Design Guidance QUICK REFERENCE GUIDE

Advanced designer/inspector

(based on version 2.4) vers 15.2

I.C.

Advanced designer req'd for Types I –V 2501-10,000 gpd, using 7080, 7081, design guidance, The U of M manual and Recommended Standards & Guidance document.

Advanced designers are not certified to design beyond scope of Guidance Document.
However, AD's are allowed to make knowledgeable decisions to fill in gaps.
Type V without prescriptive standards or where design guidance is insufficient requires an engineer.
If the guidance document is inadequate or AD knowledge is lacking, professional assistance must be obtained to finish that part of the design under the direction of the AD who understands the overall design process.
Advanced designer needs the Advanced designer class.
Advanced inspector needs the Advanced designer class and the Service provider class.
Designer, Inspector, Adv designer, Adv inspector: 18 continuing Ed. Credits every 3 years (6 credits related to soils and 3 credits related to 7080)

I.D.

Desired Treatment goals and outcomes:
No hazardous waste is allowed in ISTS systems.
Non-sewage waste must be suitable for groundwater discharge.

II.A.2

Definitions:
SSTS - Treatment of sewage from a dwelling.
Sanitary Waste: Waste originating from Human activities (toilets, showers, dishwasher)
Sewage: To include sanitary waste and household cleaners & medications restricted to amounts normally used for domestic purposes.
i.e. Sanitary waste + other household wastes = sewage
Class IV inj wells- wells that inject Hazardous wastes into or above a water source (BANNED).
Class V inj wells- wells that inject NON-Hazardous wastes into or above a water source.
(typically anything other than a single family residence)
Req'd to fill out the "basic inventory form" and register with the EPA/MPCA. (pg 38)
An SSTS is a Class V if:
a) system serves more than a single family (multi family/unit or cluster) or
b) the system serves an 'other establishment' serving 20+ people/day, or
c) any system receiving non-domestic waste (business wastes - beauty shop, etc).

II.A.3

UIC - Underground Injection Control regulations:
Owners or operators of Class V wells are required to submit a 'basic inventory form'.
If the USDW (underground source of drinking water) is not endangered, the well is in compliance by rule.

SSTS:
No footing, roof or garage floor drains; chemically treated tub/pool water; hazardous waste or chemicals in excess of normal household amounts; or unused medicines are to be discharged into an SSTS.

If the system DOES NOT receive sewage, then 7080-81 DO NOT apply.

II.A.5

Treatment and disposal that is ABOVE the ground surface such as rapid infiltration basins or sprayed irrigation require a state SDS permit.
Land Spreading sewage wastes (even soil injection) is NOT subsurface.
If it is an 'other establishment' then the amount of cleaners, medications, etc... will likely be MORE than normal household amounts.

Listing of EPA Class V factsheets : Industrial, food processing, other establishments, auto shop...

II.B.

Waste strength = BOD5 + TSS + FOG

	Maximum septic tank Influent (raw sewage):	Maximum Effluent
BOD5	= 300 mg/l	< 170 mg/l
TSS	= 200 mg/l	< 60 mg/l
FOG	= 50 mg/l	< 25 mg/l

If typical homes are to be served, then no assessment of High Strength Waste is necessary.
However, it would be wise to determine if unusual uses are possible – home business, hobby, etc.
All 'other establishments' should be assessed for High Strength Waste.

If waste strength cannot be MEASURED then it must be ESTIMATED from various tables.

II.C.

Flow determination:
Dwellings + other establishments + collection (I&I) = design flow.
Design flow may need to be modified for specific components (surge tank, groundwater mounding, etc)
Estimating flow:

Other establishments: use table on page 153 which is the same as 7081.0130.
Multiple dwellings: total of 10 largest flows + (.45 * the remaining flows). To include other estab.

Measuring flow:

a) Measure the peak 90 day flow values,
b) determine the average flow of the peak consecutive 7 days (100% use).
c) multiply this value by 2 if the system was experiencing problems.

Note: Average flow should be no more than 70% of peak/design flow.

II.D.

Permit determination:

a) If the system will discharge to a surface water --> NPDES permit.
b) If the system will discharge to a spray irrigation or rapid infiltration basin --> SDS permit.
c) If not A or B, then it is an SSTS. Jurisdiction is determined by size.
New systems use estimated flow, existing use the larger of estimated or measured peak 7 day avg.
    1) If a single, or group of, SSTS drainfields under common ownership are within 1/2 mile of each other, and has a combined flow of 10,000 gpd or more, or
    if a single or group of SSTS may cause adverse health impacts --> SDS permit.
    2) Otherwise it is an ISTS (0 - 5,000 gpd) or MSTS (5,001 - 10,000 gpd) and regulated by the LUG.

II.E.

Site evaluation for MSTS in addition to standard ISTS req's:
- must determine if drainfield(s) are within 500' of a waterbody, if so a phosphorus impact study is needed.

Field evaluation for MSTS in addition to standard req's:
- SLR must be determined from soil pits on or within drainfield borders AND perk tests.
- site located on a US geological map and the area within one mile.
- site map to include 2' contours.

II.F.

Nitrogen: ISTS between 2501-5000 gpd
The concern is the impact to drinking water quality (blue baby syndrome).
Effluent contains approximately 40-60 mg/l. Registered treatment products to meet 20mg/l.
This assessment uses a 'desktop' approach AND field borings.
Worksheet in design guidance, **appendix I**, to determine if the aquifer will be *adversely impacted.*

Impacted If
- private well locations within 200', (public well <200' is a show stopper).
-web soil survey OR other DNR aquifer ratings are "sensitive".
-a sand layer exists in the 6' zone below the bottom of the rockbed.

Then
Aquifer is *adversely impacted* and must use Best Management Practice (BMP's @ III.H.)

II.F.3

Nitrogen: MSTS between 5001-10,000:

If
The aquifer is considered adversely impacted*

Then
Nitrogen mitigation must be employed to get it below 10 mg/l at the drainfield/ property line/ nearest receptor

Else
BMP's

*To determine if aquifer is impacted:
- use a Board Professional or
-Adv designer must assume it is being impacted and then follow DG to meet the limit of 10 mg/l.

To determine 10mg/l limit:
Adv designer to use "mass balance formula" D.G. II.F.3.D.4.B&C using worksheet in **appendix O.**
and Board professional to use D.G II.F.4

II.G

Water Mounding:
A mounding assessment is needed for systems 5001-10,000 gpd.
Mounding reduces the separation to the limiting layer.
Mounding can occur over an "unsaturated restrictive layer", and over a "saturated zone".
Must assess for both, and each require a deep boring of 20' and desktop modeling.
Models to estimate mounding for "unsaturated restrictive layer" : the Kahn equation or GMOUND.
Kahn equation worksheet in **appendix M** & II.G.5.C
Saturated hydraulic conductivity / Ksat values at II.G.5 table IIB.
Models to estimate mounding for "saturated zone": Hantush equation or GMOUND.
Any mounding found to occur must be added to the limiting layer for computing vertical separation.
(7081.0210 sub 4 requires lifetime mound height monitoring, design guidance doesn't mention it)

II.H

Phosphorus:
The concern is algae growth in lakes.
Effluent contains roughly 6-12 mg/l. Registered treatment products must meet 5 mg/l.
Discharge to surface limit = 1 mg/l.
A phosphorus assessment is needed for systems 5001-10,000 gpd.
Most soils can absorb a lot of phosphorus, but it does have a limit. (soil 'filter' gets full)
Impact to a lake is greater if the full 3' of separation is not employed, or if there are sandy soils, or if pretreatment is used and 'bed' never fails which leads to overload of soil 'filter'.
If there is a water body within 500', contact the MPCA to see if a Phosphorus limit will be applied.
If so, a Board professional must make an assessment.
Phosphorus BMP- voluntary for ISTS (design guidance III.I.)
a) use phosphate free products
b) discourage garbage disposals
c) use an effluent filter and pump tanks regularly
d) use pressure distribution with perforations less than 3'x 3' spacing
e) maximize vertical separation to SHWT
f) maximize the distance to the lake
g) increase the size of the drainfield
note: in many instances the BOD/TSS must be removed prior to removal of other contaminants.

III.C.

High Strength Waste:
Do not exceed the organic loading rate to the soil.
In most cases a Registered pretreatment device will be necessary. Check the MPCA website.
Additional tankage and larger drainfields are only minimally helpful.
Best Management Practices with high strength and/or high F.O.G. conditions:
- a gravity fed grease trap (min 1 days retention), close to the bldg (short supply line)
- scrape food waste into garbage cans
- place a sewer clean-out just outside the structure
- the largest perforation size you can reasonably use

Typical restaurant estimating:
1500 BOD
665 TSS
197 FOG
Of which the flow is split 70% thru the grease trap, and 30% thru the septic only.

III.F.

Sandy soil conditions:
All SSTS's with the distribution media in contact with sandy soils with >35% rock fragments may/must use a minimum of 1' sand liner ("in ground" mound/bed).

IV.A.

Flow equalization – Surge tank:
Any system with timed dosing needs flow equalization/surge tanks, and vice-versa.
Components above the flow equalization must be sized on Peak flow.
Components below the flow equalization can be sized on Average flow.
NOTE: the drainfield must be sized at a minimum of 1.5* Average flow.
Examples given in this section, or visit www.SepticResource.com for an automated worksheet.

IV.B.2.

Common tank sizing, Pressure Collection system, (**E1 grinder stations**):

Septic tanks:

<=10 homes, add up the individual home req's then multiply by 1.5 since it is pumped.

>10 homes, capacity is determined by 4 * design flow (since it is pumped).

Pump tank: 50% of design flow (with alternating pumps).

Common tank sizing, gravity Collection system, (**big pipe**):

Septic tanks:

<=10 homes, capacity is determined by adding the individual home req's (plus disposal 50%).
Or increase total capacity by 50% if collection system has a lift station.

>10 homes, capacity is determined by 3 * design flow (gravity value).
Note: if 25% or more homes have a garbage disposal or sump, or collection system has a lift station, capacity is then 4 * design flow (lifted value).

Pump tank: 50% of design flow (with alternating pumps).

Common tank sizing, gravity collection system, (**STEG**, septic tank at each home, then gravity)

Septic tanks:

At each home, tankage as typically req'd by 7080, then a common "stilling" tank at 50% of total design flow.
Combination "stilling" tank & common pump tank at 100% of design flow.

OR

a minimum tankage at each home with a common "stilling" tank making up the difference.
individual tankage (regardless of sump or garbage disposal)

bedrooms <= 2	750 gal
3 or 4	1000 gal
5 or 6	1500 gal
7,8, 9	2000 gal

Common stilling tank capacity the greater of:
= (design flow * 4) – (total individual septic tankage)
(design flow * 3 if <25% have a sump/disposal and no collection lift station)
or = 50% of design flow.

Pump tank: 50% of design flow (with alternating pumps).

Common tank sizing,pressure collection system, (**STEP**, septic tank at each home, then pressurized)

Septic tanks:

At each home, tankage as typically req'd by 7080, then a common "stilling" tank at 50% of total design flow.
Combination "stilling" tank & common pump tank at 100% of design flow.

OR

a minimum tankage at each home with a common "stilling" tank making up the difference.
individual tankage (regardless of sump or garbage disposal)

bedrooms <= 2	750 gal
3 or 4	1000 gal
5 or 6	1500 gal
7,8, 9	2000 gal

Common stilling tank capacity the greater of:
= (design flow * 4) – (total individual septic tankage)
or = 50% of design flow.

Common Pump tank: 50% of design flow (with alternating pumps).

Individual pump tanks: 500 gal when design flow <= 600gpd,
design flow when design flow > 600 gpd.

IV.C. (per MPCA Recommended Standards & Guidance)

Recirculating Sand Filter 'RSF' : Type IV level B-2 (level B with UV lite)

Currently registered for Residential strength waste only.

Septic capacity 3* flow for gravity, 4* flow for pressurized collection systems.

Recirculating tank has a minimum capacity equal to the design flow. (allow room for surges!)

24" of sand treatment media (sand is misleading, material is coarser than sand, like "grape nuts").

The maximum hydraulic loading rate for a RSF is 5 gpd/ft^2 .

(to load this high would require a BOD limit of 120 mg/l).

The maximum organic loading rate is .005 lb BOD/ft2/day.

(with a residential BOD limit of 170 mg/l, this leads to a hydraulic loading rate of 3.53 gpd/ft2)

(tip: If your operating permit has a BOD limit of less than 170, you could increase the loading rate from 3.53 up to a maximum of 5.0 gpd/ft2.)

RSF does not have a "topsoil" cover, just rock to grade so the filter can breathe).

Building specs:

Geotextile fabric below liner if there are rocks > 3/8". Also, geotextile up and over plywood walls.

Typically 30 mil pvc liner, no field seams allowed. Liner up and over sidewalls 18".

Place geotextile fabric over liner if needed to prevent rock/equipment from puncturing.

The filter bottom should be sloped 1% to the drain pipe.

Drain pipe penetration must use a boot and be inspected.

10" of Drainage rock (3/4" - 1") over and covering the sloped 4" drain pipe containing 1/4" slots.

One drain pipe for each zone, or 20' max spacing. End of drainpipe to grade for cleaning access.

At least **2" of pea gravel** (<1/2" minus) on top of drain rock.

Total of at least 1' of drainage material (combination of 10"of drain rock and 2" pea gravel).

After filter drain portion is completely built, water test for 24hrs with <1/16" loss.

3 inspection pipes for each cell. 1) pipe w/12" of holes in drainrock 2) pipe w/6" of holes in lower sand/treatment media 3) pipe w/4" of holes in distribution rock.

24" of "grape nuts" media for a RSF on top of pea gravel.

'grape nuts': uniformity coefficient (d60 / d10) < 4.0.

effective size (d10) of 1.5-2.5 mm.

gradation :	3/8"	100%	no. 4	70-100%	no. 8	5-78%
	no.16	0-10%	no.200	0-5% (fines)		
solubility	<5% in acid for particles < no.8					

At least **8" of distribution rock** (3/4"-1") (6" under pipe, 2" covering)

Laterals and perforations each spaced 2' apart.

??? The minimum avg head on the perforations is per the chart in 7080.

RSF requires a minimum of 2 cells with 2 zones per cell for MSTS (see chart for non-MSTS).

A minimum of 2 pumps per cell for MSTS (typically each cell will then have a dist valve to its zones).

The recirc tank must be time dosed on actual flows. (Don't laugh, demand dosing has been attempted).

The last septic tank must have an effluent filter with holes no bigger than the distribution perf size.

Dose volume at least 4 times pipe volume. (this is typically not a problem with 1.5" laterals)

48 doses per day (at design flow, actual flow may not meet 4* pipe volume or 48 doses and recirc ratio)

Note: research has shown optimal treatment at dose volumes of 1.0 gal/perf/dose, and failures beginning at 2.0 gal/perf or higher (with 2' x 2' perf spacing). At a 4:1 recirc ratio and 3.53 loading rate this gives us our 48 doses/day #. If using a higher recirc ratio increase the # of doses and not the size of the dose (max 2 gal/perf/dose) or treatment may suffer.

With our spec's of 48 doses, 4:1 ratio & 2'x2' perf spacing: we end up with 1.4 gal/perf at design flow, and 1.0 gal/perf at average flow (66% of design).

With 1.5" laterals we meet 4* dose volume for each. → a perfect design!

Recirc Ratio of 3:1 - 7:1. (typical base starting point is 4:1)
Note: The recirc ratio can be a little confusing to understand.

The engineering concept states that the recirc ratio is equal to the amount that will be "recirculated" compared to the amount moving on to the drain field.

Example: if the recirc pump delivers 1500 gallons, with 1000 returning to the "recirc" tank and 500 moving on to the drain field, the recirc ratio is 2:1 (1000:500).

With the 2:1 ratio, 2 parts went to the recirc tank, and 1 part went to the drainfield, but to make this happen we have to pump 3 parts total, or 3 times the flow.
So when given the engineering ratio, you need to "add" the ratio together to obtain the correct number to multiply your flow by.

Remember: you ultimately need to know the total amount of effluent to be pumped to properly set the recirc pump timer settings.

Recirculating Sand Filter

Design example

The design example from design guidance can be hard to follow, so try the following method:
Standard specifications to Base all RSF designs on:

- 3.53 gpd/ ft^2 Hydraulic Loading Rate with residential strength (170 BOD)
- 2' lateral spacing & 2' perforation spacing
- 1.5" diameter laterals (→ dosage of 4-9 times pipe volume, with avg or peak flow)
- 1/8" perforations @ 5' head (minimum) → .41 gpm flow rate at each perforation.
- Recirculation ratio of 4:1 (pump flow of 5* design flow)
- 48 doses per day
- Tip: for every 500 gal of flow recommend 3' wide x 47.25' long zones

Example:

2000 gpd with 170 mg/l BOD and a 4:1 recirc ratio

At HLR of 3.53 gpd/ft^2 2000 gal / 3.53 gal/ft2 = **567 ft^2 filter**

Choose filter dimensions:
(Hint: always use even #'s)

12' wide by 47.25' long = 567 ft^2
12' / 2' spacing = 6 laterals (make sure # of laterals is evenly divisible for zoning)
47' / 2' spacing = 23 perforations / lateral **23 perfs/lat**

Determine # of zones
(note: Given 12' wide → 6 laterals, this divides evenly for 2 or 3 zones. We'll choose 2)
(most of the following calculations are now per zone)

6 total laterals / 2 zones = 3 laterals per zone **2 zones**
3 laterals with 23 perfs/lateral = 69 perforations/zone **3 laterals/zone**
69 perfs/zone

With a 4:1 recirc ratio, our 2000 gpd system will need to pump 5 times the design flow for a total of 10,000 gpd (5 * 2000 = 10,000)
With 2 zones this is 5,000 gpd pumped to each zone.

5,000 gal/zone

Determine the dose volume per zone:

To pump 5,000 gallons in 48 doses requires 104 gal/dose. **104 gal/dose/zone**

Determine the time to complete one dosing cycle:

1440 min in one day divided by (48 doses/zone * 2 zones) = min/cycle
1440 min / 96 total pumping events = 15.0 min/dose cycle **15.0 min/cycle**

Calculate pump rate & ON time:

With our initial design of 5' of head & 1/8" perfs, this gives a flow rate of .41 gal/perf,
1 zone of 69 perfs times .41 gal/perf = 28.3 gpm flow.

28.3 gpm pump

A 104 gal dose at 28.3 gpm will take 3.5 minutes (104 / 28.3 = 3.7)

3.7 min ON time

*A drawdown test must be done in the field to confirm the actual pump rate, then adjust the timer settings as necessary.
(Calculate the pump head requirement as you would any standard system)

Calculate pump OFF time:

A pump cycle (ON & OFF time) takes 15.0 minutes.
Cycle time - ON time = OFF time
15.0 - 3.7 = 11.3 min OFF time

11.3 min OFF time

Determine # of pump starts:

From above we have 2 zones, each being dosed 48 times a day.
2 zones times 48 cycles per zone = 96 cycles total
This system could have 2 alternating pumps, one for each zone.
With a total of 96 cycles / 2 pumps = 48 starts/day/pump
(code has a maximum of 300 starts/day) **48 starts/pump**

Verify 4* pipe volume:
Each zone has 3 - 45' laterals of 1.5" pipe.
3 * 45' * .11 gal/ft = 14.9 gal. * 4 = 59 gal (4 times pipe volume).
The 104 gal zone dose meets the 59 gal minimum amount.

If we set our pump timer for avg flow, the 104 gal dose would become 68 gal (104 * .66 = 68).
Our 68 gal dose still exceeds the 4*pipe volume amount of 59 gallons.
→our 1.5" laterals will work for both design flow and average flow settings, a perfect design!
Furthermore, at design flow we're dosing at 1.5 gal/perf/dose (104 gal dose / 69 perfs = 1.5)
Our average flow is dosing a 1.0 gal/perf/dose (68 gal dose / 69 perfs = .99 or roughly 1).
Both dose values give optimal treatment (2.0 gal/perf/dose or greater leads to poor treatment).

IV.D. (per MPCA Recommended Standards & Guidance)
Single Pass Sand Filter 'SPSF' or Intermittent Sand Filter 'ISF':
Type IV treatment level "A" limited to residential strength waste.

Final septic tank w/ effluent filter with holes smaller than drainfield perforation size.
Pump tank to sand filter w/ 1 days flow(minimum- consider flow equalization) and time dosed.
Hydraulic loading rate is 1 gal/ ft^2.
Sand filter cell & zone req's vary depending on flow volume (see chart in design guidance).

Construction:

Geotextile under liner if stone > 3/8" is present, and over plywood sidewalls.
Typically 30 mil pvc liner with no field seams.
Geotextile over liner if concern of puncturing during construction.
Pipe penetrations must use a boot and be inspected.
Floor of filter sloped 1% to drain pipe.
4" pvc drain pipe, 1 for each zone, with 1/4" slots spaced 4" or so. Upslope end of drain pipe to grade for cleaning access.
Approximately **10" of drainage rock** 3/4"-1", must cover and surround the drain pipe.
2" or more of pea gravel (<1/2" diameter) on top or drain rock.
Total of 1' or more of combined drainage material (2" pea gravel and 10" drainage rock).
After drain section is built, water test liner for 24 hours with a loss of <1/16".
3 inspection pipes for each cell. 1) pipe w/12" of holes in drainrock 2) pipe w/6" of holes in lower sand/treatment media 3) pipe w/4" of holes in distribution rock.

ISF requires **24" of sand media** on top of pea gravel.

sand:

uniformity coefficient must be (d60 / d10) <4
effective size (d10) must be < 1 mm.
solubility <5% in acid for particles
gradation:

3/8"	100%
no. 4	95-100%
no. 8	80-100%
no. 10	0-100%
no. 40	0-100%
no. 60	0-40%
no. 200	0-5% (fines)

8" of distribution rock material, 3/4" - 1" rock. (6" under & 2" over).
Final topsoil cover should be 12" no more no less for proper oxygen transfer/freezing protection.
Lateral and perforation spacing of 3' for < 2500 gpd systems.
Minimum of **8 doses per day**.
Lateral and perforation spacing of 2' for >= 2500 gpd systems.
Minimum of **4 doses per day**
See design guidance chart for proper # of pumps depending on flow volume.

Single Pass Sand Filter

Design Method

Standard specifications to base all SPSF designs on:

Hydraulic loading rate of 1 gpd/ft^2

< 2500 gpd : 3' lateral spacing & 3' perforation spacing

1.25" laterals 1/8" perfs w/ 5' head (or optional 3/16" perfs @ 2' head →50% > gpm)

8 doses per day

(tip: for every 500 gal flow recommend using 12' wide by 42' long zones)

>=2500 gpd : 2' lateral spacing & 2' perforation spacing

1.5" laterals 1/8" perfs w/ 5' (or optional 3/16" perfs @ 2' head →50% > gpm)

4 doses per day (or optional 6 doses/day with 1.25" laterals)

(tip: for every 500 gal flow recommend using 12' wide by 42' long zones)

Example:

3000 gpd system:

At HLR of 1 gpd/ft^2 = 3000 ft^2 filter — **3000 ft^2 filter**

Choose filter dimensions:

3000 ft = 72' wide by 42' long — **72' x 42' filter**

Determine # laterals and # of perfs/lateral:

(divide each filter dimension by the spacing) — **36– 40' laterals**

72' / 2' = 36 laterals (make sure # of laterals is evenly divisible for zoning later)

42' / 2' = 21 →21 perforations/lateral — **21 perfs / lat**

Lateral length : 42' – 2' = 40'

Determine # of doses:

(4 doses minimum for 2' x 2' spacing. 8 doses minimum for 3' x 3' spacing)

With our 2' x 2' spacing we need at least 4 doses per day — **4 doses / day**

Determine entire Sand Filter dose volume:

3000 gpd divided by 4 doses/day = 750 gal/dose (entire sand filter) — **750 gal / dose**

Determine # of zones:

Total # of laterals needs to be evenly divided by the # of zones.

36 laterals is evenly divided into 6 zones → 6 laterals/zone. — **6 zones**

6 lat/zone

Determine frequency of doses:

Dosing the sand filter 4 times a day, or each zone 4 times a day, is the same thing.
With 6 zones each being dosed 4 times a day, we have a total of 24 pumping cycles. **24 total cycles**

1440 min/day divided by 24 pumping cycles = 1 cycle every 60 minutes **60 min/cycle**

The entire filter dose of 750 gal is now divided into the 6 zones = **125 gal zone dose**

Determine pump rate & ON time:

We have 126 perfs per zone, @ .41 gpm for each perf.
126 perfs * .41 gpm/perf = 52 gpm pump requirement **52 gpm pump**

Pump On time is calculated the same as a standard system:
(dose + drainback amount) / 52 gpm = minutes ON time
For our example approximately 125 gal / 52 gpm = 2.4 minutes **2.4 ON time**
Pump Off time is the cycle time minus the ON time.
60 min - 2.4 min = 57.6 min **57.6 OFF time**

Determine pump starts per day:

For this example we would probably have 2 alternating pumps to a 6-way distribution valve.
24 cycles divided equally between 2 pumps = 12 starts/pump/day **12 starts/pump**
(code has a maximum of 300 starts/day per pump)

V.B.:

Gravity Collection system: (STEG "Septic Tank Effluent Gravity" and/or gravity sewer)

Wastewater must be at or below residential waste strength in order to be discharged into a gravity collection system.

The number of residential connections is 5 to 30, and other establishments to 10,000 gpd.

Design flow shall include the daily flows from 7080.1860 plus I&I from 7081.0140. (200g/inch/mile)

Design flow for other establishments from 7081.0130 plus I&I.

The Peak flow for Gravity Collection sizing shall be 3 times design flow plus I&I.

(what am I sizing at 3* flow ??? lift station? Collection pipes?)

Lift stations sized at greater of 3*flow OR 50% of design flow in one hour. (WHAT? Oranges & apples)

Pipe:

- Minimum pipe size for STEG with effluent filter is 4" sdr35, or for road crossings sdr26.
- Minimum pipe size for Gravity sewer is 6" 'sdr35', or for road crossings 'sdr26'.
- The minimum slope for 4" or 6" is 1/8"/ft or .01 ft/ft or 1% for cleansing velocity of 2 ft/sec.
- The maximum slope for 4" or 6" is 2.4"/ft or .2 ft/ft or 20% to not exceed velocity of 15 ft/sec.
- If this slope is exceeded, the pipe must be secured with concrete anchors. (specs in V.B.4)
- The minimum slope for 8" is .05"/ft or .004 ft/ft or .4% (.4 ft per 100 ft).

Separation & installation:

- Gravity sewer shall be laid at least 10 ft horizontally from a water supply main, and maintain at least 18" of vertical separation at crossings. Sewer line must also be at least 50' horiz from a well.
- Sewer line must be laid straight between cleanouts/manholes, with a constant slope.
- Cleanouts placed: at upstream end of the system, at the intersection of mains, at change in pipe size/slope/alignment, or every 100 ft. (manholes can be used in place of cleanouts).
- Manholes shall be spaced: no more than 400 ft apart, at changes in slope, alignment, or pipe size and at major junctions.

Insulation:

- Sewer pipe shall be buried 7',8',9' deep depending on area of state.
- Less burial depth or under roads will require insulation.
- Sheet insulation 2" thick, 4' wide, 8' long (minimum R-21).
- Insulation shall be placed at least 18" below ground and 6" above the pipe. 6" of sand over the insulation and 3" of sand under the insulation.
- 1" of insulation substituted for every 1' of soil reduction.
- Insulated pipe may also be used.

Bedding:

- The minimum excavation width of trench for 4" pipe is 20", and 22" for 6" pipe.
- If the native soil is class I, II or III, lay the pipe on the native soil.
- If the native soil is class IV or V, it shall be removed and replaced with class I, II or III.
- Haunching material (class I,II,III) shall be placed to provide a cradle to the centerline of the pipe.
- Initial backfill (class I,II,III) from centerline of the pipe to 6-12" above the pipe.
- Final backfill (class I - V).
- All filling compacted to 95% maximum density using 6" lifts.

Leak testing:

- The contractor shall submit (air or hydrostatic) and deflection results to the designer who shall submit results to the LUG.

Air testing:

- Each section tested to 5 psi for 15 minutes.

Hydrostatic testing:

- Each section filled with water with 3'of head for 1 hour for absorption. Then 1 more hour to test for leaks of which are not to exceed limits shown in table V.E.

Deflection testing: (pipe cave in)

- Test shall be done 30 days after installation by sending a ball or pig of 95% pipe diameter through the pipe without getting stuck.

V.C.

Pressure Collection Systems STEP (Septic Tank Effluent Pumping)

Applies to residential or commercial flows over 2500 gpd.

Wastewater must be at or below residential waste strength in order to be discharged into a pressure collection system.

The number of residential connections is 5 to 30.

Peak flow calculations Q gpm = 50% of design flow in 1 hour.

Design flow shall include the daily flows from 7080.1860 plus I&I from 7080.0140.

Design flow for other establishments from 7081.0130 plus I&I.

(reality check: I&I does not apply to a pressure line)

The design Peak flow for Large Collection systems shall be 3 times the flow given from table V.F. which is the flow from the max# of pumps on at any given time.

(what am I sizing at 3* flow ???)

A minimum cleansing velocity of **1 ft/sec for STEP**, and **2 ft/sec for grinder systems**.

Note: parallel pumps "add" gpm at a given head (two 10 gpm@50' of head will deliver 20 gpm@50').

For systems up to 30 homes, a statistical maximum of 5 pumps may be running at any one time.

Number of connections/homes	maximum number of pumps on (statistically)
2 – 3	2
4 – 9	3
10 – 18	4
19 – 30	5

Pumps and segments must be designed so maximum velocity does not exceed 6 ft/sec to avoid excess friction loss.

Flow controllers may be used to limit individual flows to 10 gpm.

(tip: 90% of cluster designs will be met by a system of 10 gpm pumps and 2" lines. A max of 5 pumps @ 10gpm = 50 gpm → 5 ft/sec in a 2" line. A min of 1 pump @ 10 gpm = 10gpm → 1 ft/sec in a 2" line. All req's are met. Now determine pump head req's at the 50 gpm rate)

System maximum pump head is 140'.

Include a weep hole after the pump and before the shut off valve (in case of air trapped).

The Hazen Williams equation is used to calculate dynamic friction loss in a pipe.

$$H_f = 10.5 * L * (Q/130)^{1.85} * D^{-4.87}.$$

where L = length of pipe in ft (to include fitting loss equivalents)

Q = flow rate in gpm

D = diameter of pipe in inches.

H_f = friction loss in ft of head

(tip: you don't have to use this crazy math formula, just determine the "equivalent" pipe length and plug that into the normal pump worksheet where we assume an additional 25% for fittings.)

Air relief valves:

An automatic air relief valve shall be placed at all high points of the collection pipe.

Thrust anchors:

Anchoring of pipe is required at: bends >22.5 degrees, tees, valves or changes in pipe size.

Anchoring must be of concrete and placed on undisturbed soil.

Collection line Leak testing:

Air testing of 150 psi for one hour without loss.

Hydrostatic testing of pipes filled with water with 3' head at the crown for 1 hour for absorption.

Then an additional hour for the test with water loss not to exceed limits in table V.E..

(table is currently lacking 2" pipe limits...)

Effluent filter/screens:

Filters must be used prior to STEP pump, except for grinder systems.

Collection system piping to be installed per ASTM D2321.

Clean outs:

At a minimum a cleanout must be placed at the upstream end of the collection system, at any junctions of the mainline, at the intersection of each main line connection, at any change in pipe size, or every 500 ft, whichever is less. Pig ports may be used in place of cleanouts. Fig V.G.

Isolation valves: (shut-offs for different areas/segments)

Should be considered each 2500-5000 feet of uninterrupted pressure sewer, at water crossings, and the intersection of two mains.

Separation:

Sewer Pipes and lift stations shall be laid 10 ft horizontally from any water main.
Sewer mains crossing water mains shall be laid with at least 18" vertical separation.
Sewer mains and lift stations must be located at least 50' from a private or public well.

Bedding:

Bottom of excavation must be stable and water free.
Unstable material to be removed 24" below pipe and replaced with acceptable material.
Rocky excavations must be over excavated 3" and backfilled with sand, etc. (pass ¾" sieve).
The next 12" of fill around/over the pipe must be sand or stone passing a 1" sieve in 6" layers.

Cover and insulation:

Sewer pipe shall be buried 7',8',9' deep depending on area of state.
Less burial depth or under roads will require insulation.
Sheet insulation 2" thick, 4' wide, 8' long (minimum R-21).
Insulation shall be placed at least 18" below ground and 6" above the pipe. 6" of sand over the insulation and 3" of sand under the insulation.
1" of insulation substituted for every 1' of soil reduction.
Insulated pipe may also be used.

A check valve must be installed after the pump and before the main line.
An isolation valve is recommended after the check valve.
For STEP systems, the main line shall be 1.5" – 2" pipe.

V.C.7. Lift stations:

(only applies to systems > 2500 gpd, & you don't typically use lift stations on a STEP system)
Pumping rates (avg & peak) shall be capable of flows contributing to that lift station.
A minimum of 2 pumps, each capable of pumping at peak flow rates.
Lift station shall have hookup for emergency power supply, unless lift station capacity has 1-day capacity of average flow(residential) or peak flow(other establishments).
Flow monitoring equipment must be installed.

VI. A. Operation and maintenance:

All SSTS's require a management plan (7082.0600), see listed req's / recommendations.
2500-5000 gpd Domestic strength: measure sludge and scum 2 times per year.
2500-5000 gpd Non-domestic waste: measure sludge and scum 4 times per year.

VI.C. Groundwater height monitoring.

The interpretation of the monitoring results can be performed by a Service Provider.

Location of water table monitoring device:

- Trenches: at the center of the system
- Beds, mounds, at-grades: at the downslope edge of absorption area, at the midpoint of the length.
- For multiple zones/dispersal areas: a monitoring device is req'd for each zone/drainfield.

Monitoring devices shall be installed to a depth 1' deeper than the limiting layer.

An additional monitoring device must be installed if there is a restrictive layer above the limiting layer.

- The bottom of this shallower device must be above the restrictive layer.

Design and installation examples also given in this section.

System compliance is met when the vertical separation is met 90% of the time.

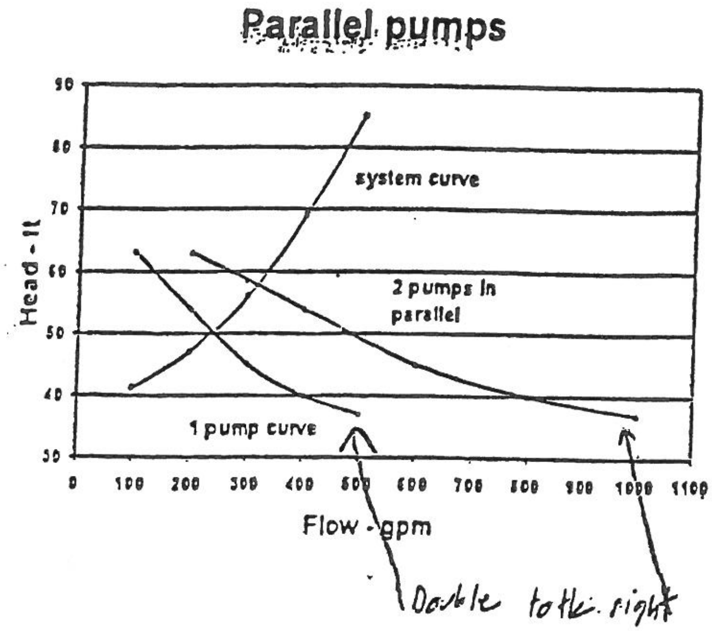
Misc items:

Calculator example: to find $2^{1.5}$ push the following keys 2 x^y 1 . 5 =

If your calculator does not have the x^y key, look for ^ instead. The answer is 2.82.

Organic loading rate: BOD * GPD * 8.34 / 1,000,000 = lbs/BOD/day

Series pumps : pick a point on the pump curve, double it and move up.
Parallel pumps : pick a point on the pump curve, double it and move right.



Tank buoyancy in order for the tank to not float up:

Water in tank + soil on top of tank + weight of tank >= water displaced by tank times 1.2 safety factor
(62.4 lbs/ft^3) (100-130 lbs/ft^3) (mfg listed) (62.4 lbs/ft^3)
(or 8.4 lbs/gal)

Example with 2' sandy soil cover on tank, empty tank, tank weight of 10,000, tank: 8'L, 6'W, 5'H:

0 + L*W*H* 120 + 10,000 >= (L * W * H * 62.4) * 1.2
8*6*2*120 + 10,000 >= (8*6*5*62.4)*1.2
11,520 + 10,000 >= (14,976)*1.2
21,520 >= 17,971

The tank and soil weight pushing down is more than the buoyancy force up, so tank will not float up.

Note: if soil on tank is saturated, the new soil density is calculated as (soil density - water density).
example (120 - 62.4 = 57.6 lbs/ft^3)

Soil density:

90 lbs/ft^3 clay, 100 lbs/ft^3 loam 120 lbs/ft^3 sand,

Basic ground water mounding formula:

$(((SHLR_1 - SHLR_2) \div 7.5 \text{ gal/ft}^3) \div 0.5)$ X 12 inches/ft = water mounding in inches

$SHLR_1$ = Soil Hydraulic Loading Rate of the Soil Treatment Area being investigated

$SHLR_2$ = Soil Hydraulic Loading Rate of the restrictive condition

The 0.5 is a porosity estimate.

Manning equation: gives velocity of water through a **gravity** pipe, (in feet per second)

For a **non-full**, non-PVC pipe, the equation is:

$$V = 1.486/n \ * \ ((.785 * D^2) / (3.14 * D_{wet}))^{.67} \ * \ S^{.5}$$

where D = pipe diameter in feet
S = slope in feet/feet
n = pipe coefficient
D_{wet} = wet perimeter in feet

For a "**full**" PVC pipe the equation becomes:

$$V = 114 * (D/4)^{.67} \ * S^{.5}$$

where D = pipe diameter in feet
and S = slope in feet/feet
114 = 1.486/n where n = .013 for PVC

for a 6" pipe at 1/8" slope(.01 ft/ft)

$V = 114 * (.5/4)^{.67} \ * .01^{.5}$

$V = 114 * .248 \ * \ .1$

V = 2.87 ft/sec

Flow from a pipe can now be found using the velocity of the water from the Manning equation:

Q	=	V * A
Flow	=	velocity through pipe * area of pipe (3.14 * r^2) using the following units:
Ft^3 / second	=	feet / second * ft^2

Continuing with the previous Example of 6" pipe (.25' radius) at 2.87 ft/sec:

$Q = 2.87 \text{ ft/sec} \ * \ (3.14 * .25^2) \text{ ft}^2$

$Q = .564 \text{ ft}^3\text{/sec}$

Convert to gpm:

$Q = .564 \text{ ft}^3\text{/sec} \ * \ 7.48 \text{ gal/ft}^3 \ * \ 60 \text{ sec/min}$

Q = 253 gpm

Manning Gravity Constants:

Pipe diameter Inches	velocity (V) ft/sec	Area (A) ft^2	flow (Q) gpm
2	(pressurized)	.020	n/a
4	2.18	.087	85.2
6	2.85	.197	253.0
8	3.46	.349	542.2

Hazen Williams Equation: gives the dynamic <u>friction loss</u> of a **full pressurized** pipe (in feet of head)

The 'system curve' or Total Dynamic Head = Static head + Dynamic head
(elevation) + (friction loss, from hazen Williams)

Using this formula multiple times with different flows, we will build our 'system curve'.

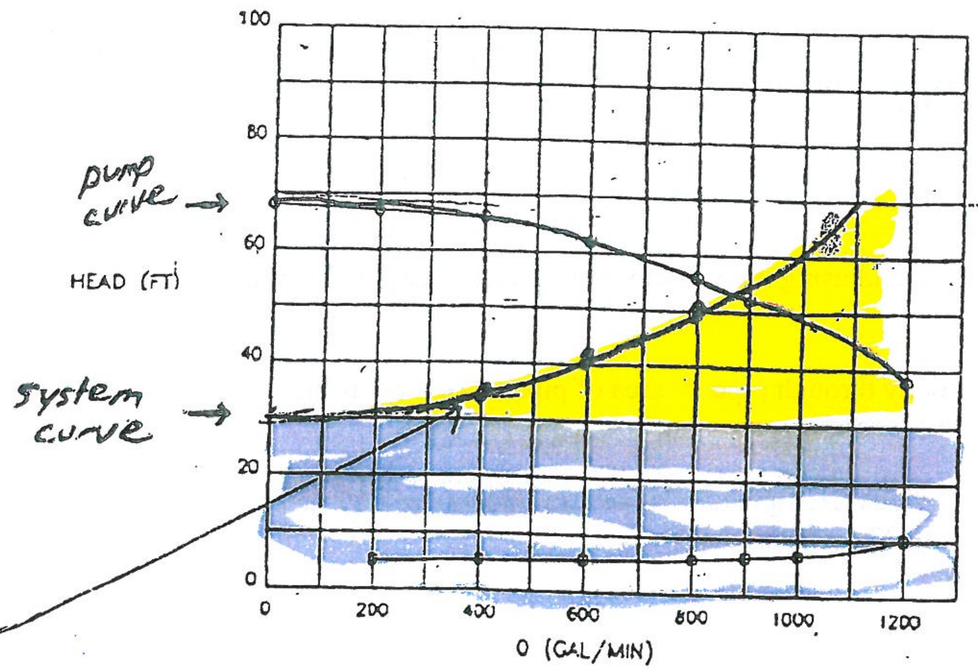
$H_f = (10.5 * L * (Q/c)^{1.85}) * D^{-4..87}$

where L = pipe length in feet
Q = flow in gpm
c = pipe coefficient PVC = 130
D = pipe diameter in inches
H_f = dynamic friction in ft of head

Example: 30' of static head, 400 gpm flow, c = 100 for 10" iron pipe, 3000' of pipe.

$H_f = (10.5 * 3000 * (400/100)^{1.85}) * 10^{-4..87}$
$H_f = (31,500 * 13) * .000013$
$H_f = 5.5$ feet of head loss

To plot this on the graph, the Total head at 400 gpm = 30' static + 5.5' dynamic, or 35.5' head



PUMP CHARACTERISTICS

gpm	Head static	+	Head dynamic	=	T.D.H.
0	30		0	=	30
400	30		5.5	=	35.5
600	30		11.7	=	41.7
800	30		20	=	50

Hazen Williams equation using charts (instead of the big math formula) to figure out the head loss in a pipe due to dynamic friction.

Use the following 2 charts to figure out the Total equivalent pipe length (pipe + fittings).

Equivalent length of pipe fittings.

Quantity X Equivalent Length Factor = Equivalent Length

Fitting Type	Quantity		Equivalent Length Factor		Equivalent Length (ft)
Gate Valve		X		=	
90 Deg Elbow		X		=	
45 Deg Elbow		X		=	
Tee - Flow Thru		X		=	
Tee - Branch Flow		X		=	
Swing Check Valve		X		=	
Angle Valve		X		=	
Globe Valve		X		=	
Butterfly Valve		X		=	
Valve 10		X		=	
Valve 11		X		=	

Equivalent Length Factors (ft.) for PVC Pipe Fittings			
Fitting Type	Pipe Diameter (in.)		
	1½	2	3
Gate Valve	1.07	1.38	2.04
90 Deg Elbow	4.03	5.17	7.67
45 Deg Elbow	2.15	2.76	4.09
Tee - Flow Thru	2.68	3.45	5.11
Tee - Branch Flow	8.05	10.30	15.30
Swing Check Valve	13.40	17.20	25.50
Angle Valve	20.10	25.80	38.40
Globe Valve	45.60	58.60	86.90
Butterfly Valve	-	7.75	11.50

Sum of Equivalent Length due to pipe fittings: ______ + Supply Pipe Length ______ ft = *Total* Equivalent Pipe Length ______ ft

Given the pump rate and size of pipe, find the appropriate friction loss factor.

Table I. Friction Loss in Plastic Pipe per 100ft				
Flow Rate (GPM)	Pipe Diameter (inches)			
	1	1.25	1.5	2
10	9.1	3.1	1.3	0.3
12	12.8	4.3	1.8	0.4
14	17.0	5.7	2.4	0.6
16	21.8	7.3	3.0	0.7
18		9.1	3.8	0.9
20		11.1	4.6	1.1
25		16.8	6.9	1.7
30		23.5	9.7	2.4
35			12.9	3.2
40			16.5	4.1
45			20.5	5.0
50				6.1
55				7.3
60				8.6
65				10.0
70				11.4
75				13.0
85				16.4
95				20.1

Calculate *Supply Friction Loss* by multiplying *Friction Loss Per 100ft* by the *Equivalent Pipe Length* and divide by 100.

Supply Friction Loss = ______ ft per 100ft X ______ ft ÷ 100 = ______ ft Dynamic head loss

add the elevation difference (between the pump and the discharge/laterals) to the dynamic head loss for total pump head loss

______ ft + ______ ft = ______ ft

Media Gradation:

D60 means the **Diameter** of the sieve size of which **60%** of the material passes through.
D10 means the **Diameter** of the sieve size of which **10%** of the material passes through

So when the spec requires the Effective size D10 to be <1 mm, they are saying that the size of the sieve in which 10% of the material passes through must be < 1 mm.
If you are given a list of data, find the "% passing" equal to 10, then read the corresponding size of opening, this size must be < 1 mm.
If you are given a chart, find 10% passing on the left side, follow that horizontal line to the right until you hit the plotted gradation line, then go straight down to read the size.

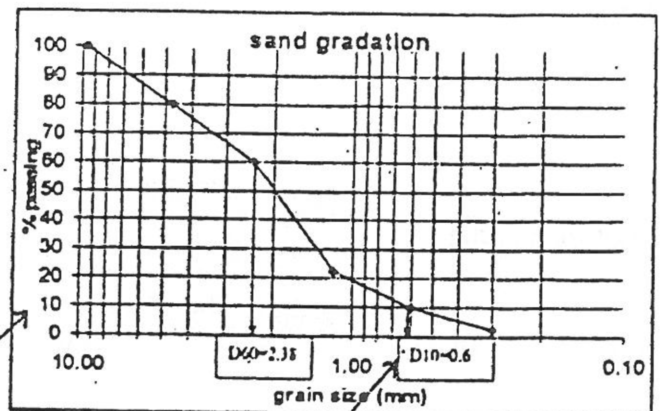
For an example lets say we found .6 mm to be the size sieve in which 10% passed. D10 = .6

The same process is used to find D60. Find the sieve size of which 60% of the material passes through.

For an example lets say we found 2.38 mm to be the size sieve in which 60% passed. D60 = 2.38

To continue, when the spec says the Uniformity Coefficient D60/D10 must be less than 4, simply divide 2.38 by .6 = 3.9 (D60 = 2.38 / D10 = .6)
In this example 3.9 is less than the 4 limit and thus it would pass this requirement.

sieve size/number	% passing	size of opening mm
3/8	100	9.53
no.4	80	4.75
no.8	60	2.38
no.16	22.5	1.18
no.30	10	0.60
no.200	2.5	



10%

.6 mm

Surge tank sizing calculation:

1. Given daily flows for the week, determine the daily average
2. find the first day with a flow larger than average, and determine the gain (+) above the daily amount being pumped out, and what the current storage amount is
3. continue with each following day determining daily (+/-) and the resultant amount in storage

	Gallons	daily +/-	stored total
Monday	0	-1400	1100
Tuesday	360	-1040	60
Wednesday	1300	-100	0
Thursday	1500	+100 (start here)	100
Friday	1700	+300	400
Saturday	2700	+1300	1700
Sunday	2200	+800	**2500**

9760 / 7 days = 1394 or approximately **1400** gal/day average

Required surge capacity = (daily avg + peak stored total) + 20%

4680 = (1400 + 2500) * 1.2

Collection system

Statistical number of pumps on at any one time.

# houses	# pumps on
2-3	2
4-9	3
10-18	4
19-30	5

IV.F.6 Organic loading to soil

	maximum lbs/ft^2/day		
SLR	BOD	TSS	FOG
1.2	.00170	.00065	.00025
.78	.00110	.00042	.00016
.6	.00087	.00033	.00013
.5	.00070	.00027	.00010
.45	.00060	.00024	.00009
Clay .25	.00035	.00013	.00005

BOD * gpd * 8.34/1,000,000 =lbs/BOD/day
now divide by drainfield sqr ft.

Collection

Figure total flow of houses (7080) = 7650 gal

Figure total pipe length of all legs = 1800 ft

I&I	If all	6"	200 x 6 x 1800/5280 = 409 gal
	If all	4"	200 x 4 x 1800/5280 = 272 gal
	If all	2"	200 x 2 x 1800/5280 = 136 gal

Design/permit/Collection flow (lift station etc)
7650 + 409 = 8059 gpd
7650 + 272 = 7923 gpd
7650 + 136 = 7786 gpd

Tankage:

Gravity	8059 x 3 = 24,200	(6" pipe)
	7923 x 3 = 23,800	(4" pipe)
Pressure	7786 x 4 = 31,100	(2" pipe)

stilling tank is greater of : 50% of design flow
or 31,144 (total req'd) minus volume of STEP tankage

Elevations:
Start at 7' below grade and go down at a rate of 1%

Peak flow:
Gravity or STEG with 4" pipe
7923 x 50% in 1 hour = 66 gpm
STEP (it will pump at pump rate * number of pumps statistically on = 5)
5 * 10 gpm STEP pumps = 50 gpm peak main line flow

Check velocity cleansing:
Flow x (1 min/60 sec) x (1 ft3/7.5 gal) / (area of 2" pipe in ft3) = ft/sec
50 gpm x .0022 / .02 = 5.5 ft/sec → greater than 1 ft/sec thus OK
(tip: 10 gpm in a 2" pipe = 1 ft/sec)

Hazen Williams friction: (using main line length & peak flow)
$10.5 \times 1400 \times (50/130)^{1.85} \times 2^{-4.87} = 86'$ head
1400' 50 gpm 2" pipe

Pump req'd:
10 gpm @ 86' dynamic head (plus static elev head)

Thrust blocks at each connection and change of direction. Man holes, cleanouts, air release, etc.

Pressure sewer (grinders)

Same as before

2"

N = 30 → 5 pumps

Standard pumps of 11 gpm

5 x 11 = 55 gpm main line flow

→ 5.5 ft/sec which is > 2 ft/sec thus OK

H_f = 102' head

Pump req'd = 11 gpm @ 102' dynamic head (plus static elev head)

STEG

Lift pump of 66 gpm (7923 x 50% in 1 hour = 66 gpm) (7923=collection + 4" I&I)

Lift station, manholes, thrust blocks

Drip Design

2.3 x psi = feet of head
30 psi = 70' head
Emitters = .6 gal/hour
End result is 2' x 2' emitter spacing
Vacuum breaker at top of system
300' lateral length maximum (manifold at each end. Or 150' max with manifolds on same end (loop back))
(total system CLR < 12)
Disc filter flushing requires 15 gpm @ 115' head

Example:

5800 gpd system

5800 / .45 SLR = 12,900 ft2 soil dispersal area

2' lateral spacing: 12,900 / 2 = 6450 lineal feet

2' perf spacing: 6,450 / 2 = 3225 emitters

3225 emitters * .61 gal/hr = 1967 gph or (1967/60 = 32.8 gpm)

CLR: 5800 / 12 = 483 ft minimum length of system

300' max lateral, design 300' each way for total 600' length, this meets our 483' CLR requirement.
6450' lineal / 600' each lateral = 10.75 laterals rounded up to 12 for zoning → 600 x 12 = 7200'
2 zones of 6 laterals = 12 laterals (each lateral is 2*300') middle feed
Dosing per zone:

Per zone = 2900 gal with 3600' of drip tubing

Daily max dose: (amount soil around tubing can absorb)

tube burial depth (inches) / 12 / 12 / x length (ft) x porosity x 7.5 gal/ft3 = gal

17 / 12 / 12 x 3600 x .50 x 7.5 = 1593 gal max dose

doses / zone / day:

2900 gal / arbitrary 150 gal/dose = 19 doses

1440 min / 19 doses = 75 min cycle

Drain back: (of solid pipe, not drip pipe, i.e. supply line and headers and return line for that zone)

320' of 1.25"(.078 gal/ft) = 25 gal

# of emitters in this zone: (every 2')

3600' / 2 = 1800 emitters

Drip tubing zone flow rate:

1800 emitters x .61 gal/hr / 60 min/hr = 18.3 gpm

Flush flow rate needed:

(2 connectors per lateral @ 1.6 gal/min)

2 x 6 laterals x 1.6 gal/min = 19 gal/min

(this should have been 4 times? Each 600' has 4 connections, 2 @ each 300' section)

Pump requirement :

Drip rate plus flush rate

18.3 + 19 = 37 gpm

Dose ON time:

Dose + drainback / drip flow rate

(150 + 25) / 18.3 gpm = 10 min

Dose OFF time:

75 min cycle – 10 min = 65 min

Flush volume:

Pipe volume x length x 5 = gal

.01 gal/ft x 3600 x 5 = 180 gal

Flush ON time:

(with return valve open, every so often)

180 gal / 37 gpm = 5 min

Flush OFF time:

75 min cycle - 4.8 = 70 min

Absorption width example: (trenches – say what?)

(SLR_b / SLR_c) * trench width = absorption width

(.78 / .5) * 3 = 4.5’

CLR contour loading rate example:

Given:

600 gpd,
maximum contour loading rate of 12,

600 gpd / 12 clr = 50’ minimum rockbed length.

Lets increase the complexity:

600 gpd,
treatment level B with mound sand loading rate of 1.6,
maximum contour loading rate of 12,
Mound ratio of 2.

600 gpd / 12 clr = 50’ minimum rockbed length.

600 gpd / 1.6 slr = 375 ft2 of rockbed area.

375 ft2 / 50 long = 7.5’ wide rockbed
→ 7.5’ x 50’ mound rock bed

7.5’ wide * 2 mound ratio = 15’ wide absorption width
→ 15’ x 50’ absorption area.

Pump tank Gallons per Inch calculations:

231 in^3/gal 7.43 gal/ft^3

Given the dimensions of the tank in inches, the gpi becomes (L” x W”) / 231
For a tank 96” long by 72” wide by 40” deep, the gpi is: (96 x 72) / 231 = 30 gpi

Given the dimensions of the tank in feet, the gpi becomes (L’ x W’) x .62
For the same tank, 8’ long by 6’ wide by 3.3’ deep, the gpi is” (8 x 6) x .62 = 30 gpi

Nutrients:

nitrogen, phosphorus, etc.

Ph:

6-9 is a healthy level.

Dissolved oxygen:

Run-off, surface infiltration water, lake water, all have DO in the 5-12 mg/l range.
Well water has a DO of about 2 mg/l
Septic tank DO is typically less than .5 mg/l

ATU's:

When sampling the aeration chamber the settled amount should be about 20-60% of total volume.