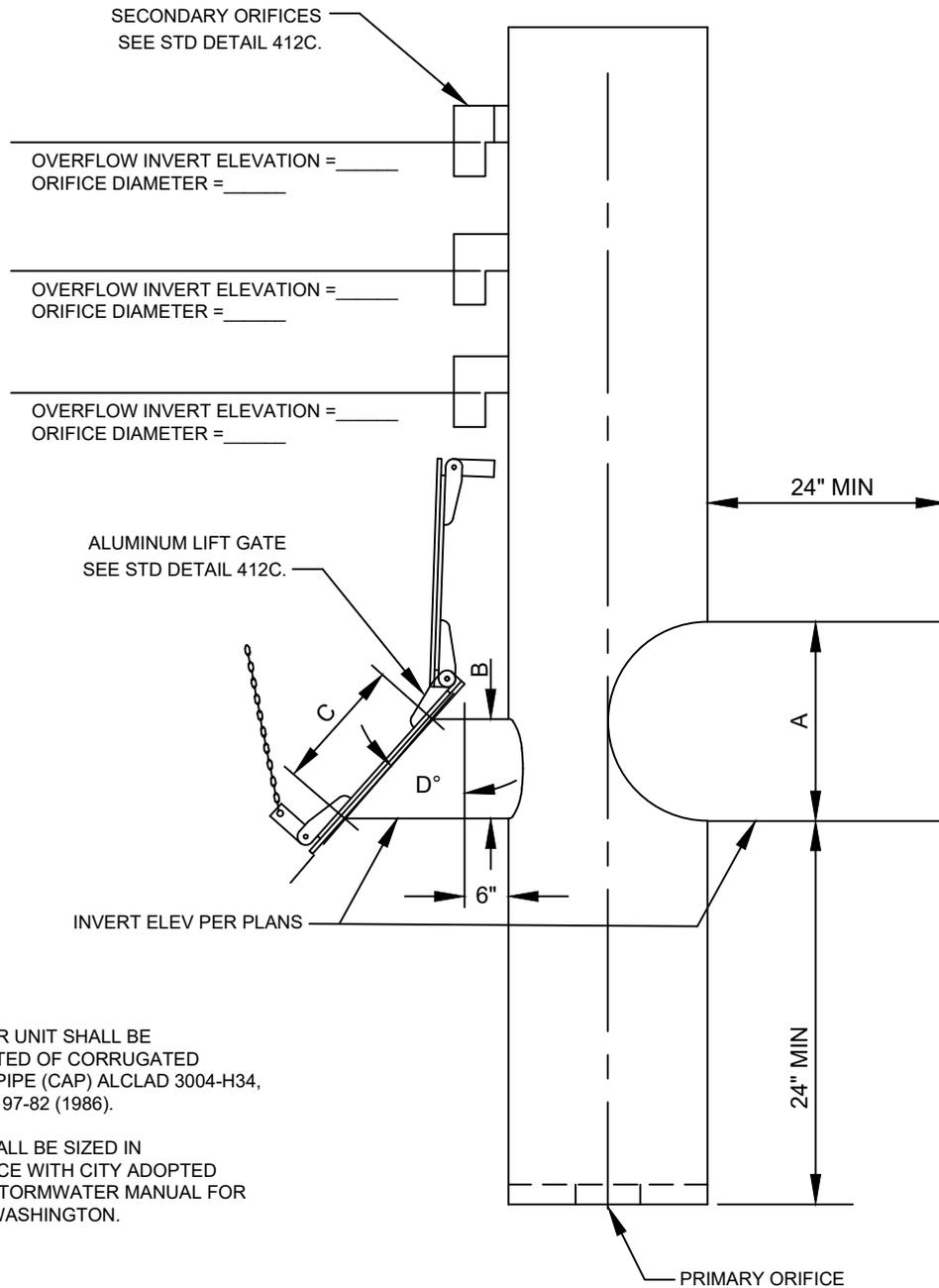
- ⑦ 54" TYPE 2 CATCH BASIN OR LARGER.
- ⑧ BAND STRAP WITH GASKET.
- ⑨ SEE PLAN AND SPECIFICATIONS FOR SIZE AND TYPE OF PIPE ENTERING AND EXITING CATCH BASIN.
- ⑩ SECURE RESTRICTOR TO CATCH BASIN WITH 8 GAGE ALUMINUM STRAPS BOLT TO CB WALL WITH STAINLESS STEEL ANCHOR BOLTS AND TACK WELD TO RESTRICTOR UNIT. ONE STRAP ABOVE AND BELOW OUTLET REQUIRED, INTERMEDIATE STRAPS REQUIRED FOR RESTRICTOR RISERS GREATER THAN 12' ABOVE OUTLET.
- ⑪ BOLT OR WELD CHAIN TO FRAME.
- ⑫ INVERT ELEVATION: SEE PLANS AND SPECIFICATIONS.



TYPICAL RESTRICTOR INSTALLATION

Approved By:
 Y. Monzaki
 City Engineer
 Date: APRIL 2021

412A
 Number



NOTES:

1. RESTRICTOR UNIT SHALL BE CONSTRUCTED OF CORRUGATED ALUMINUM PIPE (CAP) ALCLAD 3004-H34, AASHTO M 197-82 (1986).
2. ORIFICE SHALL BE SIZED IN ACCORDANCE WITH CITY ADOPTED ECOLOGY STORMWATER MANUAL FOR WESTERN WASHINGTON.

ITEM	DESCRIPTION	SIZE	
		18" AND SMALLER	24" AND LARGER
A	OUTLET	18" AND SMALLER	24" AND LARGER
B	CLEANING	6" ID	10" ID
C	GATE SIZE	8" OPENING	12" OPENING
D	ANGLE	42°±	34°±



TYPICAL RESTRICTOR INSTALLATION

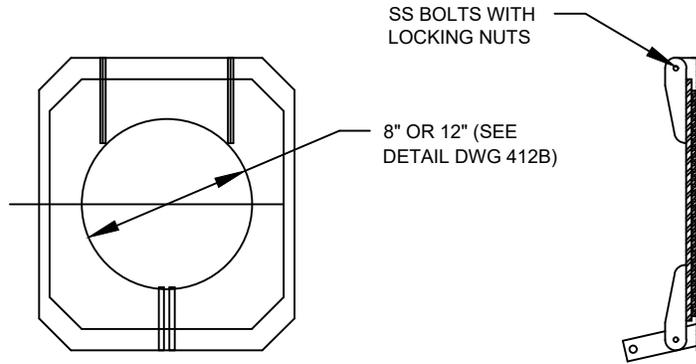
Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

412B
Number

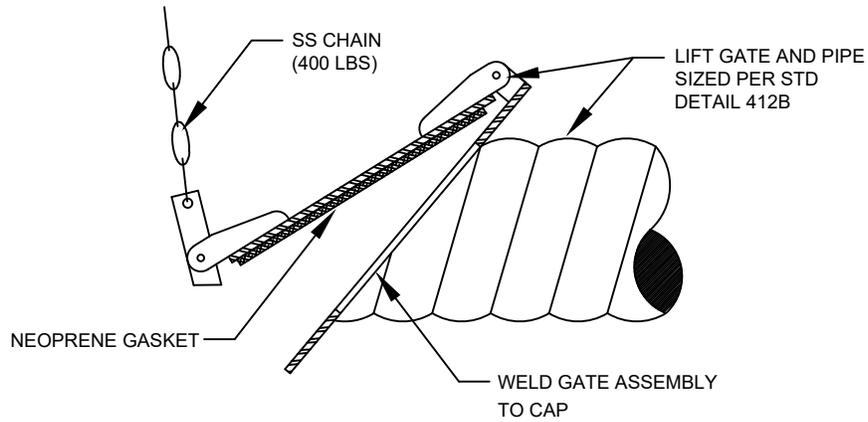
City of Snohomish Public Works Department

NOTES:

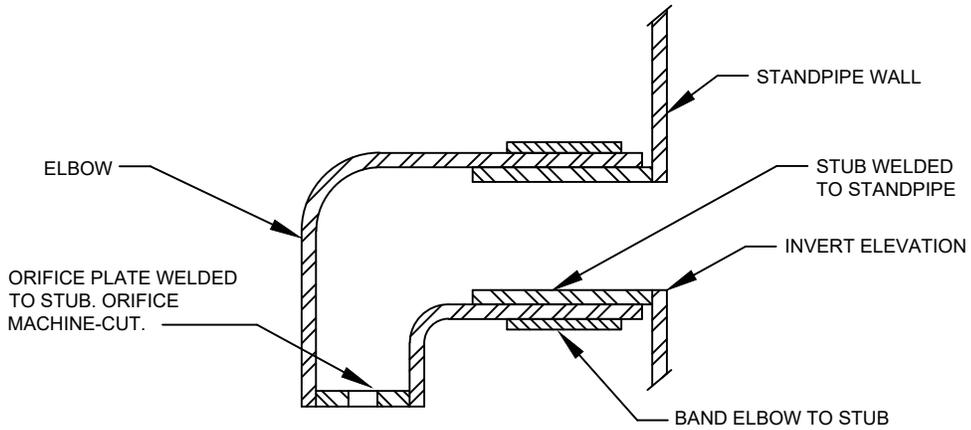
LIFT GATE SHALL BE CONSTRUCTED OF 1/4" R-6061-T6 ALUMINUM. WITH CLOSED CELL NEOPRENE PER ASTM 1056-67 CHEMICAL RESISTANT (OIL AND GREASE), OZONE RESISTANT, 67° TO 250° F SERVICE TEMPERATURE.



LIFT GATE DETAIL



LIFT GATE ASSEMBLY



ALL PARTS TO BE R-6061-T6 ALUMINUM

SECONDARY ORIFICE DETAIL

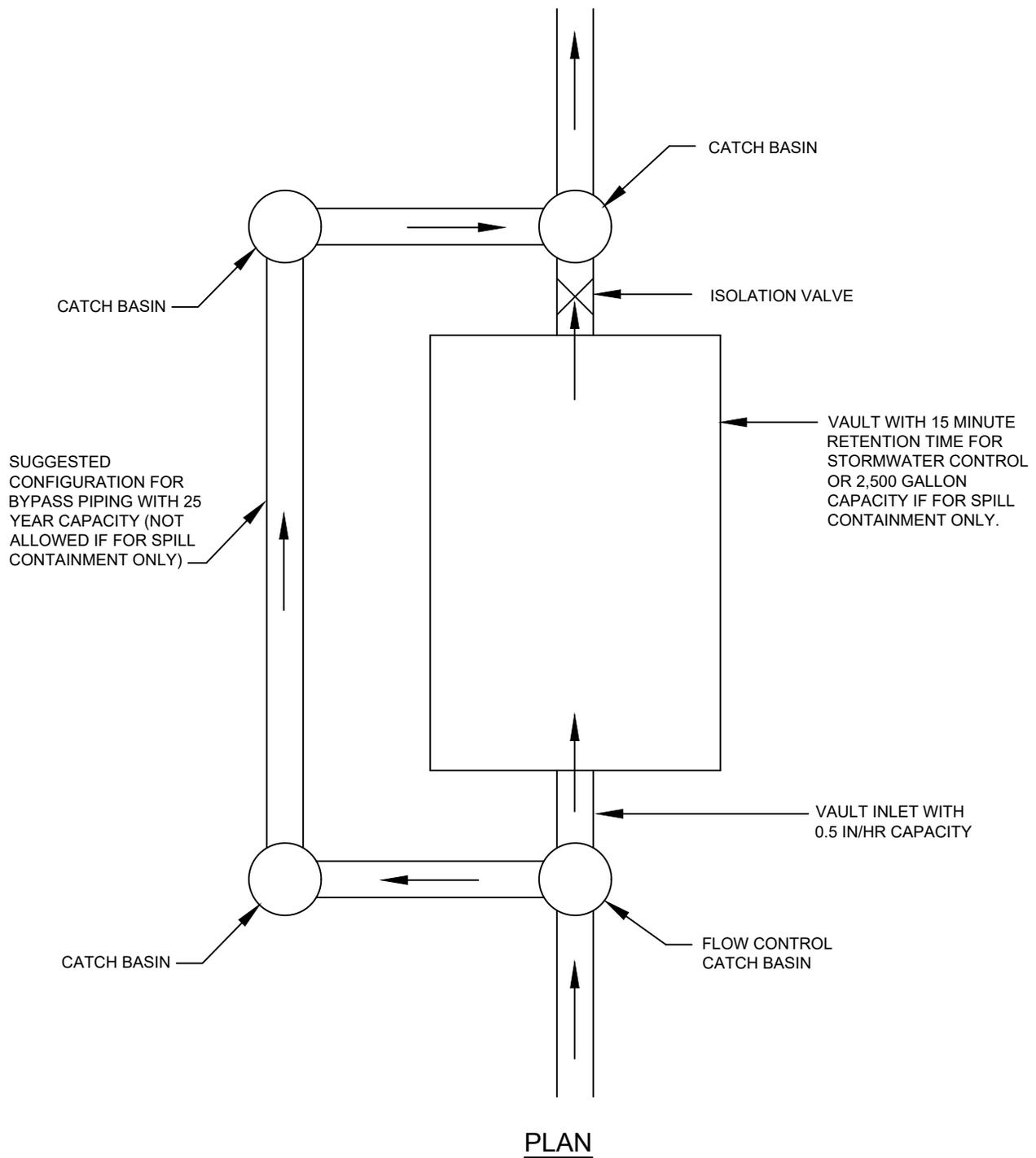


LIFT GATE ASSEMBLY AND SECONDARY ORIFICE DETAIL

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

412C
Number

City of Snohomish Public Works Department

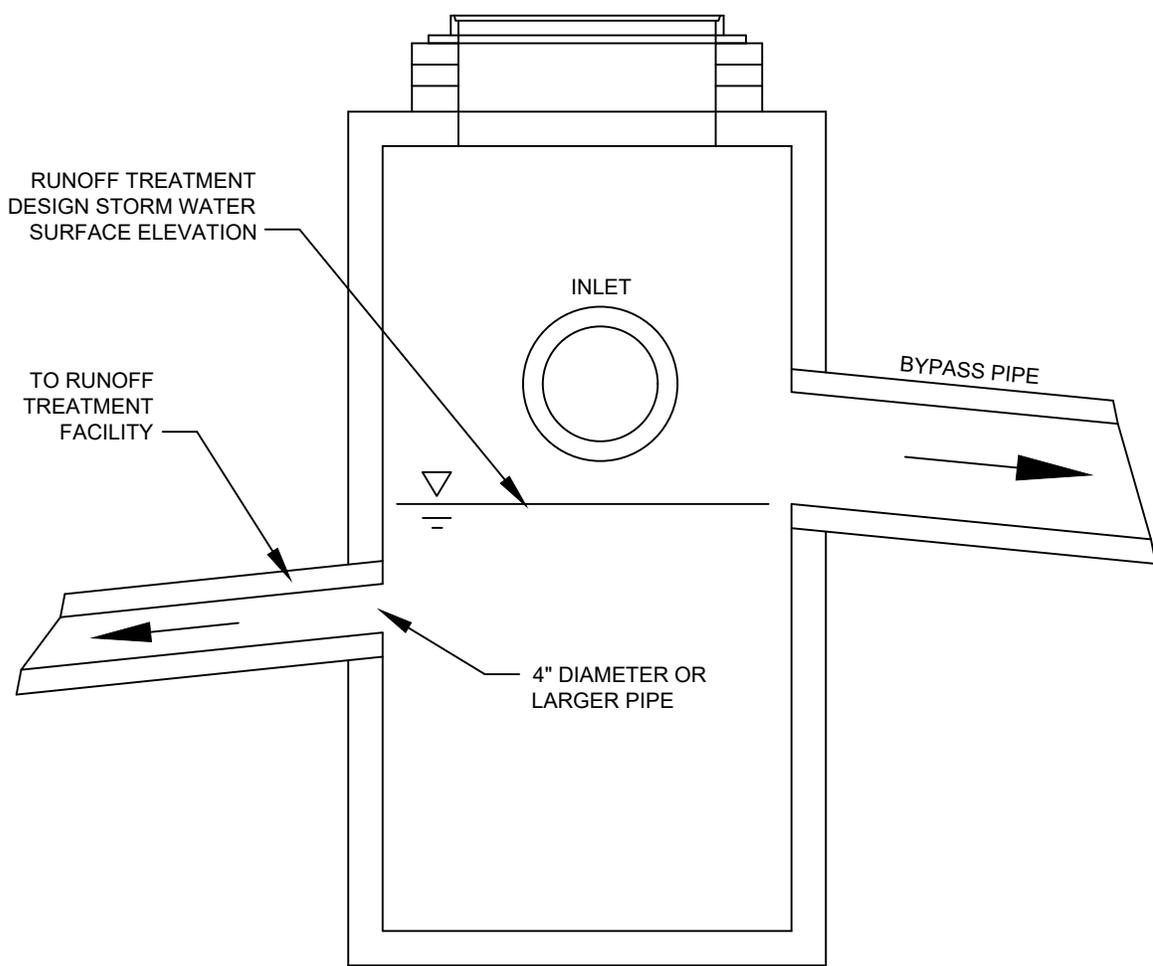


**OIL/WATER SEPARATOR AND GRIT
REMOVAL VAULT**

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

421
Number

City of Snohomish Public Works Department



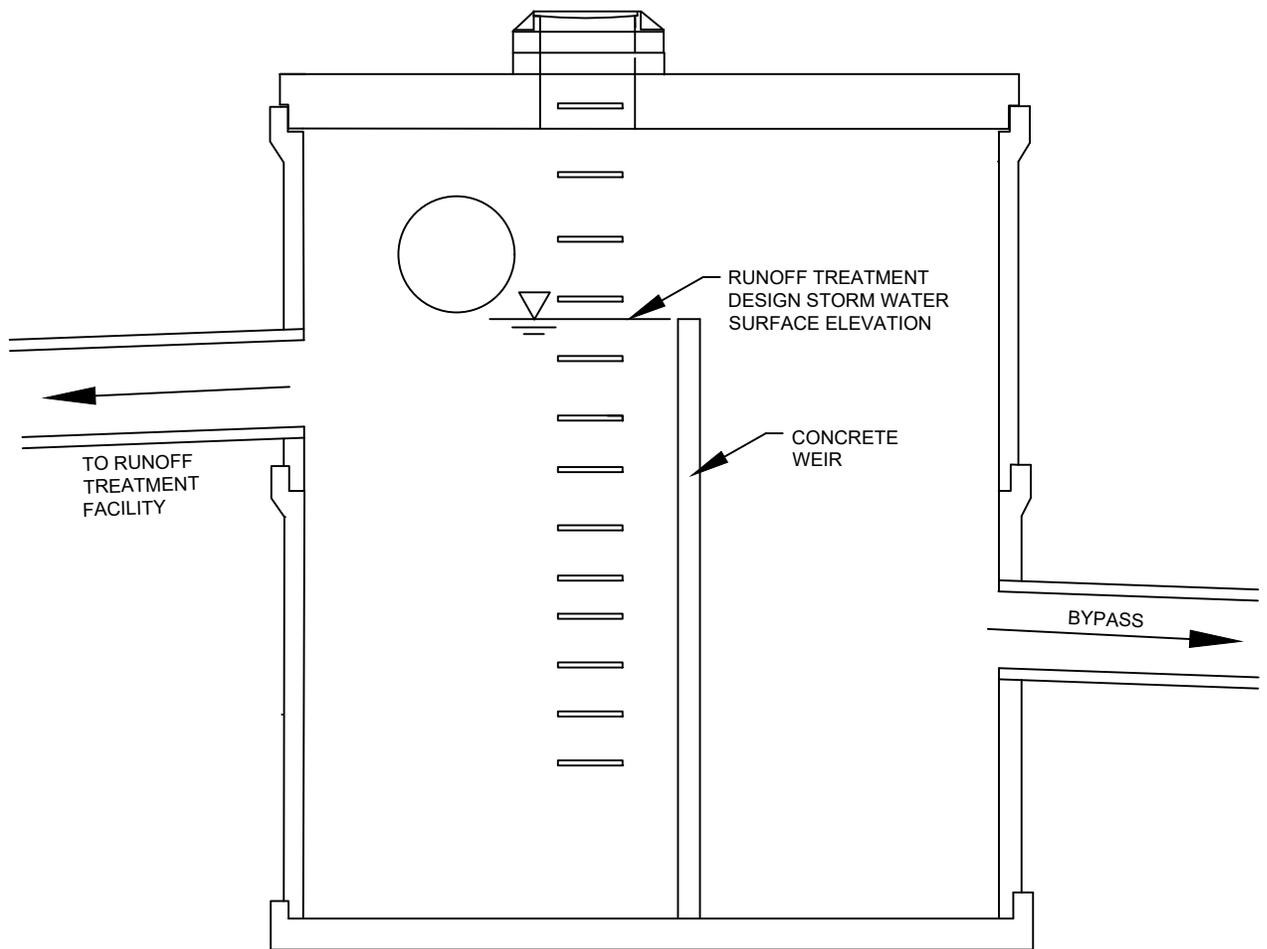
SECTION



BYPASS STRUCTURE TYPE 1

Approved By:
 Y. Monzaki
 City Engineer
 Date: APRIL 2021

422A
 Number



CONCRETE VAULT OR TYPE 2 CATCH BASIN
(SIZE DETERMINED BY CLEARANCE REQUIREMENTS)

ELEVATION

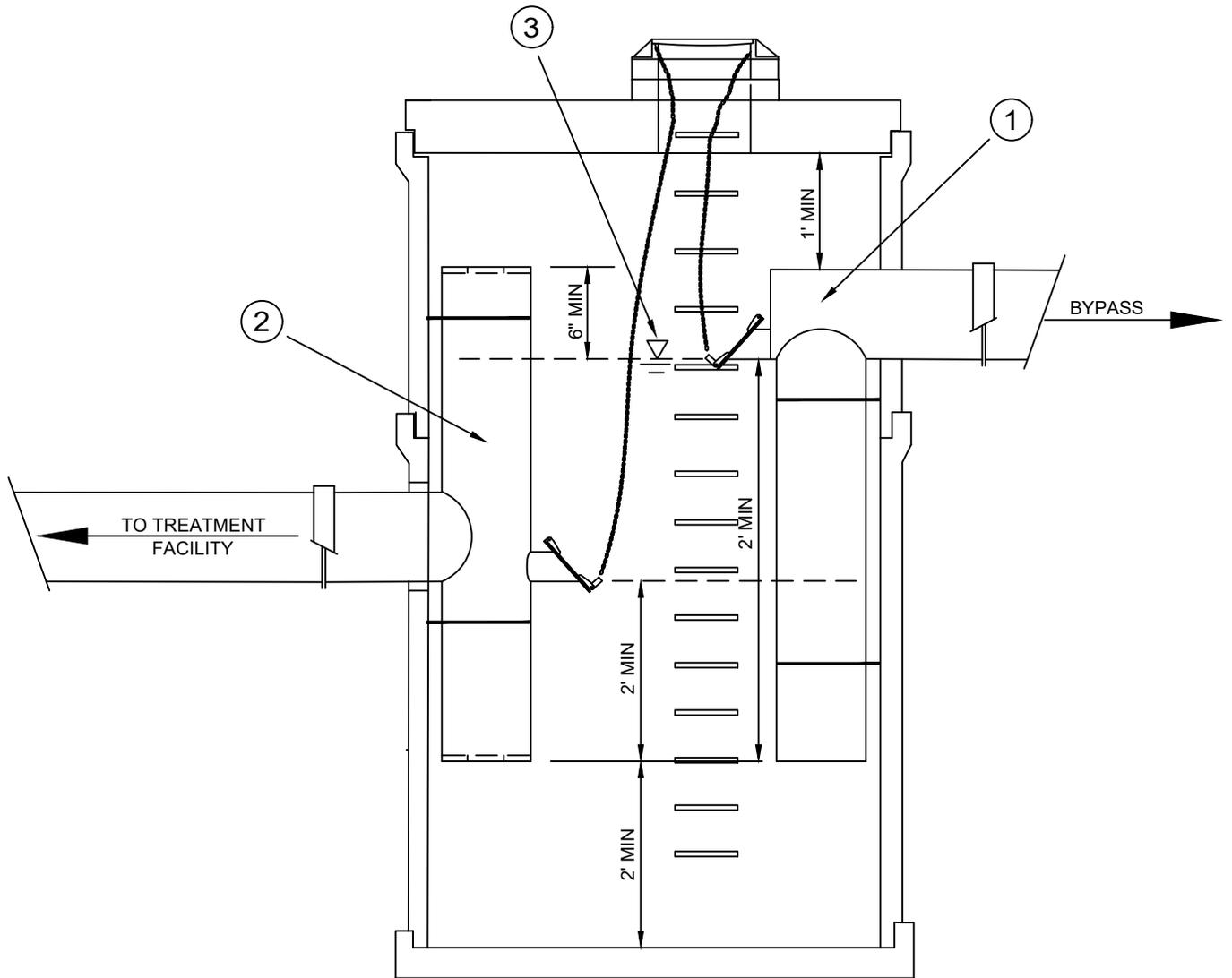


BYPASS STRUCTURE TYPE 2

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

422B
Number

City of Snohomish Public Works Department



ELEVATION

NOTES:

- ① FLOATABLE MATERIAL SEPARATOR PER STD DETAIL 411, WITHOUT VENT HOLE.
- ② RESTRICTOR STANDPIPE WITHOUT SECONDARY OVERFLOW ORIFICES AND WITH PRIMARY ORIFICE AND A CAP OR PLATE WITH 1" DIAMETER (MAXIMUM) VENT HOLE. INSTALL PER STD DETAIL 412A.
- ③ RUNOFF TREATMENT DESIGN STORMWATER SURFACE ELEVATION.

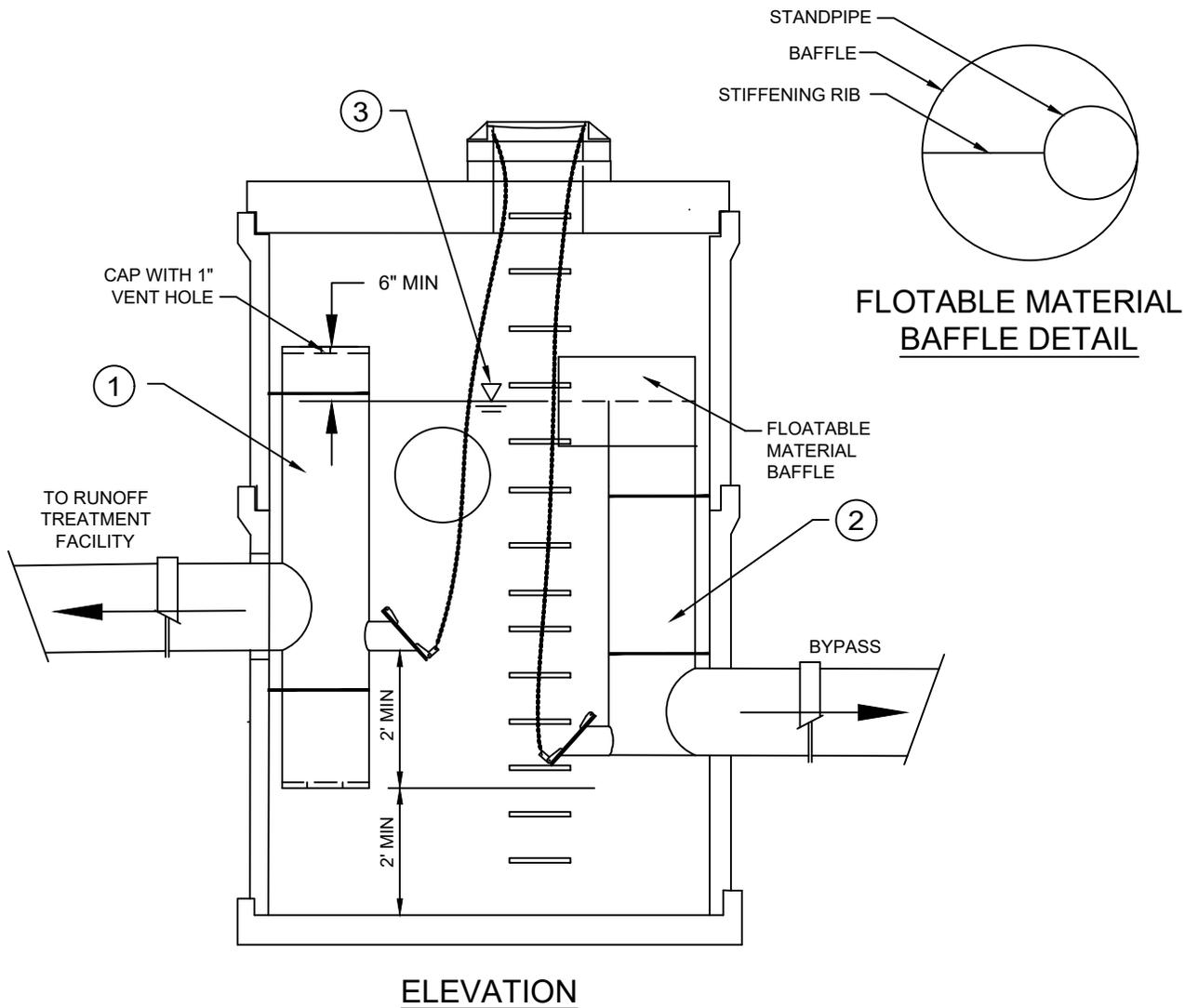


BYPASS STRUCTURE TYPE 3

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

422C
Number

City of Snohomish Public Works Department



NOTES:

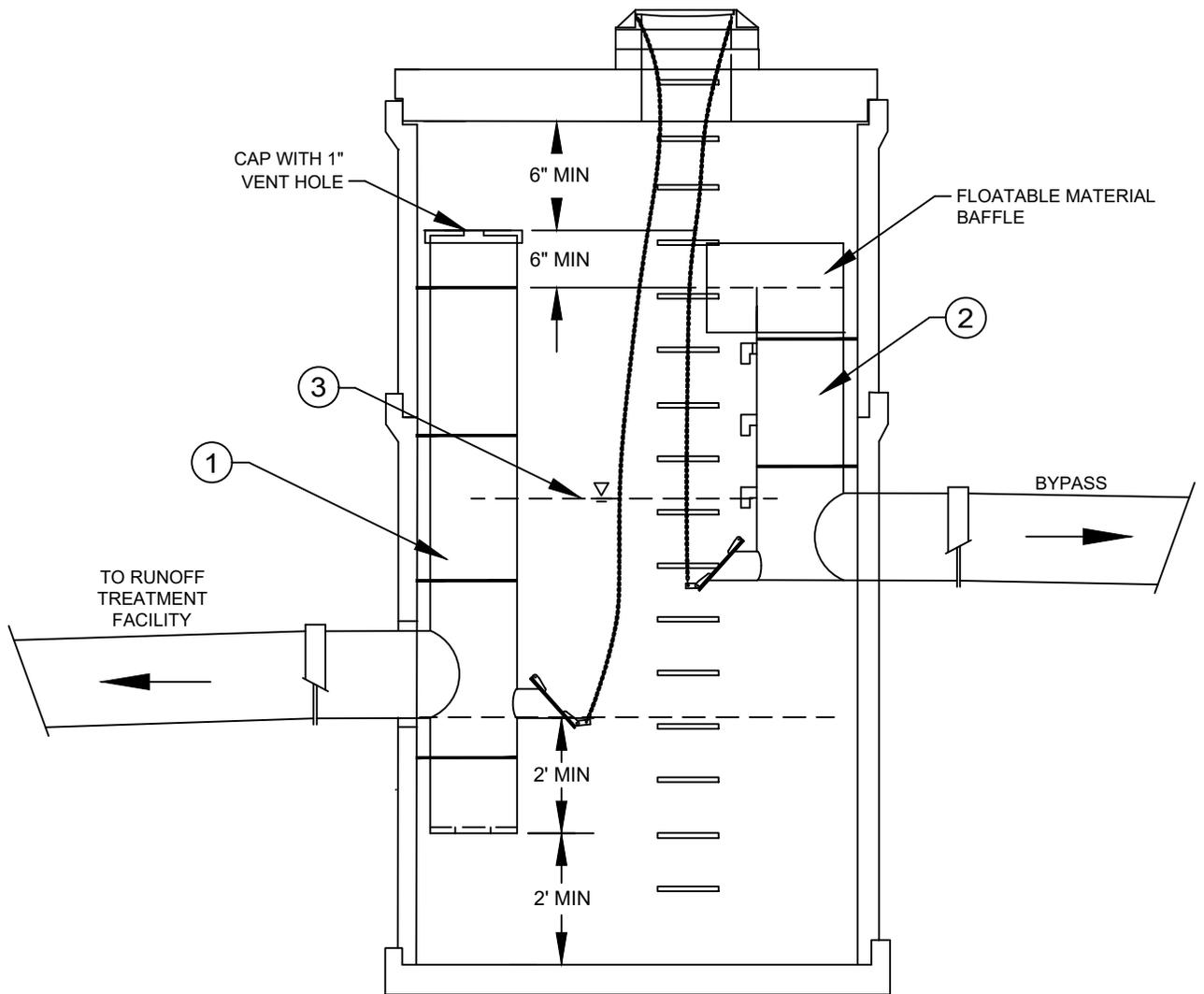
- ① RESTRICTOR STANDPIPE WITHOUT SECONDARY OVERFLOW ORIFICE AND WITH PRIMARY ORIFICE AND CAP OR PLATE WITH 1" DIAMETER (MAXIMUM) VENT HOLE. INSTALL PER STD DETAIL 412A.
- ② RESTRICTOR STANDPIPE WITHOUT ANY PRIMARY OR SECONDARY ORIFICES AND WITH FLOATABLE MATERIAL BAFFLE. INSTALL PER STD DETAIL 412A.
- ③ RUNOFF TREATMENT DESIGN STORMWATER SURFACE ELEVATION.



BYPASS STRUCTURE TYPE 4

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

422D
Number



ELEVATION

NOTES:

- ① RESTRICTOR STANDPIPE WITHOUT SECONDARY ORIFICES AND WITH PRIMARY ORIFICE AND A CAP OR PLATE WITH 1" DIAMETER (MAXIMUM) VENT HOLE. INSTALL PER STD DETAIL 412A.
- ② RESTRICTOR STANDPIPE WITH SECONDARY ORIFICES AND A FLOATABLE MATERIAL BAFFLE (PER STD DETAIL 422D). INSTALL PER STD DETAIL 412A.
- ③ RUNOFF TREATMENT DESIGN STORMWATER SURFACE ELEVATION.



MULTIPLE RESTRICTOR STRUCTURE

Approved By:
Y. Monzaki
City Engineer
Date: APRIL 2021

422E
Number

City of Snohomish Public Works Department