SANITARY SEWER SERVICE

ASSESSMENT GUIDELINES

EXAMPLES

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INTRODUCTION

This supplementary document contains several different housing development scenarios and walks the reader through the decision-making process outlined in the Bernalillo County Natural Resource Services *Sanitary Sewer Service Assessment Guidelines*. The examples demonstrate how to evaluate the appropriate wastewater treatment techniques for given site conditions. Use of the Cost Matrix to compare appropriate treatment options is also illustrated.

Although the examples are not exhaustive of all possible site conditions, a wide range of situations are discussed, ranging from simple, small development to larger, more complex development. The reader is advised to use this document as a companion to the Sanitary Sewer Service Assessment Guidelines. While the examples are intended to illustrate use of the guidelines, they do not replace the discussions within the main guidance document.

EXAMPLE 1 – NEW SMALL DEVELOPMENT

A single family desires to build a three-bedroom house on a one-acre lot in an existing subdivision in the East Mountains. The adjacent one-acre lots are undeveloped, but they are aware of potential buyers who desire to build three-bedroom homes. Their realtor tells them to expect to find rocks roughly three feet below the surface. When visiting the site, they noticed the top soil was fairly sandy.

EXAMPLE 1 – NEW SMALL DEVELOPMENT

GIVEN: A single family desires to build a three-bedroom house on a one-acre lot in an existing subdivision in the East Mountains. The adjacent one-acre lots are undeveloped, but they are aware of potential buyers who desire to build three-bedroom homes. Their realtor tells them to expect to find rocks roughly three feet below the surface. When visiting the site, they noticed the top soil was fairly sandy.

OTHER ASSUMPTIONS: There are four adjacent undeveloped lots, and the ground slopes are less than 15 percent. A public sewer is more than three miles away. Two acres of suitable disposal land is located on a small hill roughly one-half mile away.

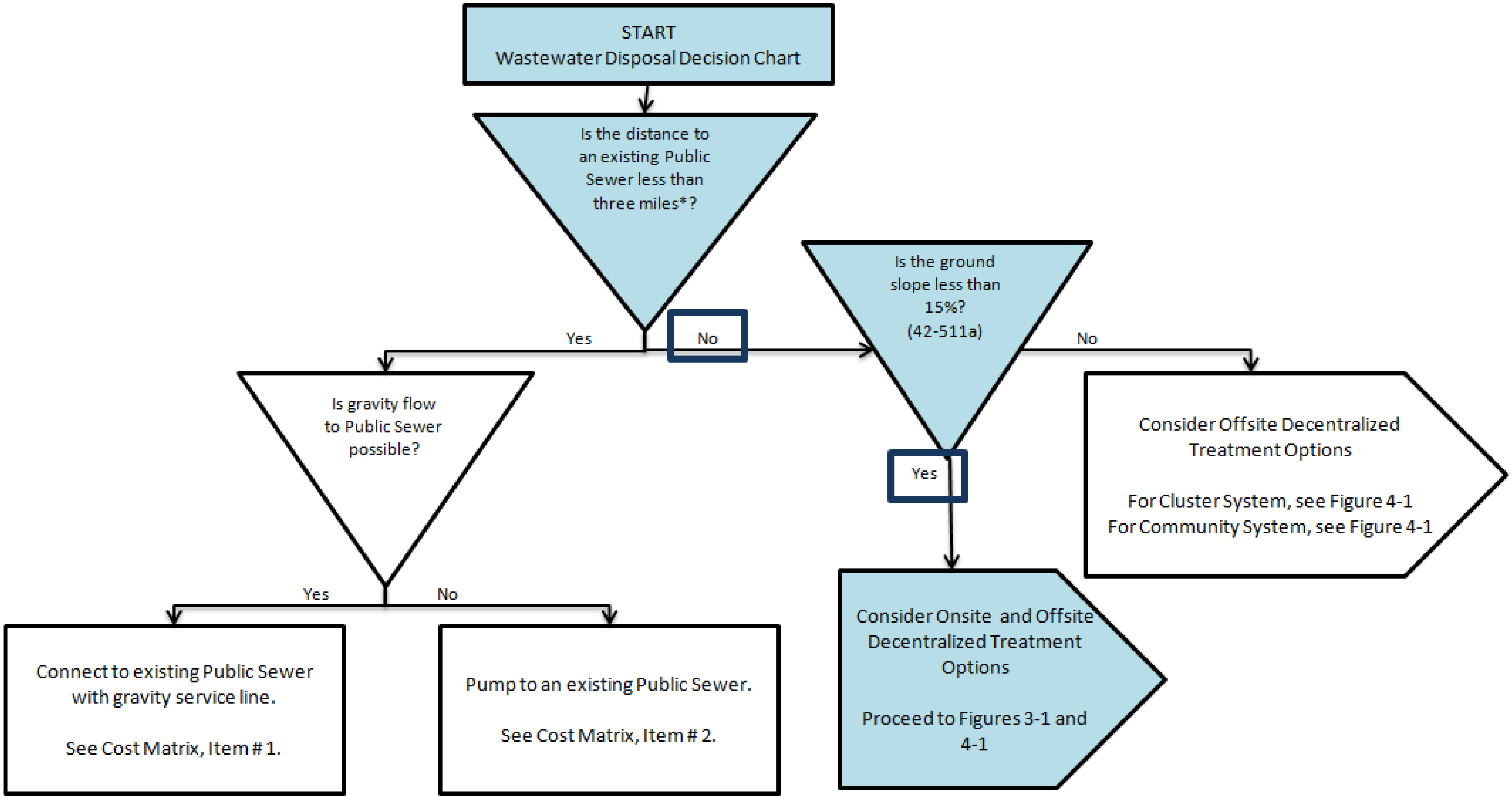
DETERMINE: What wastewater treatment systems are acceptable options for this family?

SOLUTION: Use Sewer Assessment Guidelines to determine suitable options for treatment. Use Cost Matrix to compare options. Begin the exercise with Example 1 – Figure 2-1.

Example 1 – Figure 2-1

- ***Is the distance to an existing Public Sewer less than three miles?*** No; the subject lot was assumed to be located more than three miles from a public sewer.
- ***Is the ground slope less than 15 percent?*** Yes.

As seen in Example 1 – Figure 2-1, site conditions are suitable for either onsite or offsite treatment. Example 1 – Figure 3-1 determines the appropriate technology for onsite treatment, while Example 1 – Figure 4-1 determines the appropriate configuration for offsite treatment. These options can be compared using the Cost Matrix. The next step is to see what onsite treatment technology is appropriate. Proceed to Example 1 – Figure 3-1.



EXAMPLE 1 – FIGURE 2-1

<u>Example 1 – Figure 3-1</u>

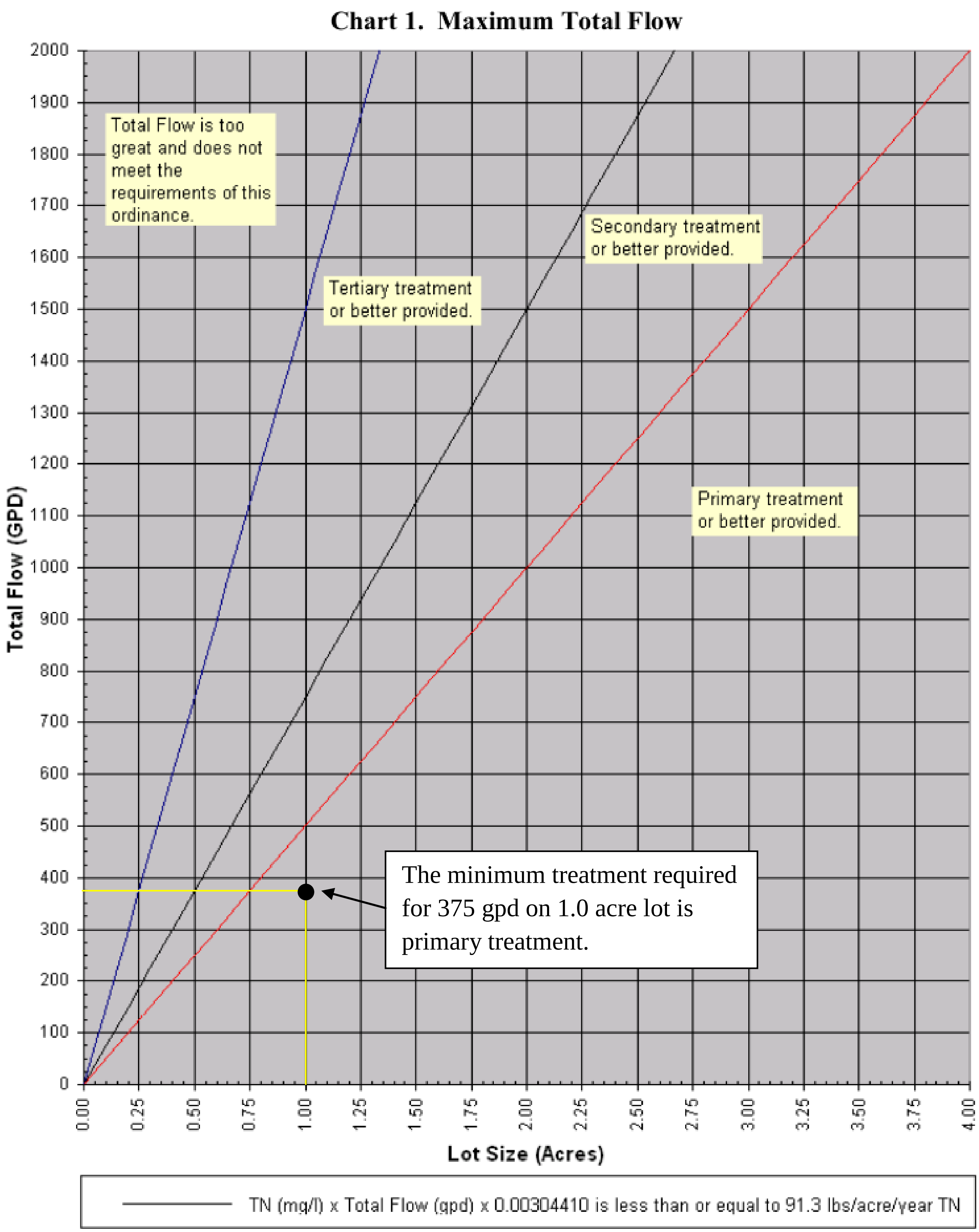
- ***What level of treatment is required based on Chart 1?*** Design flow for a three-bedroom house is 375 gpd. On one acre, primary treatment is the minimum level of treatment necessary, as seen in Chart 1. Primary treatment is labeled as **1a** in Example 1 – Figure 3-1.

- ***What is the depth of suitable soil beneath the absorption area?***
  The realtor advises that depth to rock is three feet. This depth corresponds to **2b**.

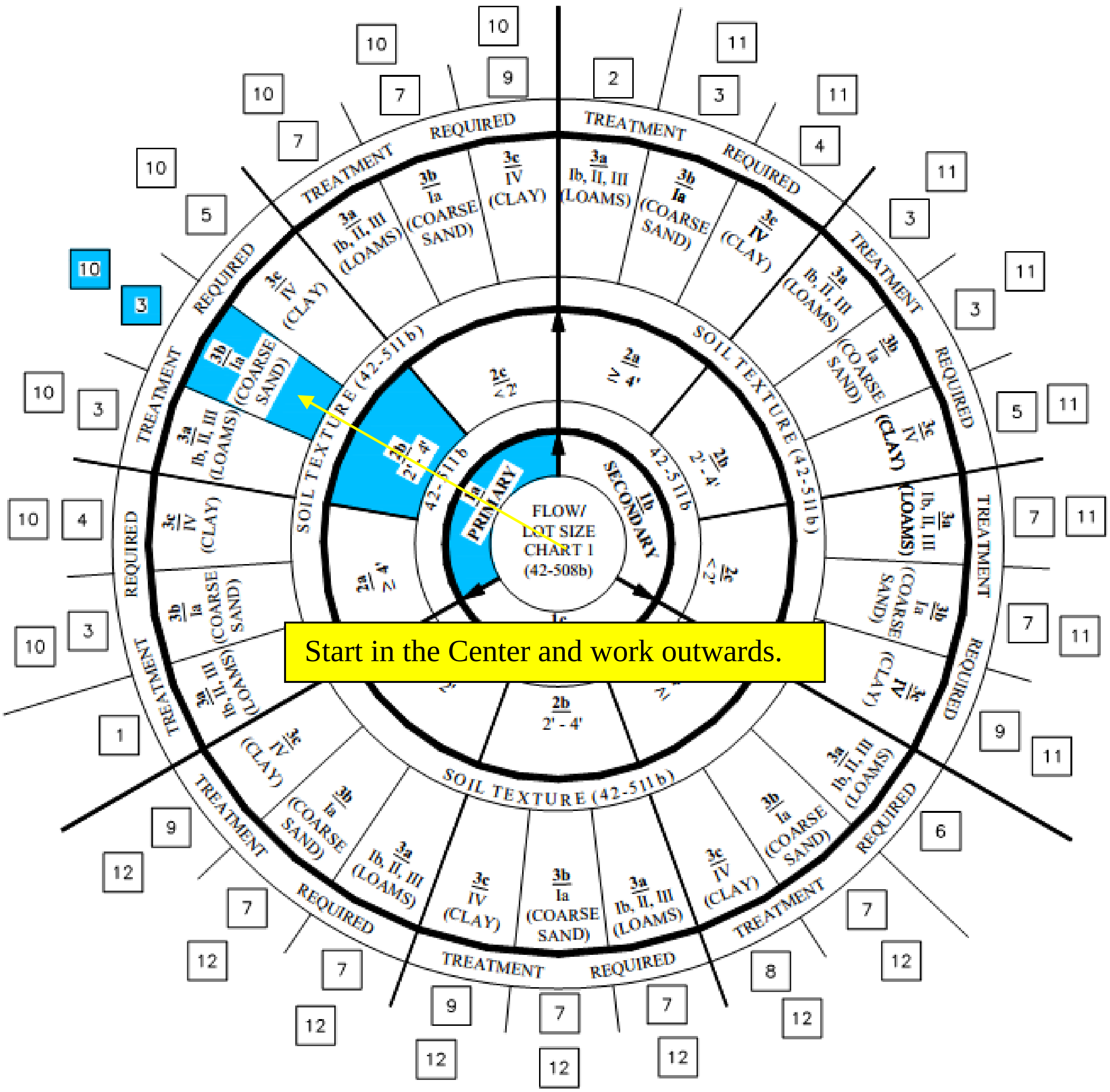
- ***What type of soil exists at the site?***
  The family noticed sandy soil conditions on the lot. Sandy soils correspond to **3b**.

As seen in Example 1 – Figure 3-1, the acceptable onsite treatment options for these particular site conditions include secondary treatment with disinfection prior to disposal in a normal disposal field (Onsite Treatment 3 in the Cost Matrix), or primary treatment using a mound disposal system (Onsite Treatment 10 in the Cost Matrix).

Offsite treatment options may also be available, considering there are nearby lots that may be interested in sharing a wastewater treatment system. Proceed to Example 1 – Figure 4-1.



EXAMPLE 1 – CHART 1 FOR ONSITE TREATMENT



TREATMENT LEGEND

1	PRIMARY
2	SECONDARY
3	SECONDARY + DISINFECTION
4	SECONDARY + LOW PRESSURE DOSING
5	SECONDARY + DISINFECTION + LOW PRESSURE DOSING
6	TERTIARY
7	TERTIARY + DISINFECTION
8	TERTIARY + LOW PRESSURE DOSING
9	TERTIARY + DISINFECTION + LOW PRESSURE DOSING
10	PRIMARY + MOUND
11	SECONDARY + MOUND
12	TERTIARY + MOUND

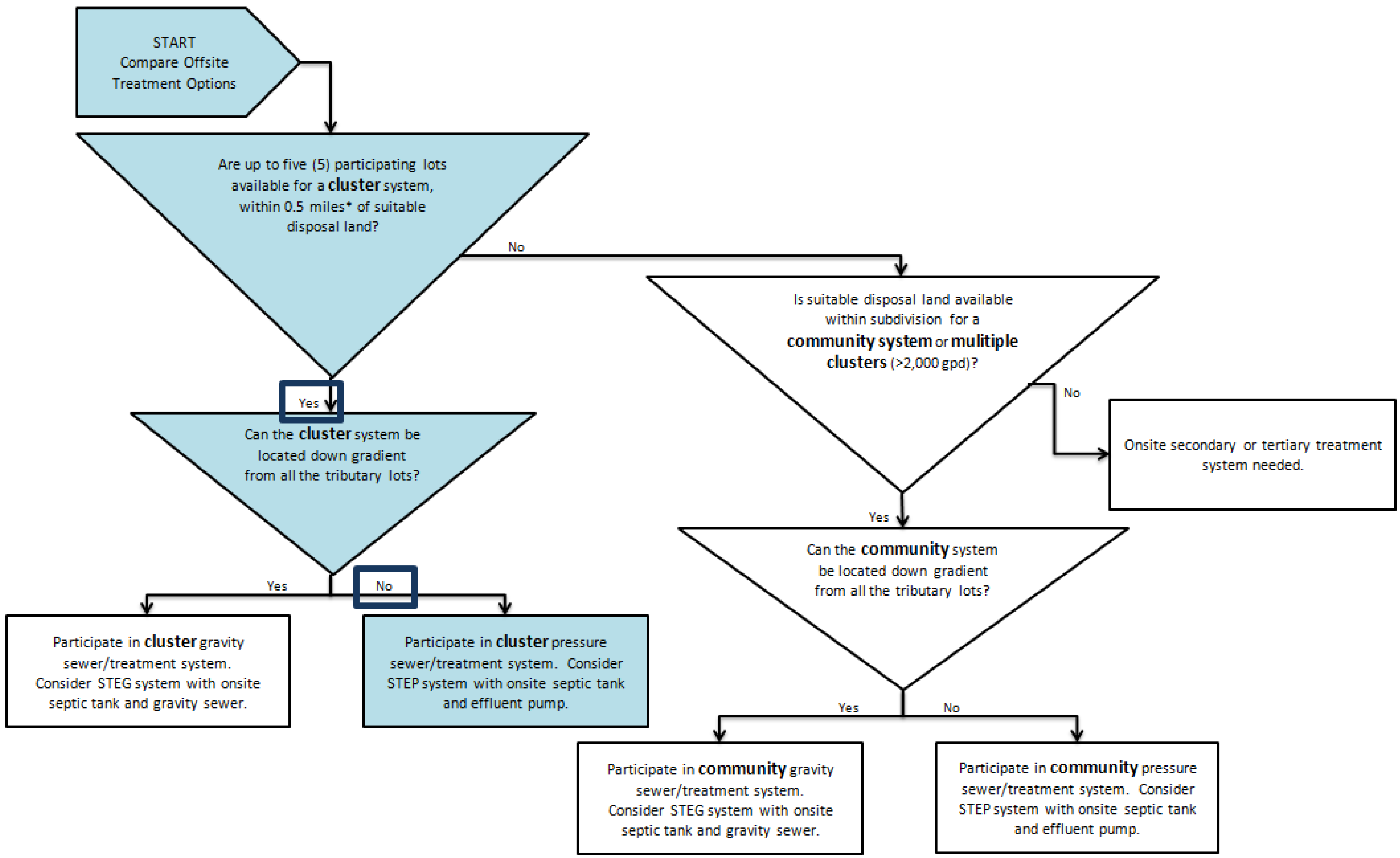
SOIL DEPTH AND TEXTURE LIMITATIONS MAY BE OVERCOME BY USE OF A MOUND DISPOSAL SYSTEM

EXAMPLE 1 – FIGURE 3-1

Example 1 – Figure 4-1

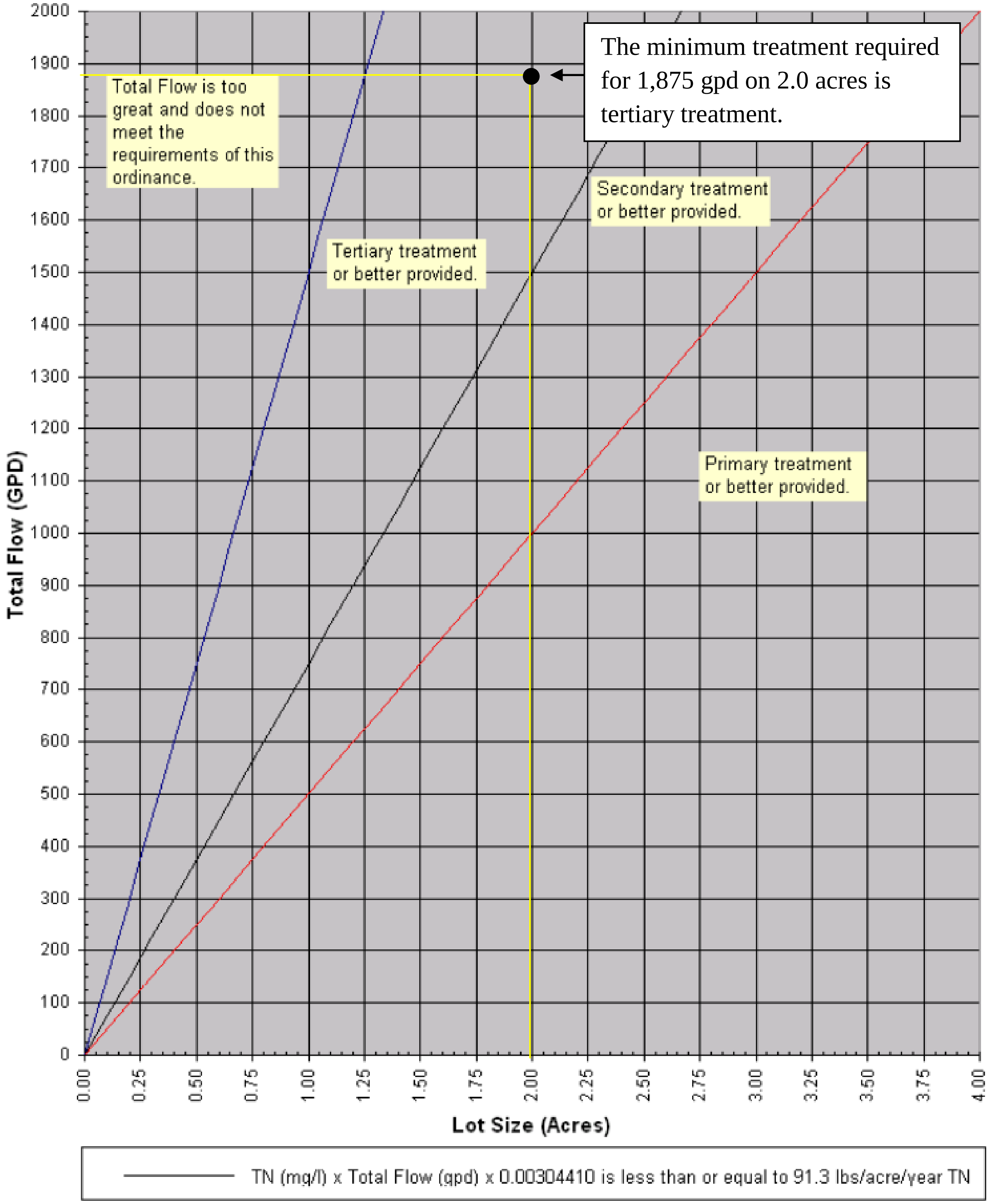
- ***Are up to five participating lots available for a cluster system, within approximately 0.5 miles of suitable disposal land?*** Yes; four lots are located adjacent to the subject lot, within about 0.5 miles of suitable disposal land.
- ***Can the cluster system be located down gradient from all the tributary lots?*** No, the available land is assumed to be located on a hill, upstream of the lots.

The lots have the option to participate in a cluster pressure effluent sewer system. The lots will need to be equipped with onsite septic tanks and effluent pumps to pump the effluent to the disposal site. As explained in the guidance document, soil conditions at the disposal site are assumed to be suitable for disposal without disinfection or low-pressure dosing. The level of effluent treatment required (primary, secondary, or tertiary) depends on total flow and available land for disposal. The design flow for five lots with three-bedroom houses is 1,875 gpd. Given that two acres of land are available for disposal, Chart 1 suggests that tertiary treatment is required for offsite disposal.



EXAMPLE 1 – FIGURE 4-1

Chart 1. Maximum Total Flow



EXAMPLE 1 – CHART 1 FOR OFFSITE TREATMENT

Example 1 – Cost Matrix

For this example, three options are applicable: onsite secondary treatment and disinfection and disposal in a normal disposal field, onsite primary treatment and disposal in a mound disposal system, and offsite cluster pressure treatment and disposal. From the Cost Matrix, these options can be compared in terms of cost, as shown in Example 1 – Table 5-1.

EXAMPLE 1 – TABLE 5-1 – EXCERPTS FROM COST MATRIX

Itemized Cost Tables	Disposal Location	Treatment Type	User's Share of Capital Cost	User's Share of O&M Cost	Annual Debt Service Cost	Life Cycle Present Worth
#5	Onsite	3 - Secondary + Disinfection	$10,200	$500	$690	$17,600
#12	Onsite	10 - Primary Treatment with Mound & Pump	$9,300	$400	$630	$15,300
#26	Offsite	5 lots (1,875 gpd), pressure, tertiary	$44,000	$440	$2,960	$50,500

Determine the Life Cycle Present Worth of Secondary + Disinfection Treatment

From the Cost Matrix (Table 5-1) in the Sanitary Sewer Assessment Guidelines, the Life Cycle Present Worth of this treatment option is $17,600.

Determine the Life Cycle Present Worth of Primary Treatment with Mound & Pump

From the Cost Matrix in the Sanitary Sewer Assessment Guidelines, the Life Cycle Present Worth of this treatment option is $15,300.

Determine Life Cycle Present Worth of Five Lots, Pressurized, with Tertiary Treatment

From the Cost Matrix in the Sanitary Sewer Assessment Guidelines, the Life Cycle Present Worth for one User is $50,500. However, the offsite disposal costs do not include the cost of a septic tank; because these lots are undeveloped and without septic tanks, the cost of a septic tank should be added to the capital cost listed in the Cost Matrix. A septic tank could be expected to cost between $2,000 and $3,000, installed. The Life Cycle Present Worth should be adjusted to include the addition of a septic tank.

Life Cycle Present Worth of Five Lots, Pressurized, Tertiary Treatment, and Septic Tank

1. **Determine User's Share of Capital Cost**

   \$44,000 (Five lots, pressurized, tertiary treatment) + \$3,000 (Septic tank) = \$44,300

2. **Determine Annual Debt Service Cost**

   Rarely can a capital expenditure of this magnitude be afforded without a loan. The annual debt service represents interest paid on the loan to fund the capital improvements. An assumed interest rate of three percent for a term of 20 years has a capital recovery factor of 0.06722 (see Section 5.6 in the Sewer Assessment Guidelines). Multiply the Capital Cost by the Capital Recovery Factor to determine the Annual Debt Cost.

   $$(CapitalCost)\cdot(Capital\ \mathrm{Re}\,\mathrm{cov}\,eryFactor) = AnnualDebtCost$$

   $$(\$44{,}300)\cdot(0.06722) = \$2{,}978 \rightarrow \$2{,}980$$

   Annual Debt Service Cost is not used to determine the Life Cycle Present Worth.

3. **Determine Life Cycle Present Worth**

   The Life Cycle Present Worth is determined according to the equation shown below.

   Life Cycle Present Worth = Capital + O&M Cost · Present Worth Factor

   Assuming an interest rate of three percent and a life of 20 years, the Present Worth Factor is 14.87747 (see Table 5-1 in the Assessment Guidelines). The Present Worth Factor is multiplied by the annual O&M Cost.

   $$LifeCycle\ \mathrm{Pr}\,esentWorth = \$44{,}300 + \$440 \cdot 14.87747 = \$50{,}846 \rightarrow \$50{,}800$$

   The adjusted Life Cycle Present Worth for offsite treatment shared between five lots, pressurized, tertiary treatment, and a septic tank is roughly \$50,800.

The onsite treatment options appear to have lower capital and life-cycle costs than the cluster treatment option, as shown in Example 1 – Table 5-2.

EXAMPLE 1 – TABLE 5-2 – ADJUSTED LIFE CYCLE PRESENT WORTH

Itemized Cost Tables	Disposal Location	Treatment Type	Life Cycle Present Worth
#5	Onsite	3 - Secondary + Disinfection	$ 17,600
#12	Onsite	10 - Primary Treatment with Mound & Pump	$ 15,300
ADJ	Offsite	5 lots (1,875 gpd), pressure, tertiary, septic tank	$ 50,800

EXAMPLE 2 – EXISTING SMALL DEVELOPMENT

A single family is living in a three-bedroom house on a two-thirds acre lot. There are three townhouses on lots adjacent to their own, each on quarter-acre lots. There is also one quarter-acre undeveloped lot nearby. The septic systems for the four properties are generally not working well, requiring frequent pumping, and their yards become “soggy” every morning. When attempting to install a trellis in the backyard, they ran into solid rock roughly one foot and eight inches deep. The backyard soil is loamy in texture.

EXAMPLE 2 – EXISTING SMALL DEVELOPMENT

GIVEN: A single family is living in a three-bedroom house on a two-thirds acre lot. There are three townhouses on lots adjacent to their own, each on quarter-acre lots. There is also one quarter-acre undeveloped lot nearby. The septic systems for the four properties are generally not working well, requiring frequent pumping, and their yards become “soggy” every morning. When attempting to install a trellis in the backyard, they ran into solid rock roughly one foot and eight inches deep. The backyard soil is loamy in texture.

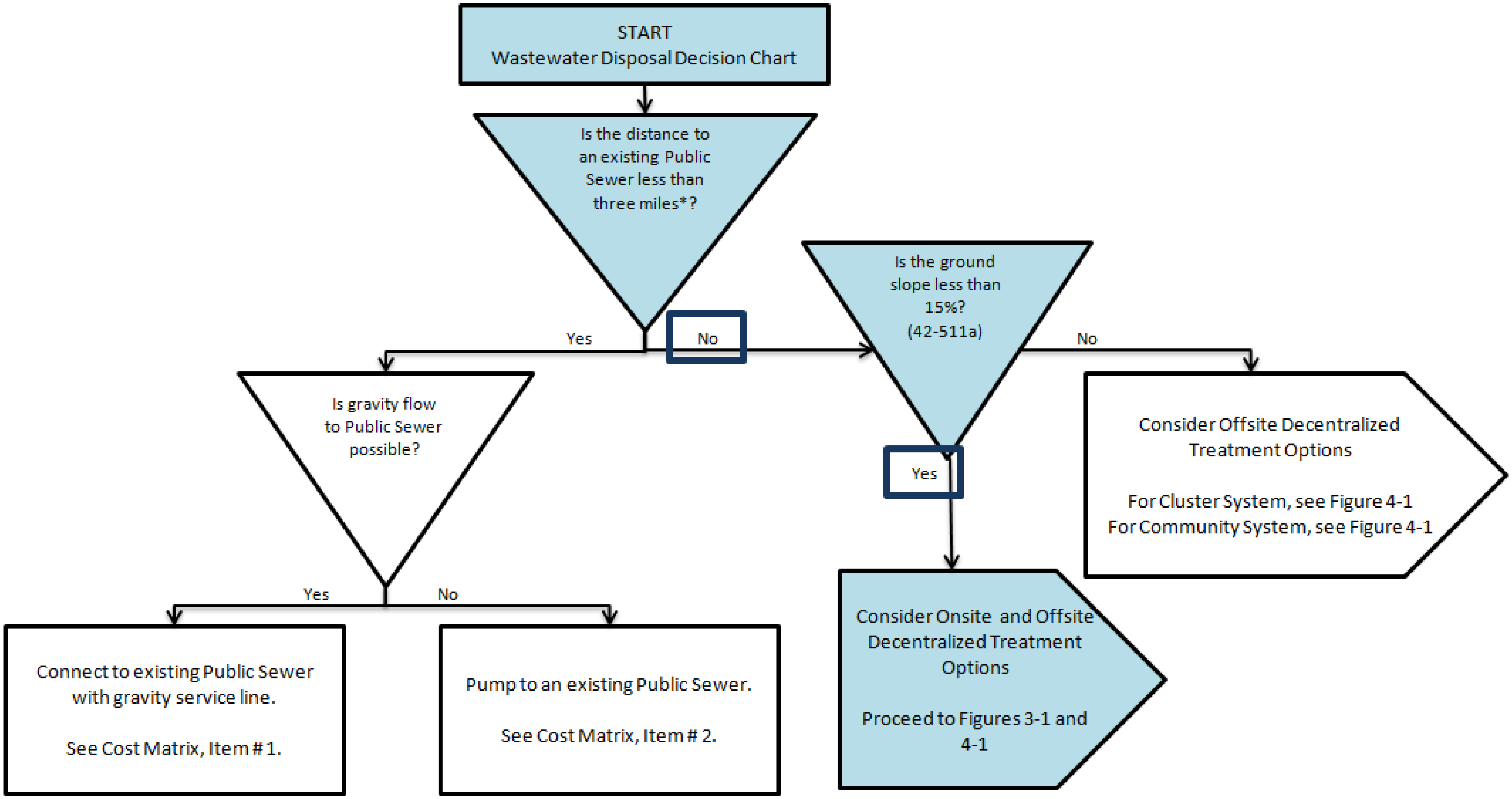
OTHER ASSUMPTIONS: A public sewer is more than three miles away. The one-quarter acre lot has generally the same characteristics of loamy soil with less than two feet of soil to bedrock, and ground slope is less than 15 percent. Three acres of undeveloped land are located uphill from the subject lot(s), approximately one-third of a mile away. Each townhouse is made up of two three-bedroom dwelling units.

DETERMINE: What wastewater treatment systems are acceptable options for this family?

SOLUTION: Use Sewer Assessment Guidelines to determine suitable options for treatment. Use Cost Matrix to compare options. Begin the exercise with Example 2 – Figure 2-1.

Example 2 – Figure 2-1

- ***Is the distance to an existing Public Sewer less than three miles?*** No.
- ***Is the ground slope less than 15 percent?*** Yes.



EXAMPLE 2 – FIGURE 2-1

Site conditions are suitable for onsite and offsite treatment. The next step is to see what onsite and offsite treatment technology is appropriate. Proceed to Example 2 – Figure 3-1 to determine the appropriate configuration for onsite treatment.

Example 2 – Figure 3-1

- ***What level of treatment is required based on Example 2 – Chart 1?*** Design flow for a three-bedroom house is 375 gpd. On two-thirds of an acre, secondary treatment is the minimum level of treatment necessary, as seen in Example 2 – Chart 1.

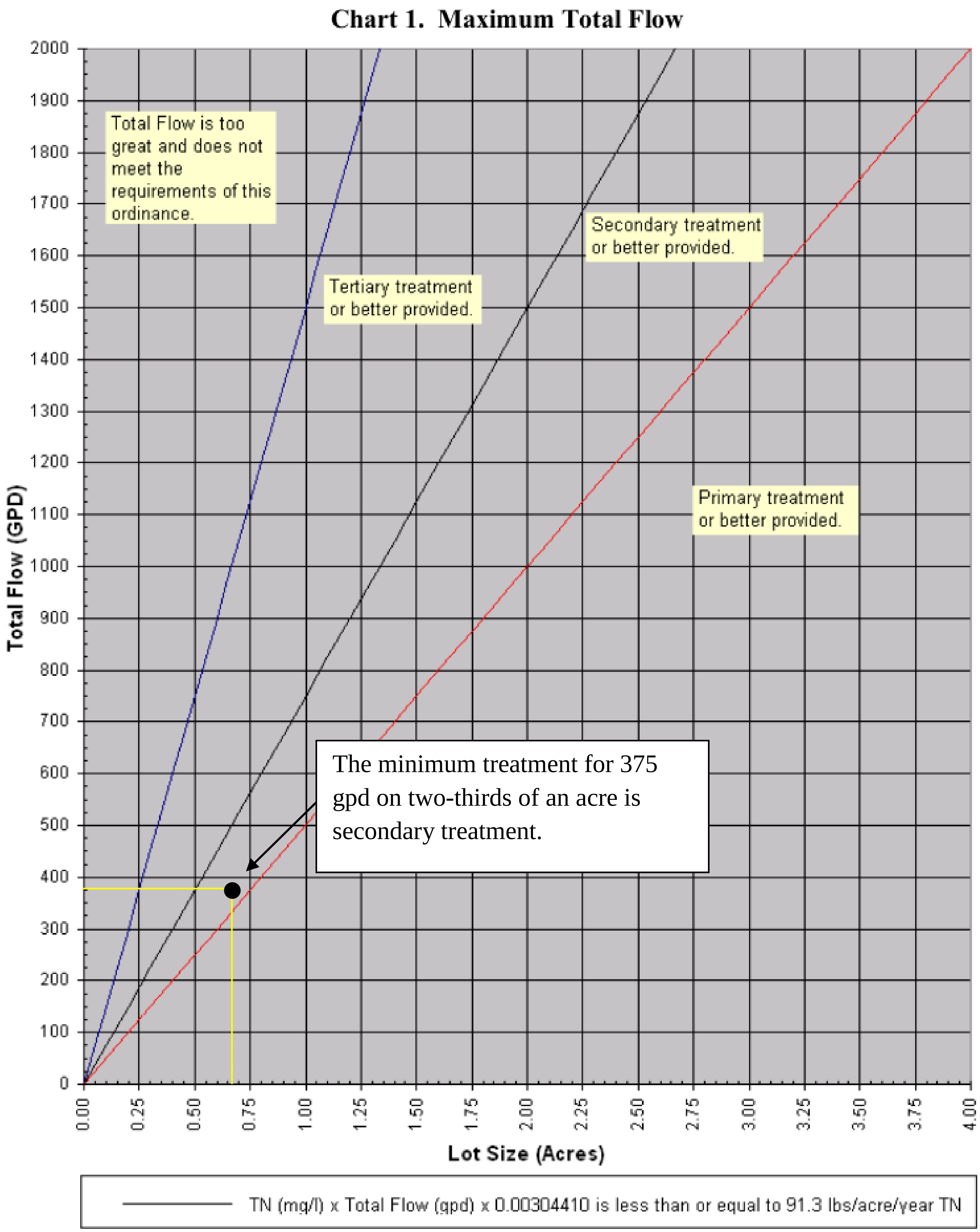
  Secondary treatment is labeled as **1b** in Example 2 – Figure 3-1.

- ***What is the depth of suitable soil beneath the absorption area?***
  The depth of soil, less than two feet, corresponds to **2c**.

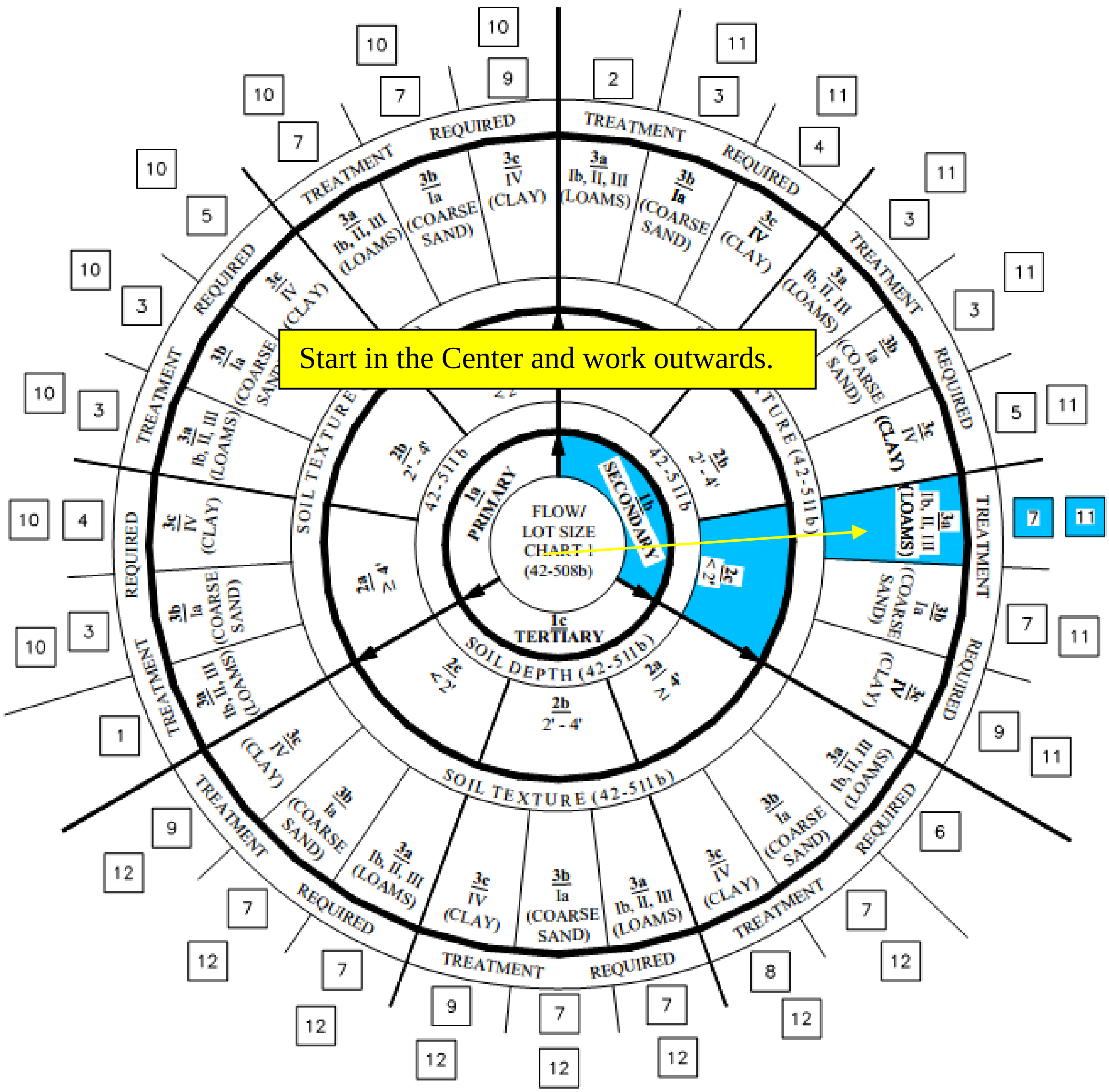
- ***What type of soil exists at the site?***
  The soil is loamy. Loams correspond to **3a**.

The acceptable onsite treatment options for these particular site conditions include tertiary treatment with disinfection prior to disposal in a normal disposal field (Onsite Treatment 7 in the Cost Matrix), or secondary treatment using a mound disposal system (Onsite Treatment 11 in the Cost Matrix).

Offsite treatment options may also be available, considering there are nearby lots that may be interested in sharing a wastewater treatment system. Proceed to Example 2 – Figure 4-1.



EXAMPLE 2 – CHART 1 FOR ONSITE TREATMENT



TREATMENT LEGEND

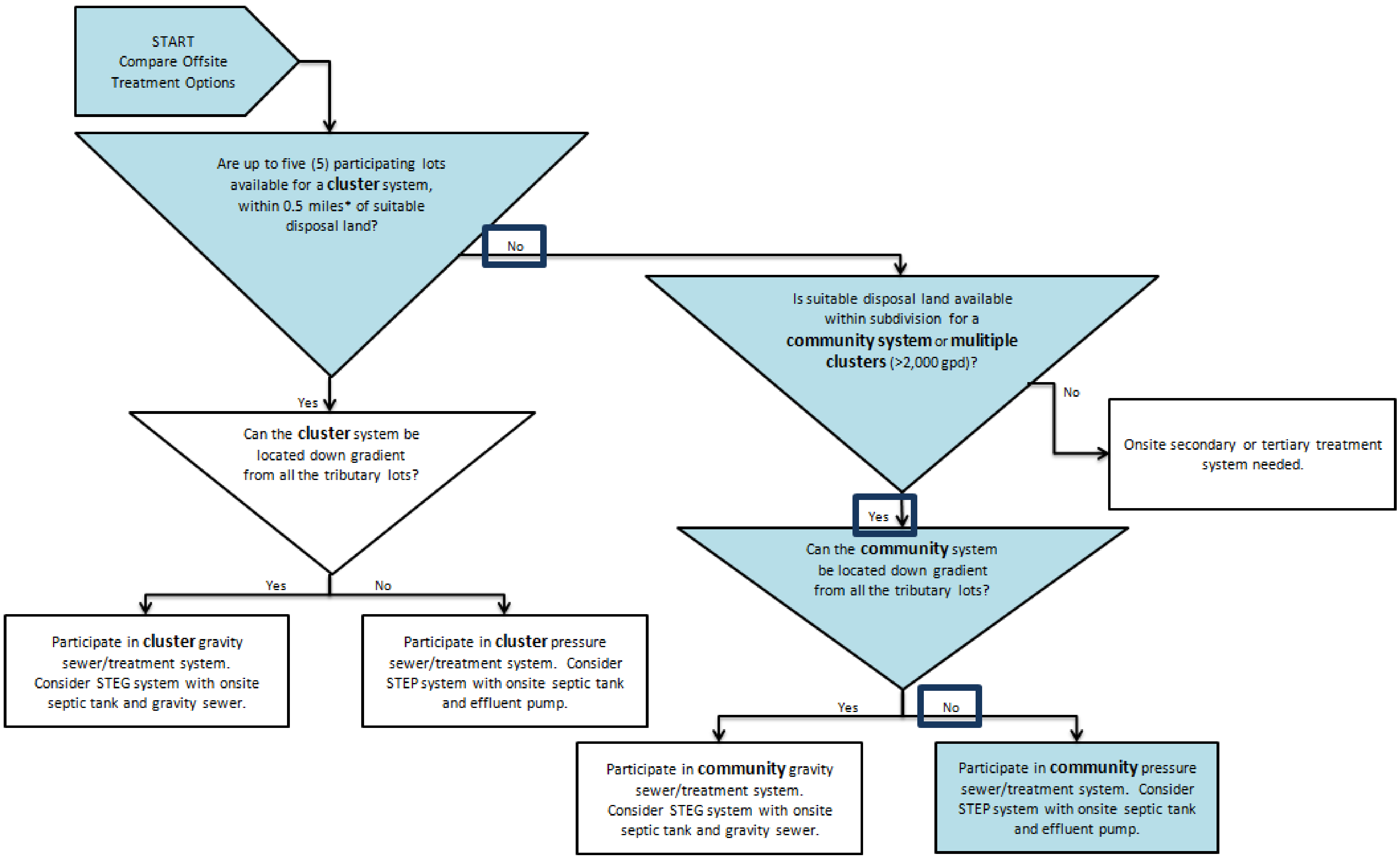
1	PRIMARY
2	SECONDARY
3	SECONDARY + DISINFECTION
4	SECONDARY + LOW PRESSURE DOSING
5	SECONDARY + DISINFECTION + LOW PRESSURE DOSING
6	TERTIARY
7	TERTIARY + DISINFECTION
8	TERTIARY + LOW PRESSURE DOSING
9	TERTIARY + DISINFECTION + LOW PRESSURE DOSING
10	PRIMARY + MOUND
11	SECONDARY + MOUND
12	TERTIARY + MOUND

SOIL DEPTH AND TEXTURE LIMITATIONS MAY BE OVERCOME BY USE OF A MOUND DISPOSAL SYSTEM

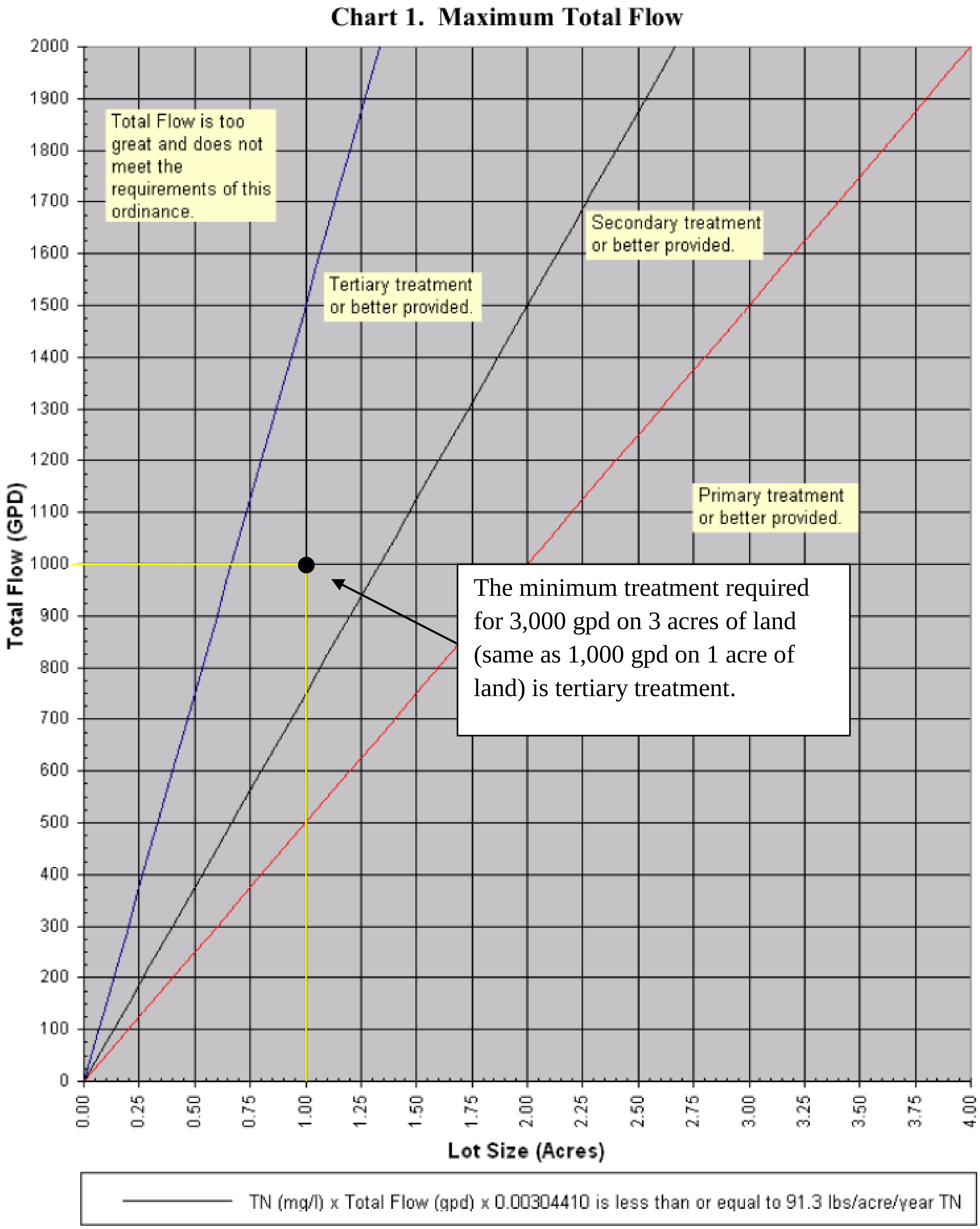
EXAMPLE 2 – FIGURE 3-1

Example 2 – Figure 4-1

- ***Are up to five participating lots available for a cluster system, within approximately 0.5 miles of suitable disposal land?*** The single-family house, three townhouses, and the undeveloped lot constitute eight lots. One cluster system will not serve all the properties.
- ***Is suitable disposal land available for a community system or multiple cluster systems?*** Eight lots with three-bedroom houses will have a design flow of 3,000 gpd. According to the Maximum Total Flow Chart, three acres is an acceptable amount of land for disposal if effluent receives tertiary treatment.
- ***Can the community system be located down gradient from the tributary lots?*** No. The disposal land is uphill.



EXAMPLE 2 – FIGURE 4-1



EXAMPLE 2 – CHART 1 FOR OFFSITE TREATMENT

The lots have the option to participate in a cluster pressure effluent sewer system. The lots will need to be equipped with onsite septic tanks and effluent pumps to pump the effluent to the disposal site. As explained in the guidance document, soil conditions at the disposal site are assumed to be suitable for disposal without disinfection or low-pressure dosing. The level of effluent treatment required (primary, secondary, or tertiary) depends on total flow and available land for disposal. As indicated in Example 2 – Chart 1, tertiary treatment is required for offsite disposal.

<u>Example 2 – Cost Matrix</u>

For this example, three options are applicable: onsite tertiary treatment plus disinfection and disposal in a normal disposal field, onsite secondary treatment with a mound disposal field, or offsite community pressure treatment and disposal. The anticipated costs associated with these options are found in Table 5-1 of the Sewer Assessment Guidelines and repeated in Example 2 – Table 5-1.

<u>EXAMPLE 2 – TABLE 5-1 – EXCERPTS FROM COST MATRIX</u>

Disposal Location	Treatment Type	User's Share of Capital Cost	User's Share of O&M Cost	Annual Debt Service Cost	Life Cycle Present Worth
Onsite	7 - Tertiary + Disinfection	$12,900	$500	$870	$20,300
Onsite	11 - Secondary Treatment with Mound and Pump	$11,700	$500	$790	$19,100
Offsite	8 lots (3,000 gpd), pressure, tertiary	$38,100	$330	$2,560	$43,000

Determine the Life Cycle Present Worth of Tertiary + Disinfection Treatment

From the Cost Matrix (Table 5-1) in the Sanitary Sewer Assessment Guidelines, the Life Cycle Present Worth of this treatment option is $20,300.

Determine the Life Cycle Present Worth of Secondary Treatment with Mound & Pump

From the Cost Matrix in the Sanitary Sewer Assessment Guidelines, the Life Cycle Present Worth of this treatment option is $19,100.

Determine Life Cycle Present Worth of Eight Lots, Pressurized, with Tertiary Treatment

From the Cost Matrix in the Sanitary Sewer Assessment Guidelines, the Life Cycle Present Worth for one User is $43,000.

The onsite secondary treatment with mound disposal system appears to have the lowest capital and life-cycle costs compared to the other options.

EXAMPLE 3 – NEW HIGH DENSITY DEVELOPMENT

A developer is contemplating developing ten acres of land on the east side of the Rio Grande in the South Valley. The development will be adjacent to a proposed industrial distribution facility. The subdivision is two miles from the nearest ABCWUA sewer system. The developer desires to construct a condominium complex. Each complex would have four dwelling units and be situated on one-third acre of land. Preliminary site investigations indicate that the area is comprised of generally loamy soils, roughly five-feet deep or more.

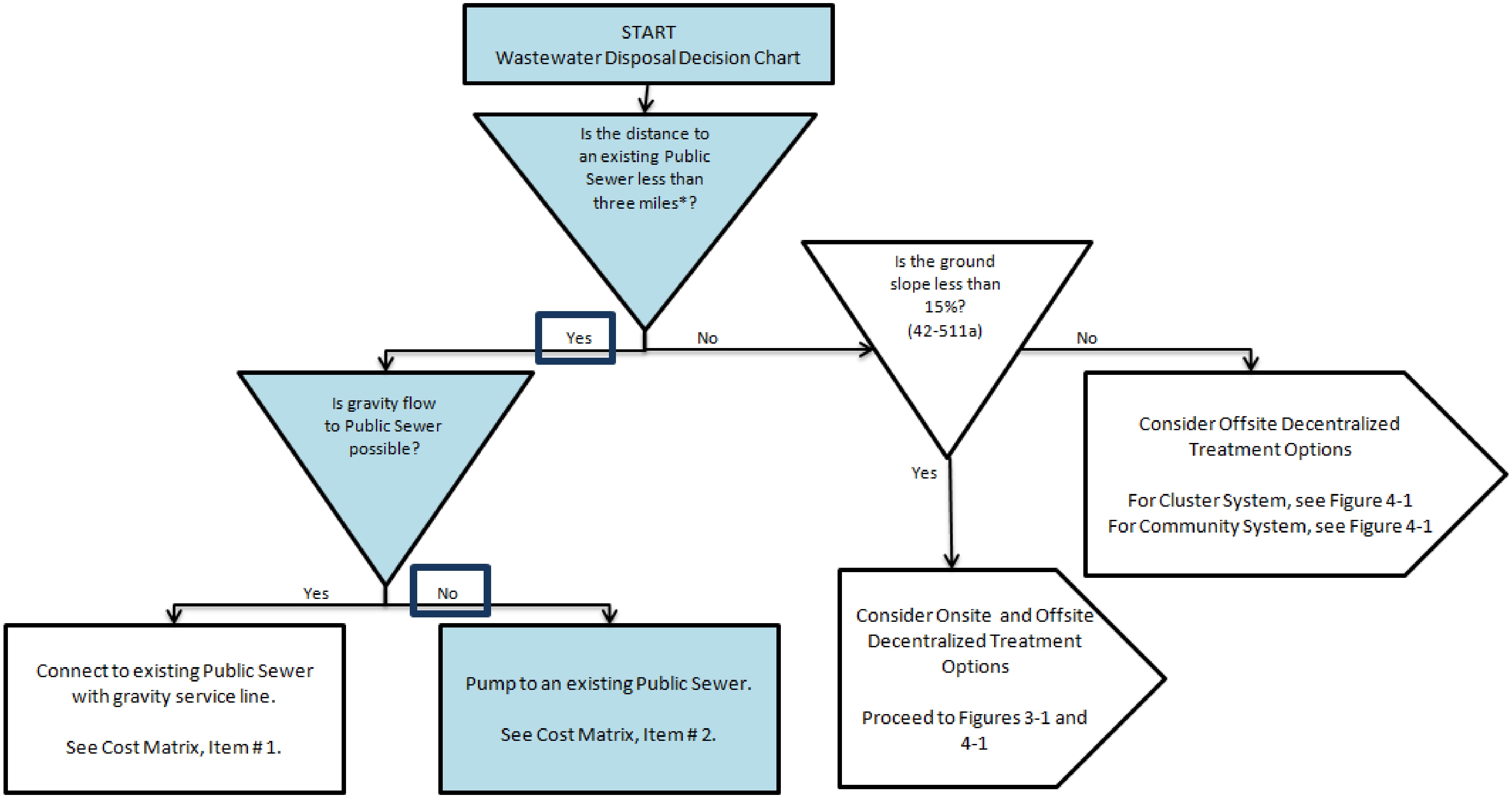
EXAMPLE 3 – NEW HIGH DENSITY DEVELOPMENT

GIVEN: A developer is contemplating developing ten acres of land on the east side of the Rio Grande in the South Valley. The development will be adjacent to a proposed industrial distribution facility. The subdivision is two miles from the nearest ABCWUA sewer system. The developer desires to construct a condominium complex. Each complex would have four dwelling units and be situated on one-third acre of land. Preliminary site investigations indicate that the area is comprised of generally loamy soils, roughly five-feet deep or more.
OTHER ASSUMPTIONS: Assume two bedrooms per condo. A significant amount of land is not available for disposal within reasonable distance. The South Valley is generally flat.
DETERMINE: What wastewater treatment systems are acceptable for this development?

SOLUTION: Use Sewer Assessment Guidelines to determine suitable options for treatment. Use Cost Matrix to compare options. Begin the exercise with Example 3 – Figure 2-1.

Example 3 – Figure 2-1

- ***Is the distance to an existing Public Sewer less than three miles?*** Yes.
- ***Is gravity flow to Public Sewer possible?*** No, the South Valley is too flat for gravity flow to public sewers.



EXAMPLE 3 – FIGURE 2-1

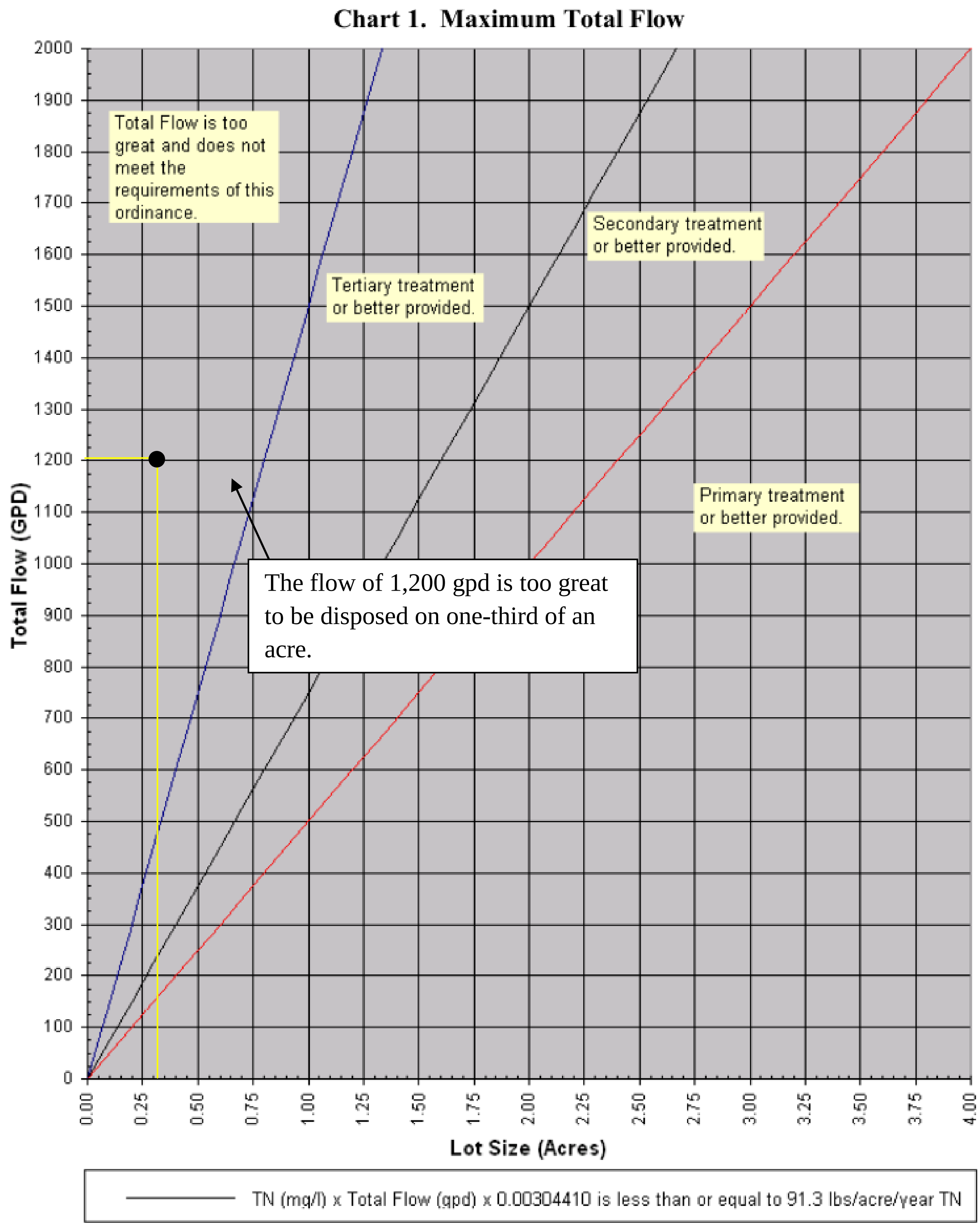
The close proximity to a public sewer suggests this is a feasible option. However, comparison with onsite and offsite treatment may be warranted. Proceed to Example 3 – Figure 3-1.

<u>Example 3 – Figure 3-1</u>

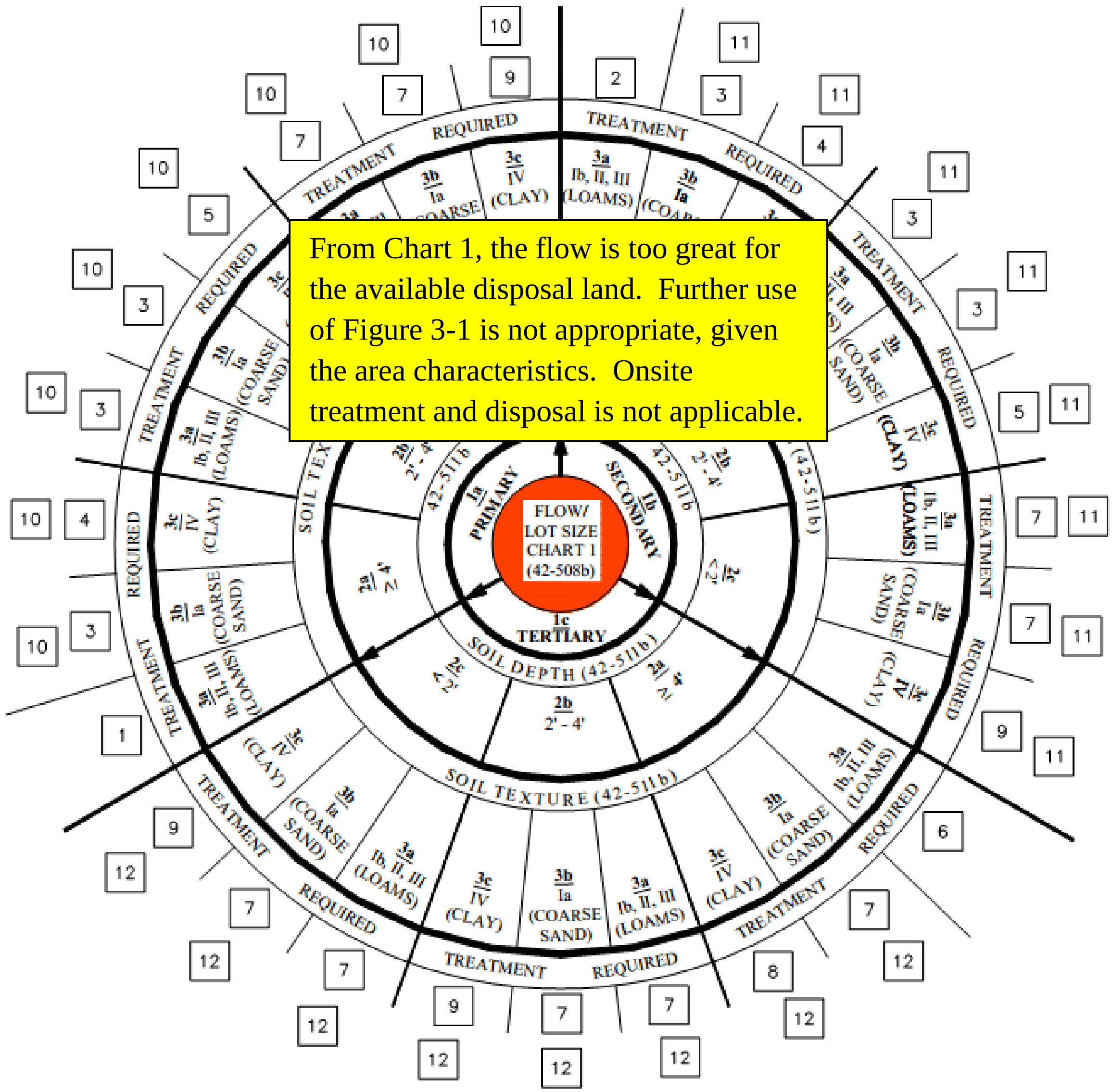
- ***What level of treatment is required based on Chart 1?*** Design flow for a two-bedroom house is 300 gpd; however, there are four two-bedroom dwelling units per complex, for a design flow of 1,200 gpd. On one-third acre, this design flow is too great for onsite treatment and disposal, and another form of treatment should be considered.

Although soil depth and texture may be suitable for onsite disposal, onsite treatment systems are not viable options based on the high design flow compared to available disposal land.

Offsite treatment options are not available, based on the assumption that suitable disposal land is not located close by. Example 3 – Figure 4-1 illustrates that onsite treatment is the suitable option. However, from Example 3 – Figure 3-1, it is clear that onsite treatment is not available.



EXAMPLE 3 – CHART 1 FOR ONSITE TREATMENT



TREATMENT LEGEND

1	PRIMARY
2	SECONDARY
3	SECONDARY + DISINFECTION
4	SECONDARY + LOW PRESSURE DOSING
5	SECONDARY + DISINFECTION + LOW PRESSURE DOSING
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10	PRIMARY + MOUND
11	SECONDARY + MOUND
12	TERTIARY + MOUND

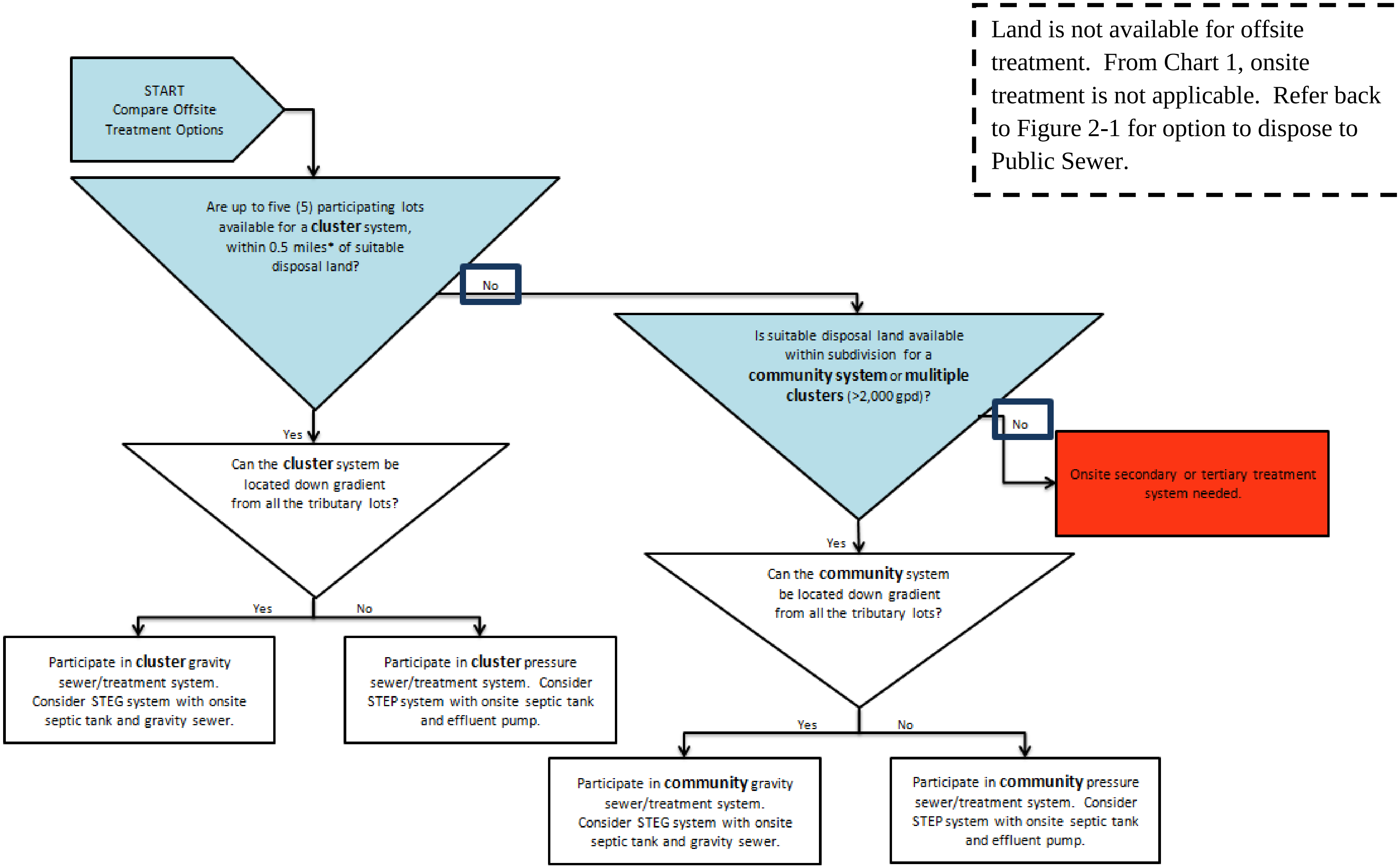
SOIL DEPTH AND TEXTURE LIMITATIONS MAY BE OVERCOME BY USE OF A MOUND DISPOSAL SYSTEM

EXAMPLE 3 – FIGURE 3-1

Example 3 – Figure 4-1

- ***Are up to five participating lots available for a cluster system, within approximately 0.5 miles of suitable disposal land?*** No; disposal land is not available. Additionally, there are approximately 30 lots that will require treatment.
- ***Is suitable disposal land available for a community system or multiple clusters?*** No, again, disposal land is not available.

Without available land for disposal, such high-density development will need to utilize disposal to a public sewer for wastewater treatment.



EXAMPLE 3 – FIGURE 4-1

Example 3 – Cost Matrix

For this example, only one option is applicable: disposal to a public sewer system. The Cost Matrix presents the cost of this option, as shown in Example 3 – Table 5-1.

EXAMPLE 3 – TABLE 5-1 – EXCERPTS FROM COST MATRIX

Itemized Cost Tables	Disposal Location	Treatment Type	User's Share of Capital Cost	User's Share of O&M Cost	Annual Debt Service Cost	Public Sewer Monthly Servic Fee	Life Cycle Present Worth
#2	Public Sewer	Pump to Public Sewer, based on one mile of pipe and 40 Users	$ 9,000	--	$ 600	$ 13	$ 11,300

The Public Sewer cost is based on one mile of pipe and 40 Users. When the development is fully occupied, there will be approximately 120 Users (10 acres of one-third acre lots with four condos per lot). The cost will increase based on an increased length of pipe, but decrease because the number of Users will be greater than 40. The User's share of capital and annual debt service cost must be adjusted to determine the resulting Life Cycle Present Worth, as shown in the following calculations. Refer to Table 5-1 in the Assessment Guidelines for Present Worth Factors.

1. **Determine User's Share of Capital Cost**

$$\frac{\$9{,}000}{mi \cdot User}\left(\frac{40 Users}{120 Users}\right)(2 miles) = \$6{,}000$$

2. **Determine Annual Debt Service Cost**

   Rarely can a capital expenditure of this magnitude be afforded without a loan. The annual debt service represents interest paid on the loan to fund the capital improvements. An assumed interest rate of three percent for a term of 20 years has a capital recovery factor of 0.06722 (see Section 5.6 in the Sewer Assessment Guidelines). Multiply the Capital Cost by the Capital Recovery Factor to determine the Annual Debt Cost.

$$(Capital Cost)\cdot(Capital Recovery Factor) = Annual Debt Cost$$

$$(\$6{,}000)\cdot(0.06722) = \$403 \rightarrow \$400$$

   Annual Debt Service Cost is not used to determine the Life Cycle Present Worth.

3. Determine Public Sewer Monthly Service Fee

The monthly sewer bill received by each User will likely not vary widely with the number of Users; a flat rate is usually paid for sewer services. The monthly fee of approximately $13 is not adjusted for 120 Users.

4. Determine Life Cycle Present Worth

The Life Cycle Present Worth is determined according to the equation shown below.

Life Cycle Present Worth = Capital + Monthly Cost · Present Worth Factor

Assuming an interest rate of three percent and a life of 20 years, the Present Worth Factor is 14.87747 (see Table 5-1 in the Assessment Guidelines). Monthly costs were multiplied by twelve to assume an annual cost for use in determining Present Worth.

$$LifeCycle\ \mathrm{Pr}\,esentWorth = \$6{,}000 + \frac{\$13}{mo} \cdot 12mo \cdot 14.87747 = \$8{,}321 \rightarrow \$8{,}300$$

The adjusted Life Cycle Present Worth for 120 Users discharging by pressure to a Public Sewer two miles away is roughly $8,300, as shown in Example 3 – Table 5-2.

<u>EXAMPLE 3 – TABLE 5-2 – ADJUSTED LIFE CYCLE PRESENT WORTH</u>

Itemized Cost Tables	Disposal Location	Treatment Type	Life Cycle Present Worth
ADJ	Public Sewer	Pump to Public Sewer, based on two miles of pipe and 120 Users	$ 8,300

EXAMPLE 4 – REHABILITATE EXISTING SYSTEM

A homeowner decides to build a three-bedroom mother-in-law house behind an existing three-bedroom house on a one-acre property in the East Mountains. Bedrock is roughly five feet below the ground surface, and clay is the dominant soil type. The existing septic tank and leach field are located in a mound on the property and must be relocated.

EXAMPLE 4 – REHABILITATE EXISTING SYSTEM

GIVEN: A homeowner decides to build a three-bedroom mother-in-law house behind an existing three-bedroom house on a one-acre property in the East Mountains. Bedrock is roughly five feet below the ground surface, and clay is the dominant soil type. The existing septic tank and leach field are located in a mound on the property and must be relocated.

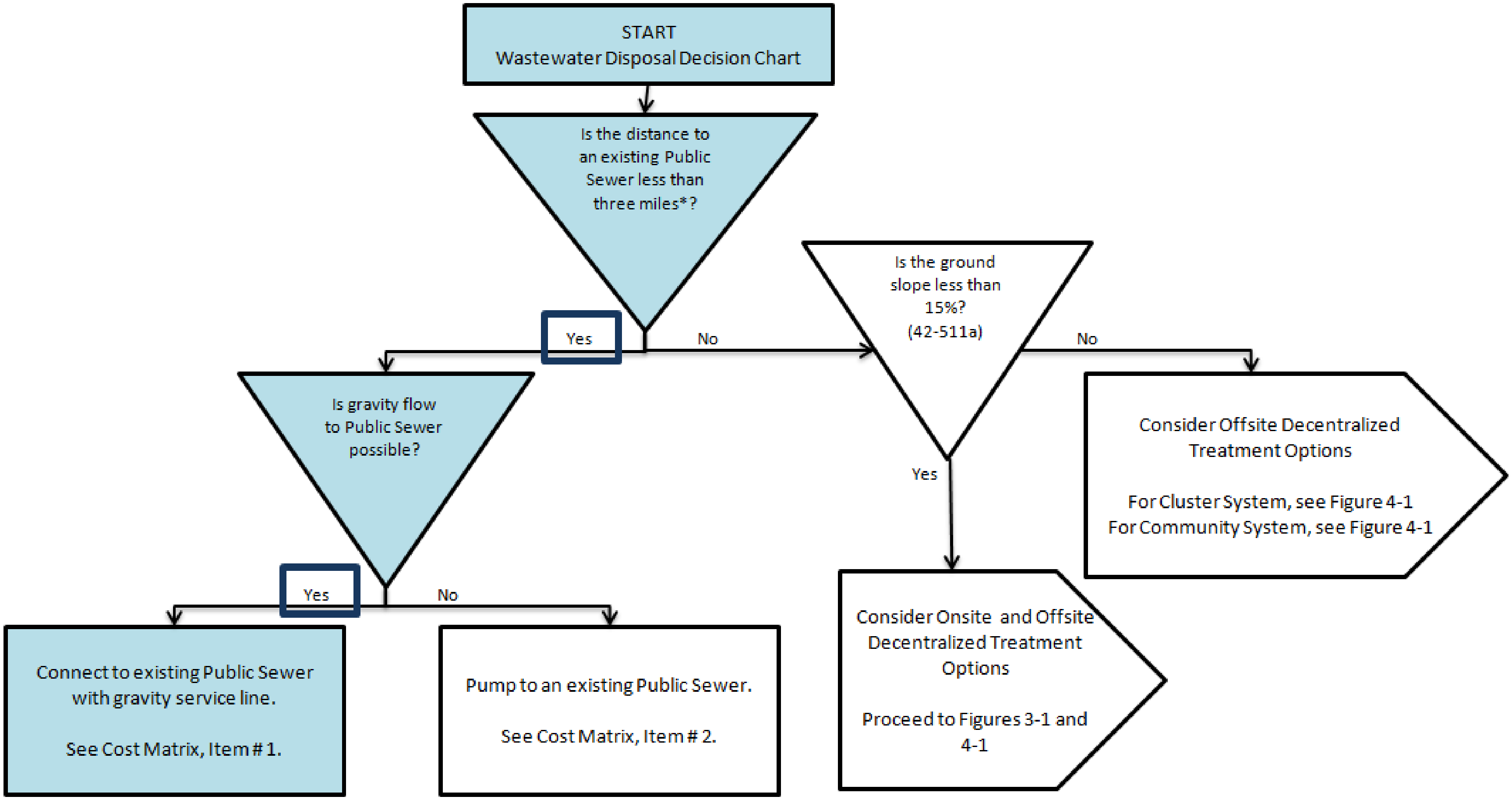
OTHER ASSUMPTIONS: A public sewer is two-and-a-half miles away, downhill. A total of 24 lots are located within a half-mile radius, including the property described above. Six-and-one-half acres of land may be available for offsite disposal three quarters of a mile **down the canyon**. The ground slope on the homeowner's lot is less than 15 percent.

DETERMINE: What wastewater treatment systems are acceptable options for this homeowner?

SOLUTION: Use Sewer Assessment Guidelines to determine suitable options for treatment. Use Cost Matrix to compare options. Begin the exercise with Example 4 – Figure 2-1.

Example 4 – Figure 2-1

- ***Is the distance to an existing Public Sewer less than three miles?*** Yes.
- ***Is gravity flow to Public Sewer possible?*** Yes.



EXAMPLE 4 – FIGURE 2-1

Discharge to a public sewer with a gravity line applies.

Because the ground slope is less than 15 percent, onsite and offsite treatment systems may also be considered. Example 4 – Figure 3-1 determines the appropriate technology for onsite treatment, while Example 4 – Figure 4-1 determines the appropriate configuration for offsite treatment. These options can be compared using the Cost Matrix. The next step is to see what onsite treatment technology is appropriate. Proceed to Example 4 –Figure 3-1.

<u>Example 4 – Figure 3-1</u>

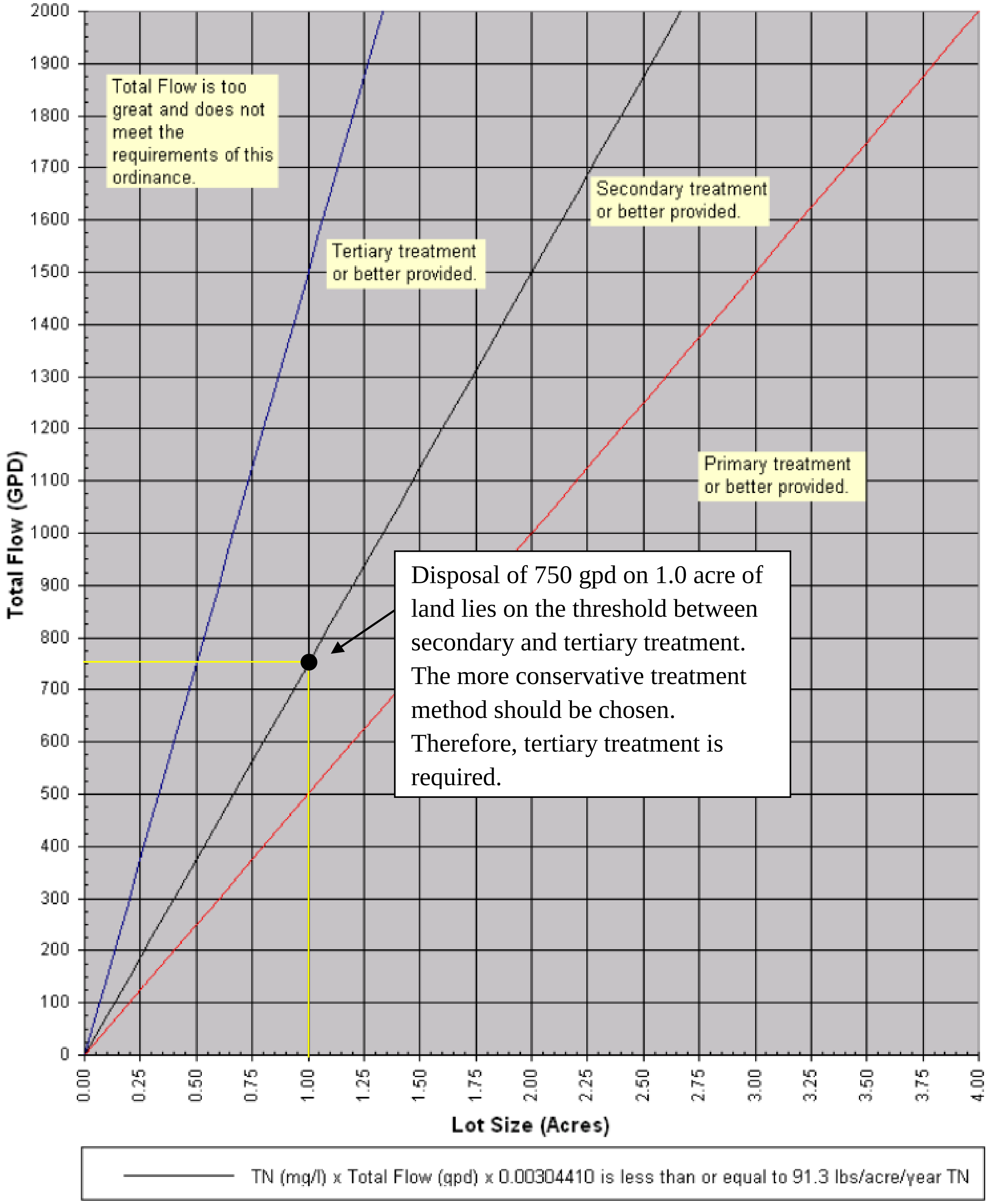
- ***What level of treatment for the one-acre property is required based on Chart 1?*** Design flow for a three-bedroom house is 375 gpd. Two three-bedroom houses have a combined design flow of 750 gpd. Disposal of this design flow on one acre lies on the threshold between secondary and tertiary treatment. The more conservative treatment method, tertiary treatment, should be selected.

  Tertiary treatment is labeled as **1c** in Example 4 – Figure 3-1.

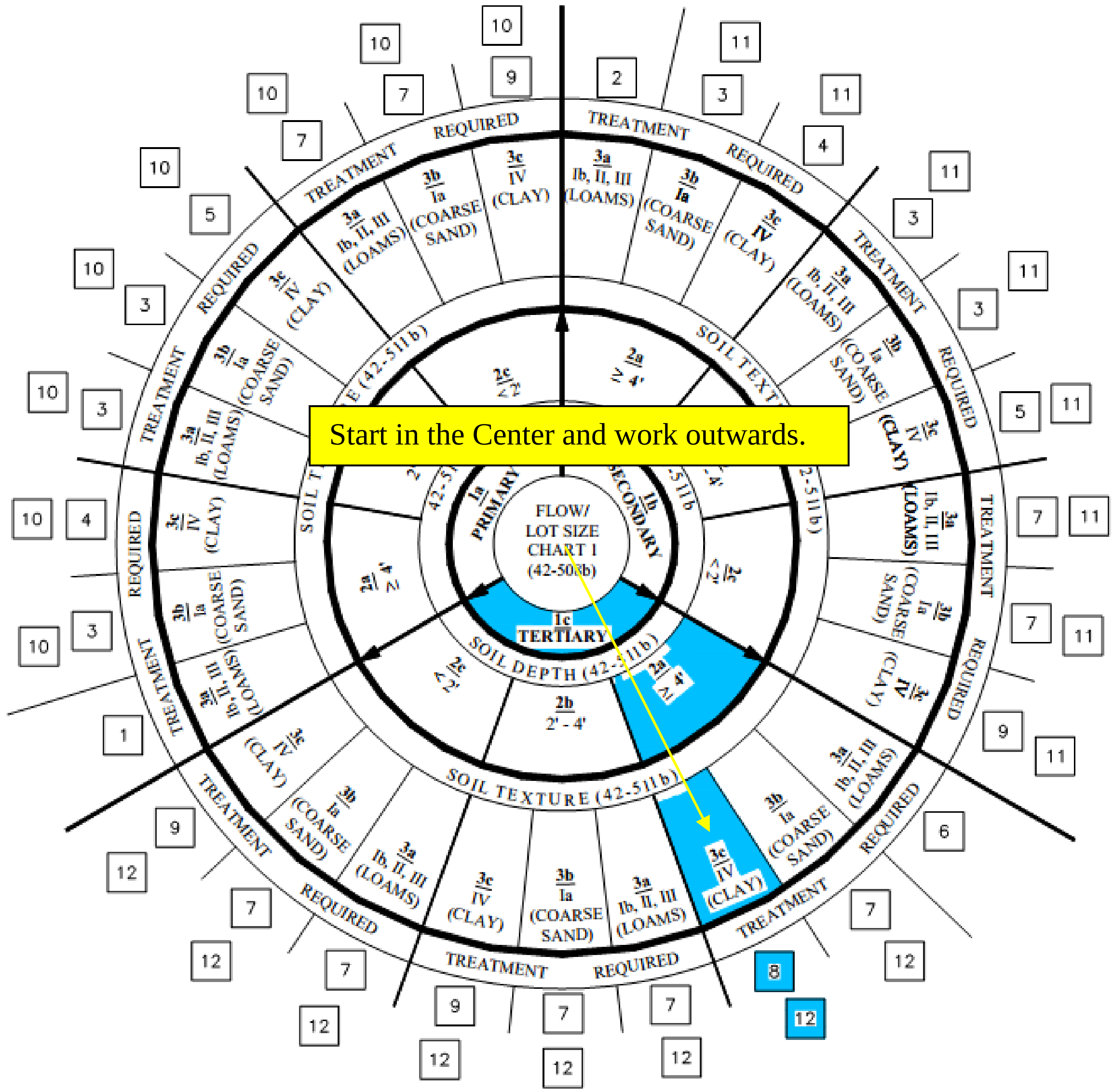
- ***What is the depth of suitable soil beneath the absorption area?***
  Bedrock is five feet below the ground surface. The depth of soil corresponds to **2a**.

- ***What type of soil exists at the site?***
  Clay soils are dominant on the lot. Clay soils correspond to **3c**.

Chart 1. Maximum Total Flow



EXAMPLE 4 – CHART 1 FOR ONSITE TREATMENT



TREATMENT LEGEND

1	PRIMARY
2	SECONDARY
3	SECONDARY + DISINFECTION
4	SECONDARY + LOW PRESSURE DOSING
5	SECONDARY + DISINFECTION + LOW PRESSURE DOSING
6	TERTIARY
7	TERTIARY + DISINFECTION
8	TERTIARY + LOW PRESSURE DOSING
9	TERTIARY + DISINFECTION + LOW PRESSURE DOSING
10	PRIMARY + MOUND
11	SECONDARY + MOUND
12	TERTIARY + MOUND

SOIL DEPTH AND TEXTURE LIMITATIONS MAY BE OVERCOME BY USE OF A MOUND DISPOSAL SYSTEM

EXAMPLE 4 – FIGURE 3-1

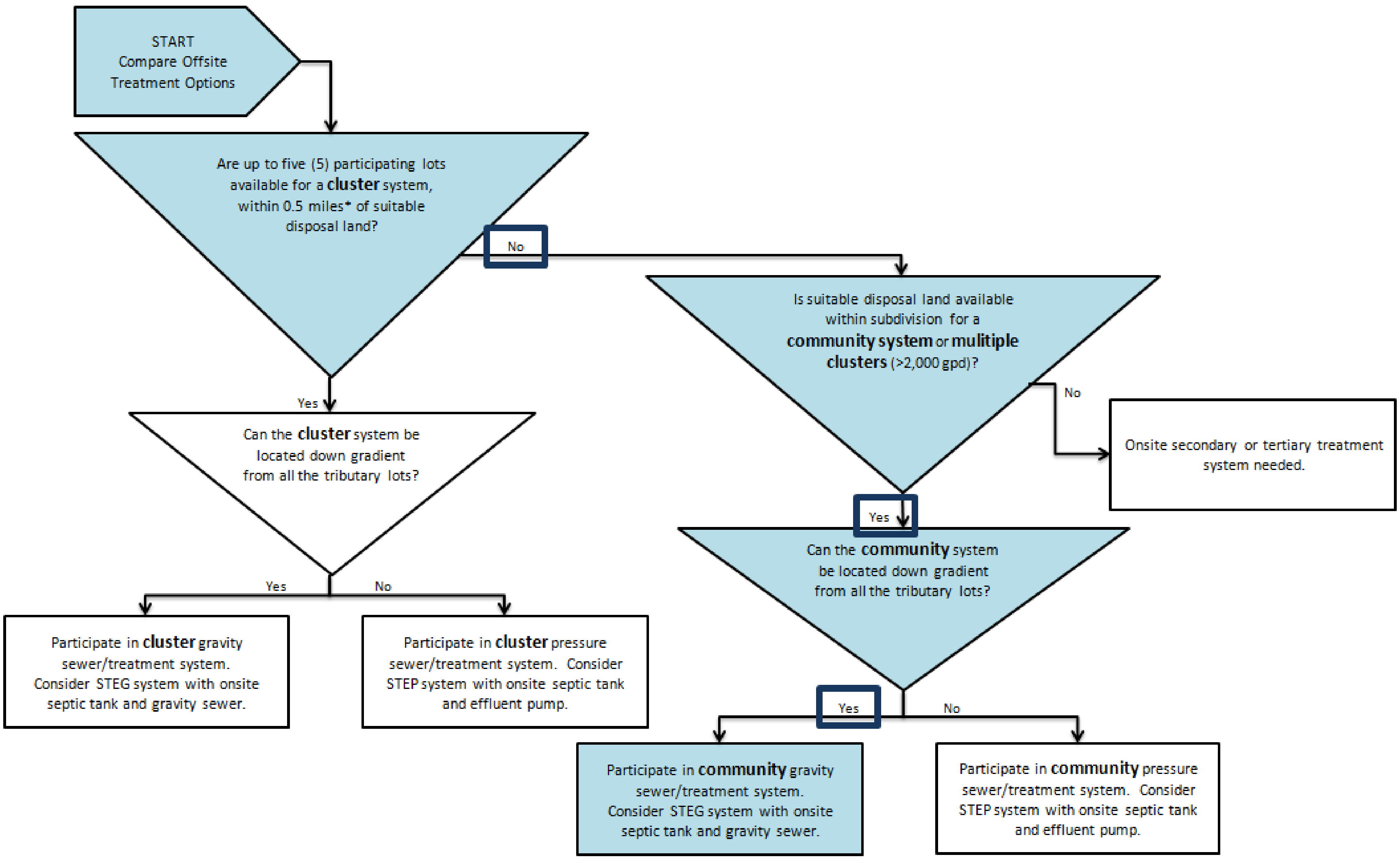
The acceptable onsite treatment options for these particular site conditions include tertiary treatment with low-pressure dosing in a normal disposal field (Onsite Treatment 8 in the Cost Matrix), or tertiary treatment using a mound disposal system (Onsite Treatment 12 in the Cost Matrix).

Offsite treatment options may also be available, considering there are nearby lots that may be interested in sharing a wastewater treatment system. Proceed to Example 4 – Figure 4-1.

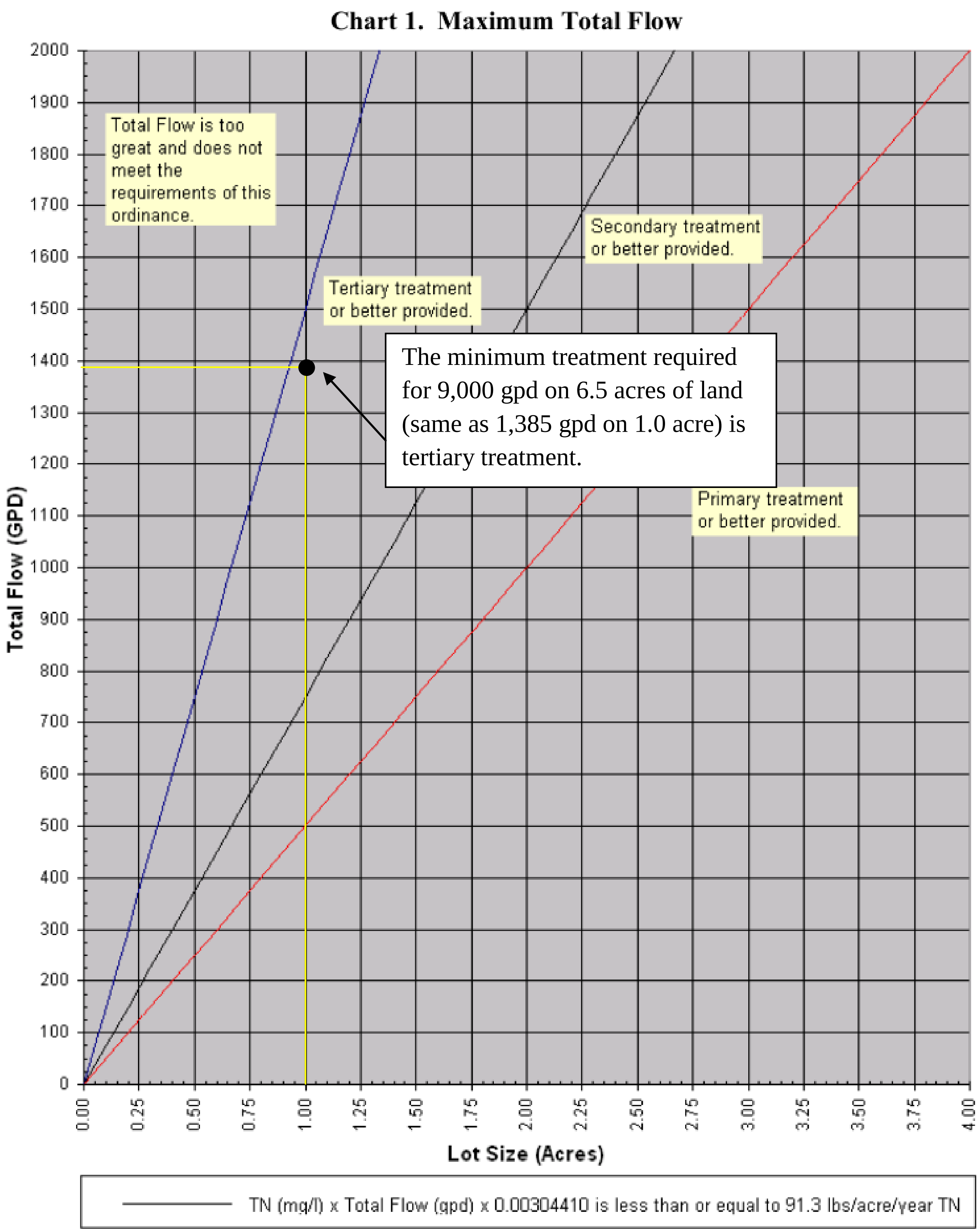
<u>Example 4 – Figure 4-1</u>

- ***Are up to five participating lots available for a cluster system, within approximately 0.5 miles of suitable disposal land?*** No. Although five lots are available, disposal land is located further than one-half mile away.
- ***Is suitable disposal land available for a community system or multiple cluster systems?*** Yes. Six and one-half acres of land are available for disposal.
- ***Can the community system be located down gradient from all the tributary lots?*** Yes, the available land is located downhill from the lots.

The lots have the option to participate in a community gravity effluent sewer system. As explained in the guidance document, soil conditions at the disposal site are assumed to be suitable for disposal without disinfection or low-pressure dosing. The level of effluent treatment required (secondary or tertiary) depends on total flow and available land for disposal. Assuming 24 lots with three-bedroom houses will choose to participate in a community treatment system, the design flow for would be 9,000 gpd. Given that six and one-half acres of land are available for disposal, 1,385 gpd would be disposed of on each acre. Example 4 – Chart 1 suggests that tertiary treatment is required for offsite disposal.



EXAMPLE 4 – FIGURE 4-1



EXAMPLE 4 – CHART 1 FOR OFFSITE TREATMENT

Example 4 – Cost Matrix

For this example, four options are applicable: disposal to public sewer by gravity, onsite tertiary treatment with low-pressure dosing in a normal disposal field, onsite tertiary treatment and disposal in a mound disposal system, and offsite community system with gravity conveyance, tertiary treatment, and disposal. From the Cost Matrix, these options can be compared in terms of Cost, as shown in Example 4 – Table 5-1.

EXAMPLE 4 – TABLE 5-1 – EXCERPTS FROM COST MATRIX

Itemized Cost Tables	Disposal Location	Treatment Type	User's Share of Capital Cost	User's Share of O&M Cost	Annual Debt Service Cost	Public Sewer Monthly Service Fee	Life Cycle Present Worth
#1	Public Sewer	Gravity to Public Sewer, based on one mile of pipe and 40 Users	$ 6,900	--	$ 460	$ 13	$ 9,200
#10	Onsite	8 - Tertiary + Low Pressure Dosing	$ 15,700	$ 500	$ 1,060	--	$ 23,100
#14	Onsite	12 - Tertiary Treatment with Mound and Pump	$ 13,000	$ 500	$ 870	--	$ 20,400
#29	Offsite	8 lots (3,000 gpd), gravity, tertiary	$ 35,300	$ 290	$ 2,370	--	$ 39,600
#35	Offsite	40 lots (15,000 gpd), gravity tertiary	$ 22,100	$ 140	$ 1,490	--	$ 24,200

Life Cycle Present Worth Public Sewer (assuming 24 Users and 2.5 miles of pipe to main spine)

The cost shown for public sewer in the Cost Matrix is for 40 Users and one mile of pipe; it is unlikely that the individual homeowner could afford two and one-half miles of pipe to the public sewer without sharing the cost with other Users. The Life Cycle Present Worth of the Public Sewer cannot simply be interpolated, because monthly service fees are not dependent on the number of Users, but represent flat fees associated with a sewer bill. The User's share of capital and annual debt service cost must be adjusted to determine the Life Cycle Present Worth, as shown in the following calculations. Refer to Table 5-1 in the Assessment Guidelines for Present Worth Factors.

1. **Determine User's Share of Capital Cost**

$$\frac{\$6,900}{mi \cdot User}\left(\frac{40Users}{24Users}\right)(2.5miles) = \$28,750 \rightarrow \$28,800$$

2. **Determine Annual Debt Service Cost**

Rarely can a capital expenditure of this magnitude be afforded without a loan. The annual debt service represents interest paid on the loan to fund the capital improvements. An assumed interest rate of three percent for a term of 20 years has a capital recovery factor of 0.06722 (see Section 5.6 in the Sewer Assessment Guidelines). Multiply the Capital Cost by the Capital Recovery Factor to determine the Annual Debt Cost.

$$(CapitalCost)\cdot(Capital\ \mathrm{Re}\,\mathrm{cov}\,eryFactor) = AnnualDebtCost$$

$$(\$28,800)\cdot(0.06722) = \$1,936 \rightarrow \$1,940$$

Annual Debt Service Cost is not used to determine the Life Cycle Present Worth.

3. **Determine Public Sewer Monthly Service Fee**

The monthly sewer bill received by each User will likely not vary widely with the number of Users; a flat rate is usually paid for sewer services. The monthly fee of approximately $13 is not adjusted for 24 Users.

4. **Determine Life Cycle Present Worth**

The Life Cycle Present Worth is determined according to the equation shown below.

Life Cycle Present Worth = Capital + Monthly Cost · Present Worth Factor

Assuming an interest rate of three percent and a life of 20 years, the Present Worth Factor is 14.87747 (see Table 5-1 in the Assessment Guidelines). Monthly costs were multiplied by twelve to assume an annual cost for use in determining Present Worth.

$$LifeCycle\ \mathrm{Pr}\,esentWorth = \$28,800 + \frac{\$13}{mo}\cdot 12mo \cdot 14.87747 = \$31,121 \rightarrow \$31,100$$

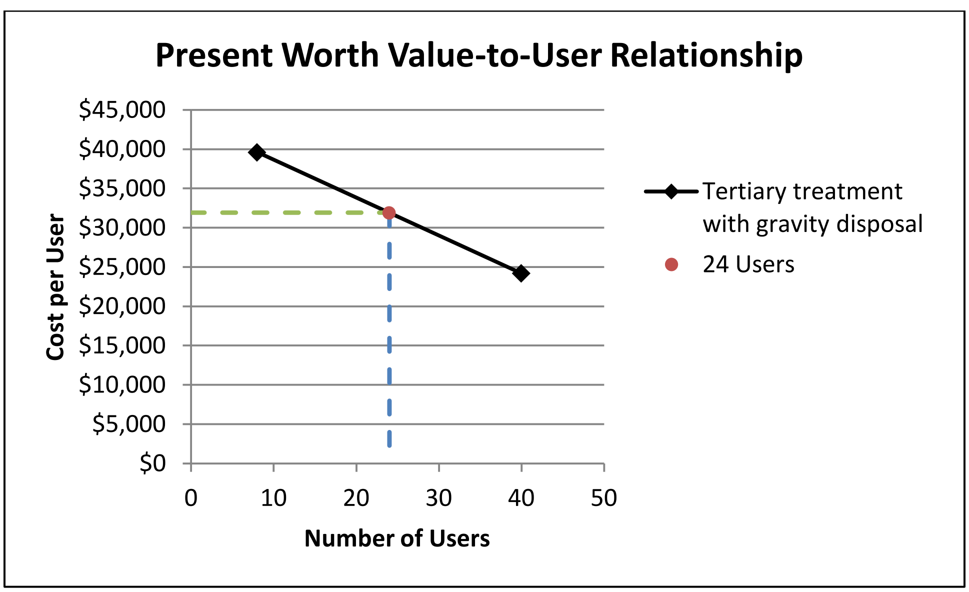
The adjusted Life Cycle Present Worth for 24 Users discharging by gravity to a Public Sewer 2.5 miles away is roughly $31,100.

Life Cycle Present Worth Offsite Community Treatment System (assuming 24 Users)

The Cost Matrix presents the Life Cycle Present Worth for 8 and 40 Users participating in a community treatment system. Because Users share capital and O&M costs and there is no flat fee associated with the offsite treatment system, the Life Cycle Present Worth can either be recalculated or interpolated. Interpolation is a simpler way to determine the cost of a system for 24 Users knowing the costs for 8 and 40 Users, assuming a linear cost-to-user relationship exists. The Life Cycle Present Worth for 24 Users is determined graphically and using interpolation in the following calculations.

Graphically Determine Life Cycle Present Worth of 24 Users

- Draw a line (connect the dots) between the known data points ($39,600 for 8 Users and $24,200 for 40 Users).
- On the axis labeled "Number of Users", locate approximately 24 Users. Draw a vertical line from the axis up to the line between the known data points (illustrated by a blue dashed line).
- From the point where the vertical line intercepts the black line created in the first step (marked by a red dot), draw a horizontal line (represented by the green dashed line) across to the vertical axis labeled "Cost per User". It appears that the cost associated with 24 Users is about $31,900.



Determine Life Cycle Present Worth of 24 Users Using Interpolation

The same process can be followed mathematically. The first step is to determine the slope between the known data points ($39,600 for 8 Users and $24,200 for 40 Users).

$$Slope = \frac{rise}{run} = \left(\frac{y_1 - y_2}{x_1 - x_2}\right) = \left(\frac{Difference\,in Costs}{Difference\,in Users}\right) = \left(\frac{\$39{,}600 - \$24{,}200}{8 - 40}\right) = -\frac{\$15{,}400}{32}$$

In this equation, y_1 and y_2 represent the respective life cycle present worth values based on the number of Users, x_1 and x_2.

The slope is used to determine the Life Cycle Present Worth, using the same equation as above, but letting y_2 be the unknown present worth value for 24 Users. Then the cost shared by 24 Users is calculated as shown below.

$$-\frac{\$15{,}400}{32} = \left(\frac{\$39{,}600 - y_2}{8 - 24}\right)$$

$$\$39{,}600 - y_2 = -\frac{\$15{,}400}{32} \cdot (-16)$$

$$y_2 = \$39{,}600 - \$7{,}700 = \$31{,}900$$

The adjusted Life Cycle Present Worth Values for the different treatments are summarized for comparison in Example 4 – Table 5-2. The onsite treatment options appear to have lower capital and life-cycle costs than the public sewer and offsite treatment options. Tertiary treatment plus use of a mound disposal field appears to be the option with the lowest Life Cycle Present Worth.

<u>EXAMPLE 4 – TABLE 5-2 – ADJUSTED LIFE CYCLE PRESENT WORTH</u>

Itemized Cost Tables	Disposal Location	Treatment Type	Life Cycle Present Worth
ADJ	Public Sewer	Gravity to Public Sewer, based on 2.5 miles of pipe and 24 Users	$31,100
#10	Onsite	8 - Tertiary + Low Pressure Dosing	$23,100
#14	Onsite	12 - Tertiary Treatment with Mound and Pump	$20,400
ADJ	Offsite	24 lots (9,000 gpd), gravity, tertiary	$31,900

EXAMPLE 5 – LARGE DEVELOPMENT

A homeowners association in an 80 percent developed subdivision with fifty 0.25-acre and fifty 0.75-acre lots is assessing how to ensure they have safe wastewater systems in their community. The developed lots have standard septic systems, some of which are not performing well. Generally, homeowners encounter thick layers of clay soil and report rock is three feet deep. Two-bedroom houses are located on 0.25-acre lots; four-bedroom houses are located on 0.75-acre lots.

EXAMPLE 5 – LARGE DEVELOPMENT

GIVEN: A homeowners association in an 80 percent developed subdivision with fifty 0.25-acre and fifty 0.75-acre lots is assessing how to ensure they have safe wastewater systems in their community. The developed lots have standard septic systems, some of which are not performing well. Generally, homeowners encounter thick layers of clay soil and report rock is three feet deep. Two-bedroom houses are located on 0.25-acre lots; four-bedroom houses are located on 0.75-acre lots.

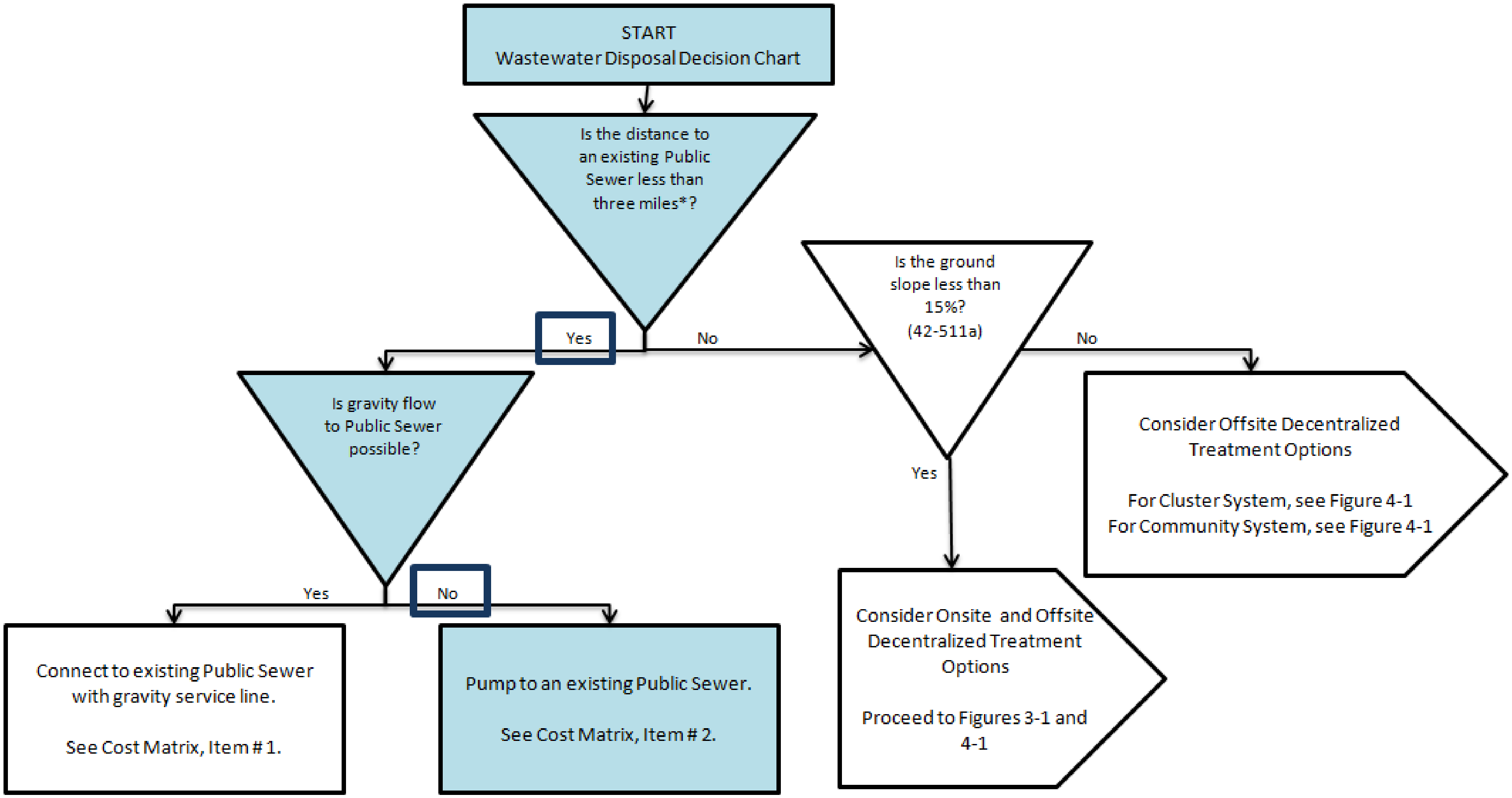
OTHER ASSUMPTIONS: Public sewer is located 2.7 miles away at the same elevation as the subdivision, which has ground slopes near zero. Land is not available for offsite disposal.

DETERMINE: What wastewater treatment systems are acceptable options for this association?

SOLUTION: Use Sewer Assessment Guidelines to determine suitable options for treatment. Use Cost Matrix to compare options. Begin the exercise with Example 5 – Figure 2-1.

Example 5 – Figure 2-1

- ***Is the distance to an existing Public Sewer less than three miles?*** Yes. The subdivision was assumed to be located less than three miles from a Public Sewer.
- ***Is gravity flow to the Public Sewer possible?*** No. Elevation difference is not sufficient to provide the gradient required for gravity flow.

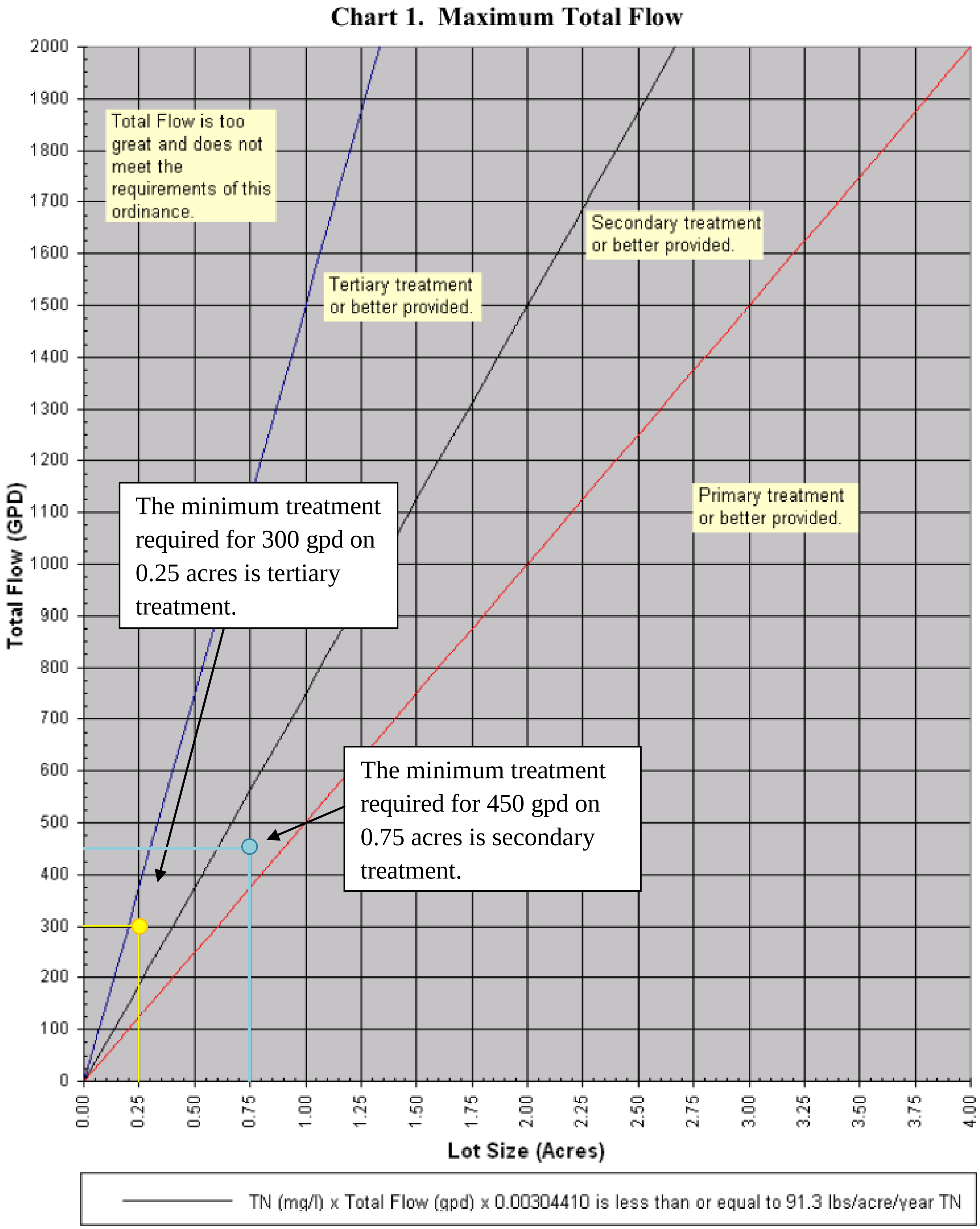


EXAMPLE 5 – FIGURE 2-1

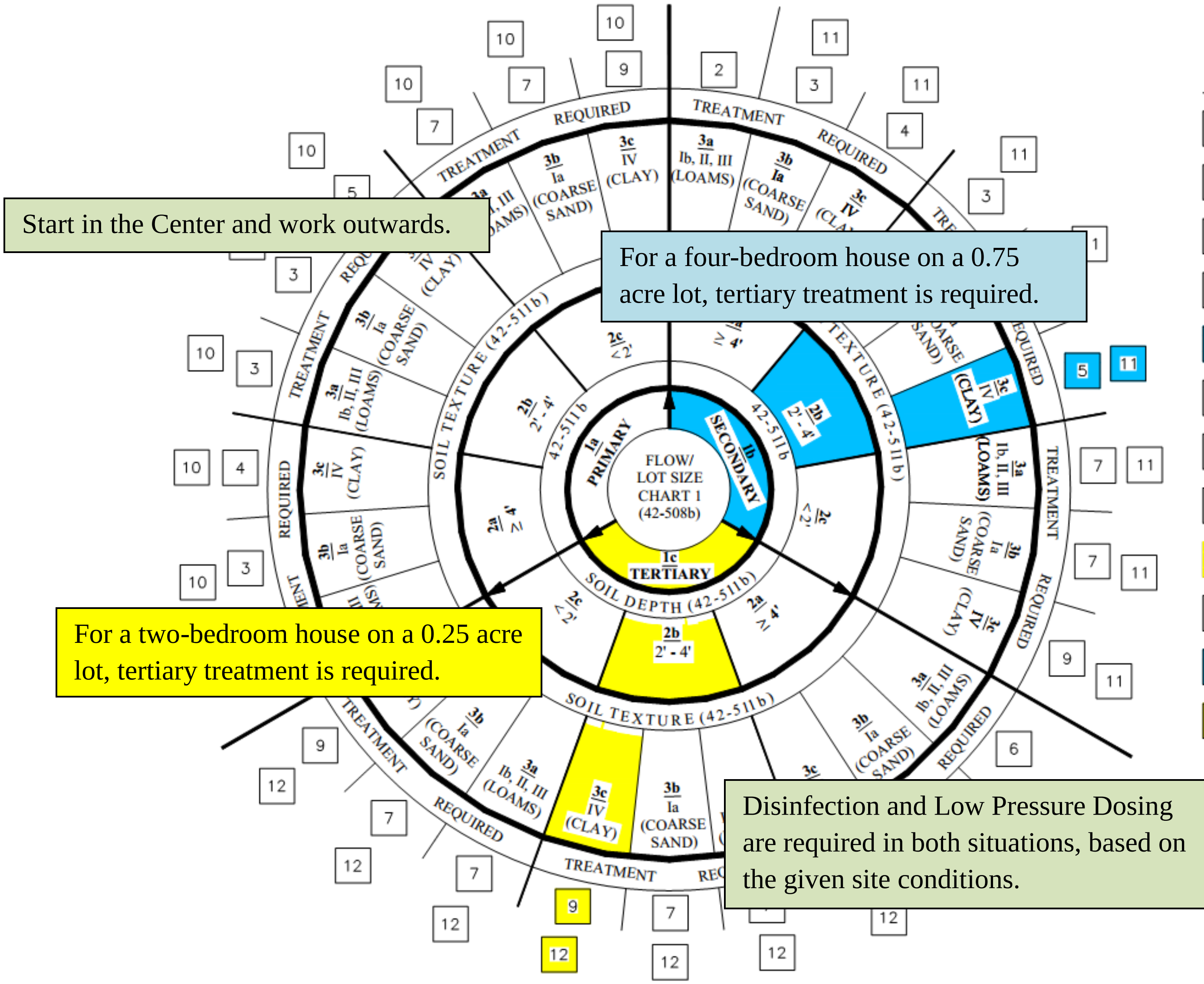
The subdivision is located close enough to a Public Sewer to warrant further investigation into this method of disposal. The Cost Matrix can be used to estimate the cost of pumping to a Public Sewer. Comparison with onsite and offsite treatment will be evaluated to determine the level of treatment necessary to rehabilitate the existing systems. Proceed to Example 5 – Figure 3-1.

<u>Example 5 – Figure 3-1</u>

- ***What level of treatment is required based on Example 5 – Chart 1?***
  Design flow for a two-bedroom house (on the 0.25-acre lots) is 300 gpd; for a four-bedroom house (on the 0.75-acre lots), the design flow is 450 gpd. According to Example 5 – Chart 1, tertiary treatment is required on the 0.25-acre lots, and secondary treatment is required on the 0.75-acre lots.
- ***What is the depth of suitable soil beneath the absorption area?***
  The depth to rock is three feet. This depth corresponds to **2b**.
- ***What type of soil exists at the site?***
  Clay soils are common in the area, corresponding to **3c**.



EXAMPLE 5 – CHART 1 FOR ONSITE TREATMENT



TREATMENT LEGEND

- 1 PRIMARY
- 2 SECONDARY
- 3 SECONDARY + DISINFECTION
- 4 SECONDARY + LOW PRESSURE DOSING
- 5 SECONDARY + DISINFECTION + LOW PRESSURE DOSING
- 6 TERTIARY
- 7 TERTIARY + DISINFECTION
- 8 TERTIARY + LOW PRESSURE DOSING
- 9 TERTIARY + DISINFECTION + LOW PRESSURE DOSING
- 10 PRIMARY + MOUND
- 11 SECONDARY + MOUND
- 12 TERTIARY + MOUND

SOIL DEPTH AND TEXTURE LIMITATIONS MAY BE OVERCOME BY USE OF A MOUND DISPOSAL SYSTEM

EXAMPLE 5 – FIGURE 3-1

The 0.75-acre lots require secondary treatment with disinfection and low pressure dosing prior to disposal in a normal disposal field (Onsite Treatment 5 in the Cost Matrix) or secondary treatment using a mound disposal system (Onsite Treatment 11 in the Cost Matrix). The smaller 0.25-acre lots require tertiary treatment plus disinfection and low pressure dosing prior to disposal in a normal disposal field (Onsite Treatment 9 in the Cost Matrix) or tertiary treatment using a mound disposal system (Onsite Treatment 12 in the Cost Matrix).

Example 5 – Figure 4-1

The problem statement indicated offsite treatment options are not available. Use of Figure 4-1 is not necessary.

Example 5 – Cost Matrix

For this example, three options would be applicable: The subdivision can dispose of wastewater to a Public Sewer, or onsite treatment can occur. The smaller lots would require tertiary treatment and either a mound disposal system or disinfection and low pressure dosing. The larger lots would likewise require either a mound disposal system or disinfection and low pressure dosing; however, only secondary treatment is needed for the larger lots. From the Cost Matrix, these options can be compared in terms of cost, as shown in Example 5 – Table 5-1.

The Public Sewer option appears to have lower capital and life-cycle costs than the cluster treatment option. However, the User's share of cost for the homeowners association will be based on 80-100 Users and 2.7 miles of pipe. The Life Cycle Present Worth of the Public Sewer should be adjusted for fair comparison between the alternatives. For this exercise, 100 Users will be assumed to share the cost of constructing a line to the main sewer trunk.

EXAMPLE 5 – TABLE 5-1 – EXCERPTS FROM COST MATRIX

Itemized Cost Tables	Disposal Location	Treatment Type	User's Share of Capital Cost	User's Share of O&M Cost	Annual Debt Service Cost	Public Sewer Monthly Service Fee	Life Cycle Present Worth
#2	Public Sewer	Pump to Public Sewer, based on one mile of pipe and 40 Users	$9,000	--	$600	$13	$11,300
#7	Onsite	5 - Secondary + Disinfection + Low Pressure Dosing	$14,500	$500	$970	--	$21,900
#11	Onsite	9 - Tertiary + Disinfection + Low Pressure Dosing	$17,200	$500	$1,160	--	$24,600
#13	Onsite	11 - Secondary Treatment with Mound & Pump	$11,700	$500	$790	--	$19,100
#14	Onsite	12 - Tertiary Treatment with Mound & Pump	$13,000	$500	$870	--	$20,400

Life Cycle Present Worth Public Sewer (assuming 100 Users and 2.7 miles of pipe to main spine)

It is unlikely that the homeowners association could afford 2.7 miles of pipe to the Public Sewer without passing the cost along to residents in the subdivision. The Life Cycle Present Worth of the Public Sewer cannot simply be interpolated, because monthly service fees are not dependent on the number of Users, but represent flat fees associated with a sewer bill. The User's share of capital and annual debt service cost must be adjusted to determine the Life Cycle Present Worth, as shown in the following calculations. Refer to Table 5-1 in the Assessment Guidelines for Present Worth Factors.

1. Determine User's Share of Capital Cost

$$\frac{\$9{,}000}{mi \cdot User}\left(\frac{40Users}{100Users}\right)(2.7miles) = \$9{,}700$$

2. **Determine Annual Debt Service Cost**

Rarely can a capital expenditure of this magnitude be afforded without a loan. The annual debt service represents interest paid on the loan to fund the capital improvements. An assumed interest rate of three percent for a term of 20 years has a capital recovery factor of 0.06722 (see Section 5.6 in the Sewer Assessment Guidelines). Multiply the Capital Cost by the Capital Recovery Factor to determine the Annual Debt Cost.

$$(CapitalCost)\cdot(Capital\ \mathrm{Re}\,\mathrm{cov}\,eryFactor) = AnnualDebtCost$$

$$(\$9{,}700)\cdot(0.06722) = \$652 \rightarrow \$650$$

Annual Debt Service Cost is not used to determine the Life Cycle Present Worth.

3. **Determine Public Sewer Monthly Service Fee**

The monthly sewer bill received by each User will likely not vary widely with the number of Users; a flat rate is usually paid for sewer services. The monthly fee of approximately $13 is not adjusted for 24 Users.

4. **Determine Life Cycle Present Worth**

The Life Cycle Present Worth is determined according to the equation shown below:

Life Cycle Present Worth = Capital + Monthly Cost · Present Worth Factor

Assuming an interest rate of three percent and a life of 20 years, the Present Worth Factor is 14.87747 (see Table 5-1 in the Assessment Guidelines). Monthly costs were multiplied by twelve to assume an annual cost for use in determining Present Worth.

$$LifeCycle\ \mathrm{Pr}\,esentWorth = \$9{,}700 + \frac{\$13}{mo}\cdot 12mo\cdot 14.87747 = \$12{,}021 \rightarrow \$12{,}000$$

The adjusted Life Cycle Present Worth for 100 Users discharging by pressure to a Public Sewer 2.7 miles away is roughly $12,000.

The adjusted Life Cycle Present Worth Value for pumping to a Public Sewer is summarized in Example 5 – Table 5-2 with the other Life Cycle Present Worth Values for comparison. Disposal to a Public Sewer appears to have a Life Cycle Present Worth significantly less than the onsite treatment options.

<u>EXAMPLE 5 – TABLE 5-2 – ADJUSTED LIFE CYCLE PRESENT WORTH</u>

Itemized Cost Tables	Disposal Location	Treatment Type	Life Cycle Present Worth
ADJ	Public Sewer	Pump to Public Sewer, based on 2.7 miles of pipe and 100 Users	$12,000
#7	Onsite	5 - Secondary + Disinfection + Low Pressure Dosing	$21,900
#11	Onsite	9 - Tertiary + Disinfection + Low Pressure Dosing	$24,600
#13	Onsite	11 - Secondary Treatment with Mound & Pump	$19,100
#14	Onsite	12 - Tertiary Treatment with Mound & Pump	$20,400