APPENDIX A – SOLUTION CHARTS

APPENDIX A – SOLUTION CHARTS

A.1 Preface

The solution charts presented in this Section are intended to assist the owner and/or renter of an individual household in the identification of potential solutions to water or wastewater problems experienced by the household. For the charts to be useful, the party associated with the individual household must first establish the problem that needs to be addressed. Additionally, the information provided in this Appendix is specifically designed to address conditions experienced by individual households (private systems) or groups of houses, which together, would consist of no more than 15 connections.

A.2 General

A series of charts have been prepared to assist a party associated with an individual household in identifying potential solutions to established water or wastewater problems. Each set of charts presents a series of responses to yes/no questions directing the individual to a solution or a set of solutions for consideration. Table A-1 summarizes the series of solution charts.

Each series of solution charts has been color coded to assist the individual in using the solution charts. The color identifies the type of solution chart and is shown on the right hand side of the solution charts.

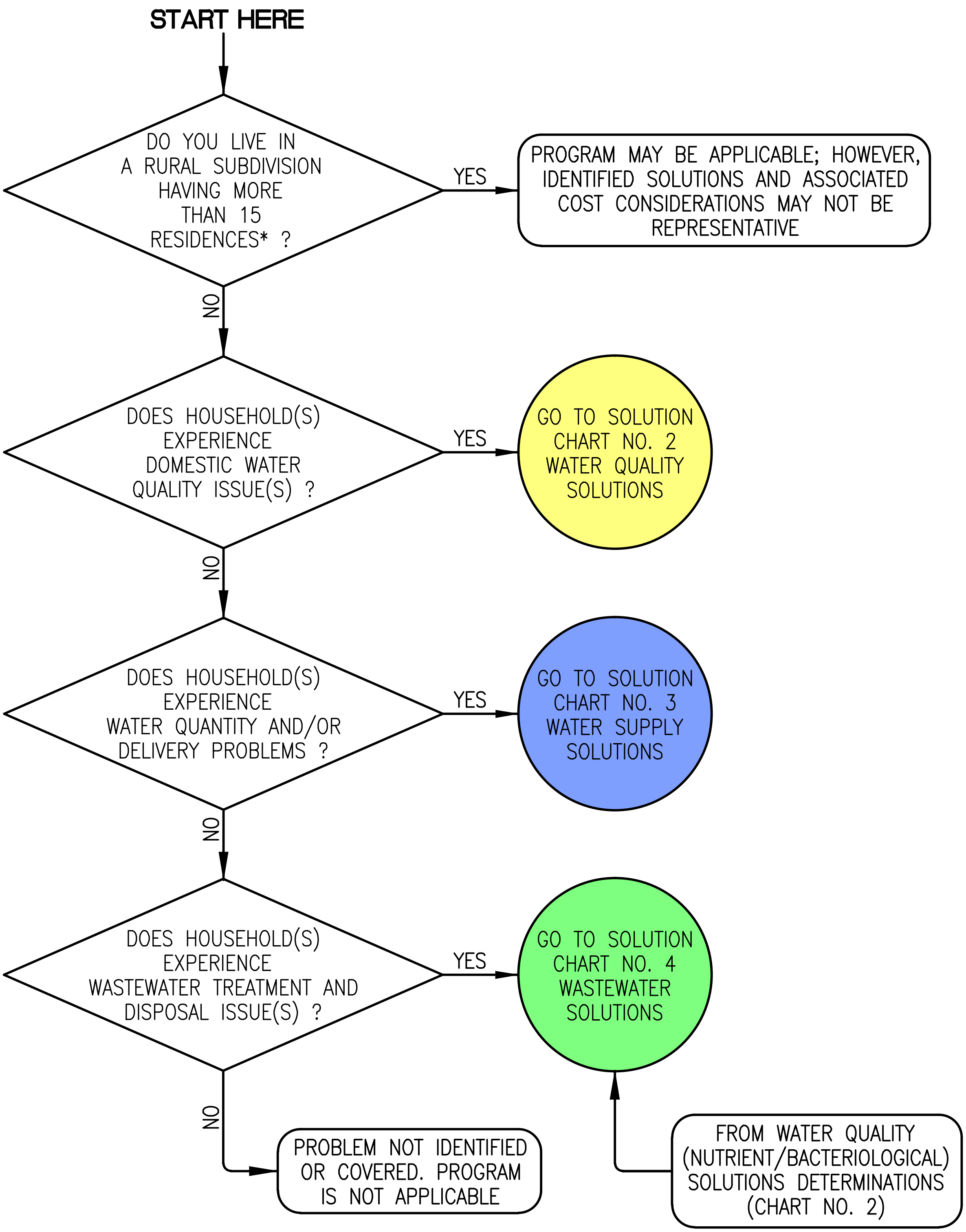
APPENDIX A – SOLUTION CHARTS

The individual starts with Solution Chart No. 1, Initial Classification. The individuals proceed to subsequent solution charts depending on the response to the questions presented by Solution Chart No. 1.

APPENDIX A – SOLUTION CHARTS

TABLE A-1
SUMMARY OF SOLUTION CHARTS
INDIVIDUAL HOUSEHOLD PILOT STUDY

SOLUTION CHART (SERIES)	DESCRIPTION	PURPOSE	COLOR
1	Initial Classification	Use to direct party associated with individual household to solution chart based upon identified water and/or wastewater problems(s).	-
2	Water Quality Solutions	Use to direct party associated with individual household to solution charts for addressing water quality problems based upon identified conditions.	Yellow
2a	Nutrients	Use to establish solutions that address water quality problems associated with nutrients (example: nitrates (NO_3)).	Orange
2b	Bacteriological	Use to establish solutions that address bacteriological water quality problems (examples: fecal coliform and E. coli).	Red
2c	Inorganics	Use to establish solutions that address water quality problems associated with inorganic constituents (examples: arsenic and lead).	Light Green
2d	Organics	Use to establish solutions that address water quality problems associated with organic constituents (example: DBCP).	Dark Blue
2e	General Water Quality	Use to establish solutions that address general water quality problems with constituents that represent non-specific conditions (examples: conductivity, turbidity and hydrogen sulfide).	Light Blue
3	Water Quantity/Delivery Solutions	Use to establish solutions that address water quantity and/or delivery problems.	Blue
4	Wastewater Treatment and Disposal Solutions	Use to establish solutions that address wastewater treatment and/or disposal problems.	Green



*THIS PROGRAM IS SPECIFICALLY DESIGNED FOR INDIVIDUAL HOUSEHOLDS OR GROUPS OF HOUSEHOLDS CONSISTING OF 15 RESIDENCES OR LESS

SOLUTION CHART NO. 1 - INITIAL CLASSIFICATION

INDIVIDUAL HOUSEHOLD PILOT STUDY

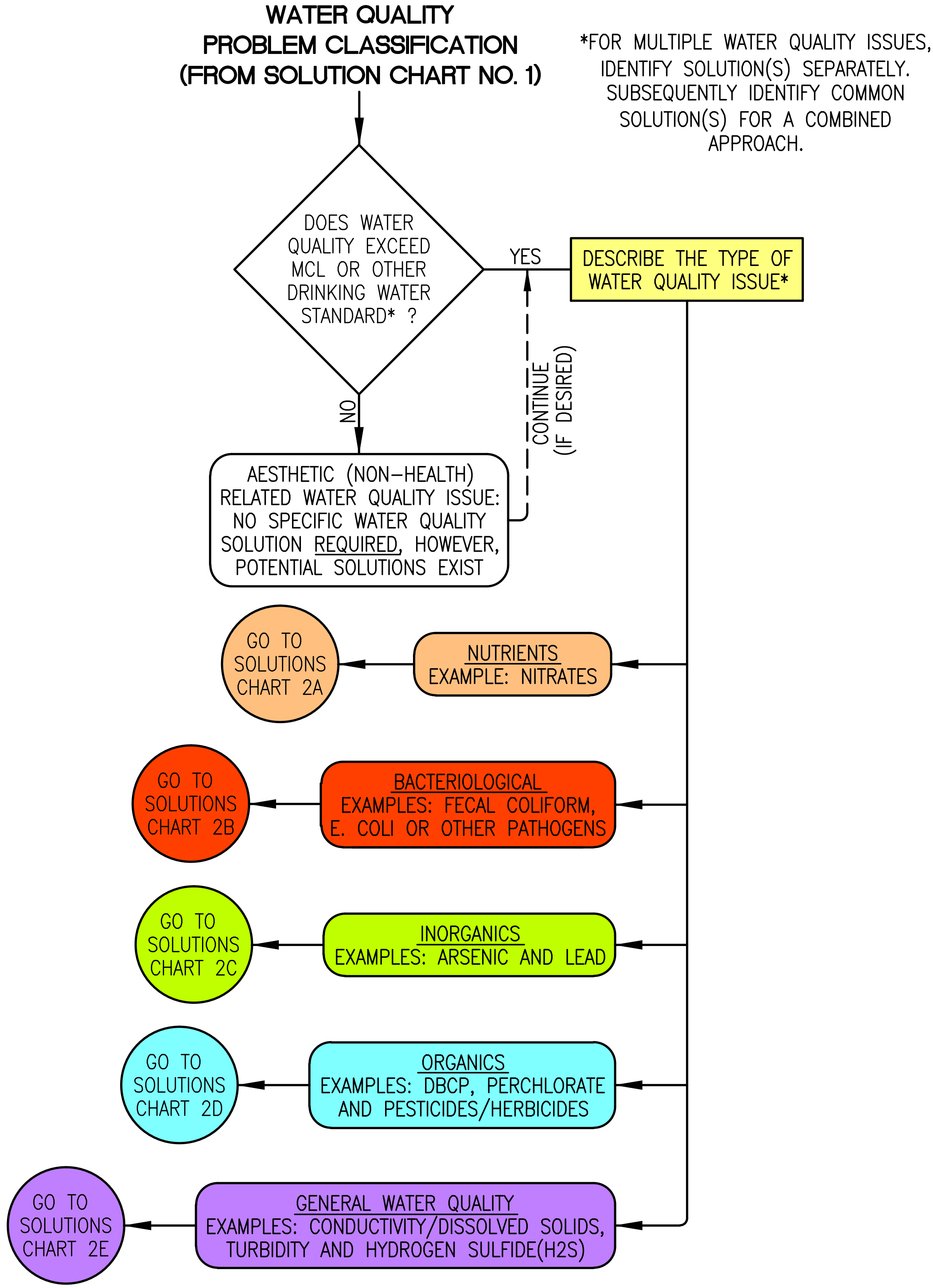
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\8.5 x 11 SOLUTION CHART NO. 1.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 2 – WATER QUALITY SOLUTIONS

This solution charts is specifically prepared to identify the appropriate water quality solution chart.



SOLUTION CHART NO. 2 - WATER QUALITY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

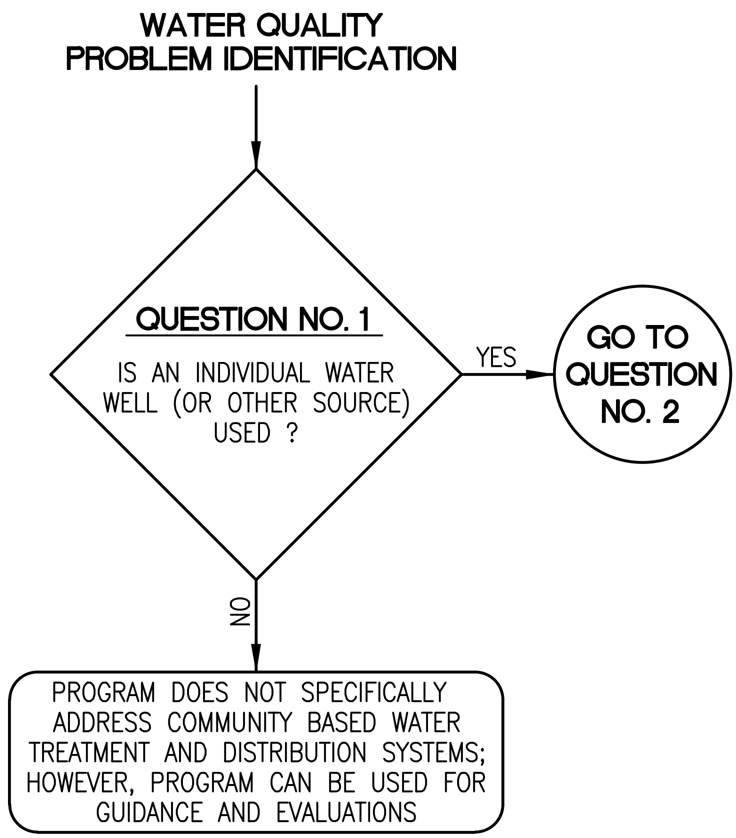
L:\TCDC\8.5 x 11 SOLUTION CHART NO. 2.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 2A – NUTRIENTS

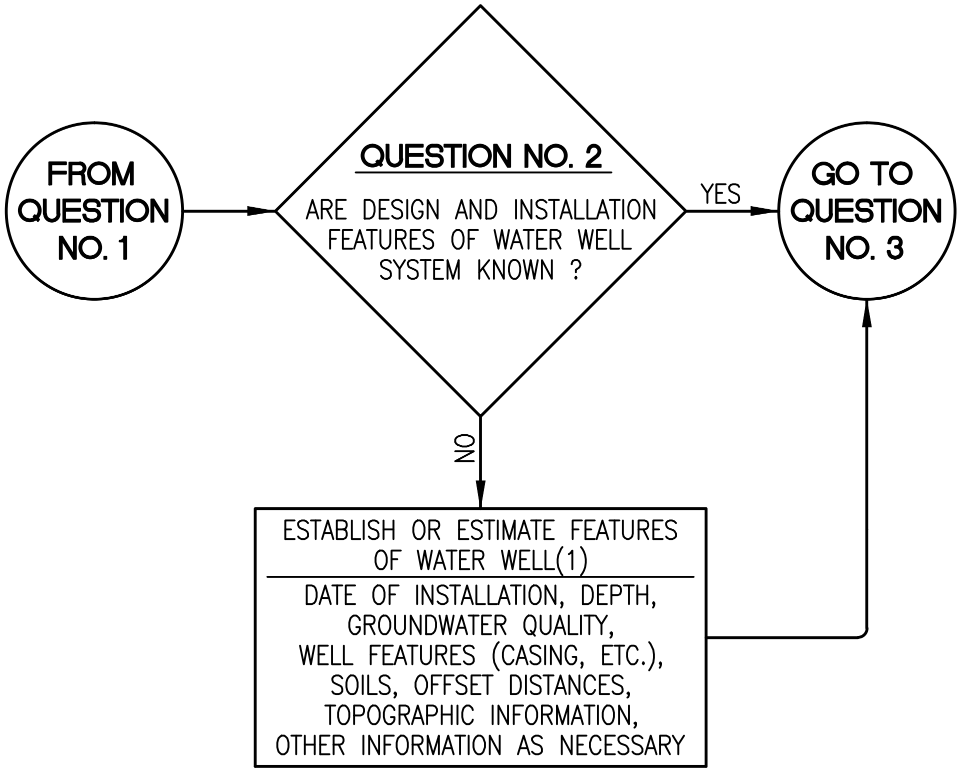
This series of solution charts is specifically prepared to address water quality problems associated with nutrients (e.g. nitrates).

The solution sets referenced in the charts can be found in Appendix B – Solution Sets.



QUESTION NO. 1

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

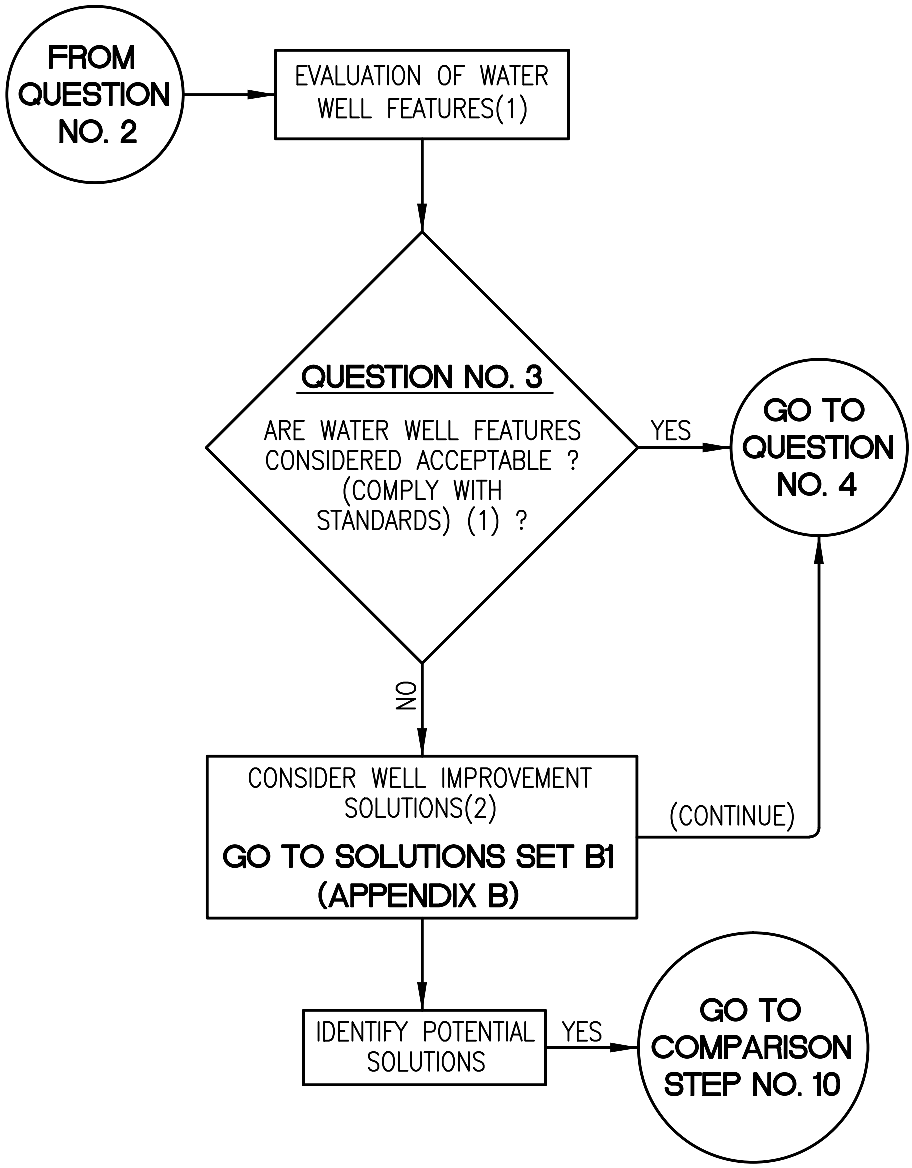


NOTE:

1. EVALUATION SHOULD BE CONDUCTED BY INDIVIDUAL WITH EXPERIENCE IN WATER WELL DESIGN AND INSTALLATION.

QUESTION NO. 2

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



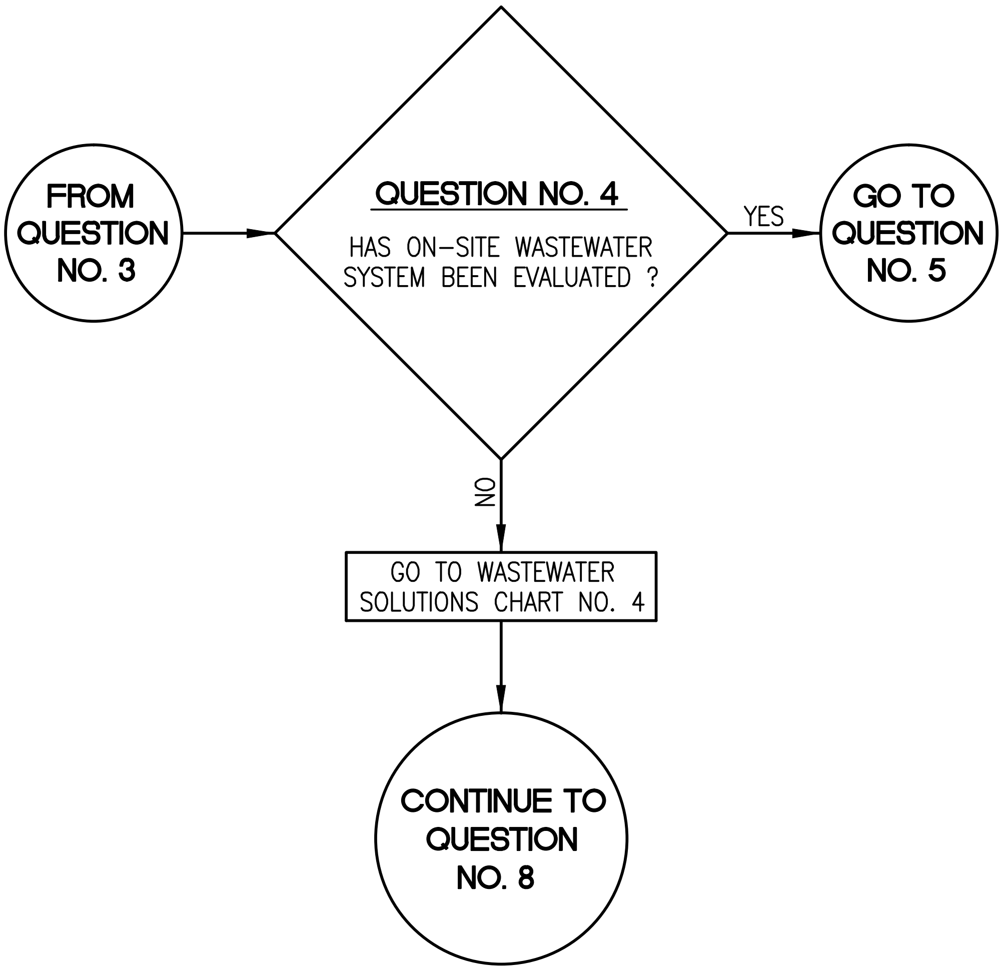
NOTES:

1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN WATER WELL DESIGN, INSTALLATION AND REGULATORY REQUIREMENTS.

2. SOLUTIONS SHOULD BE EVALUATED AND ESTABLISHED BY PERSON(S) EXPERIENCED IN DRINKING WATER TREATMENT. EXAMPLES: DRINKING WATER TREATMENT CONSULTANTS, HEALTH DEPARTMENT REPRESENTATIVES AND WATER TREATMENT EQUIPMENT MANUFACTURERS.

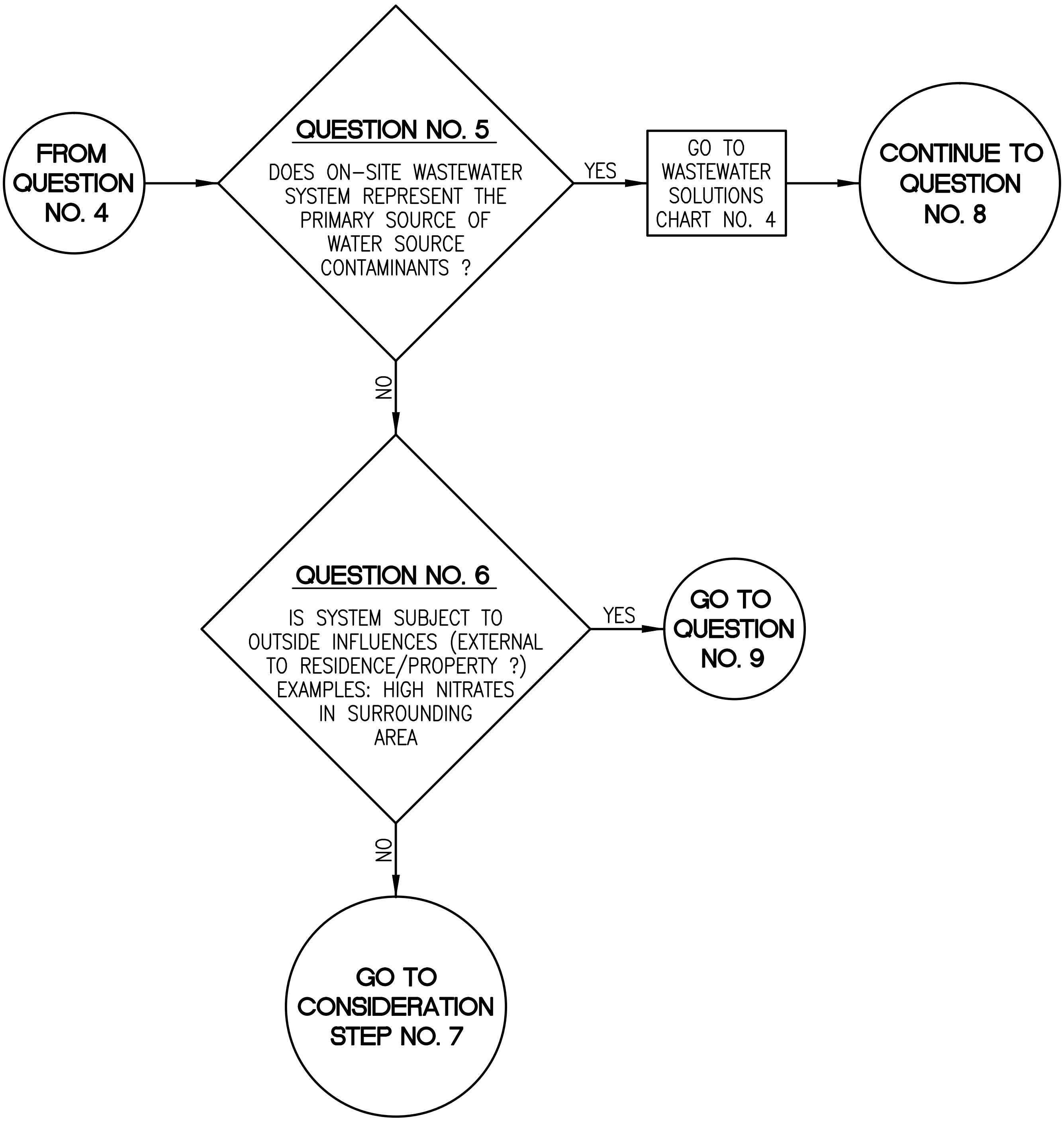
QUESTION NO. 3

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



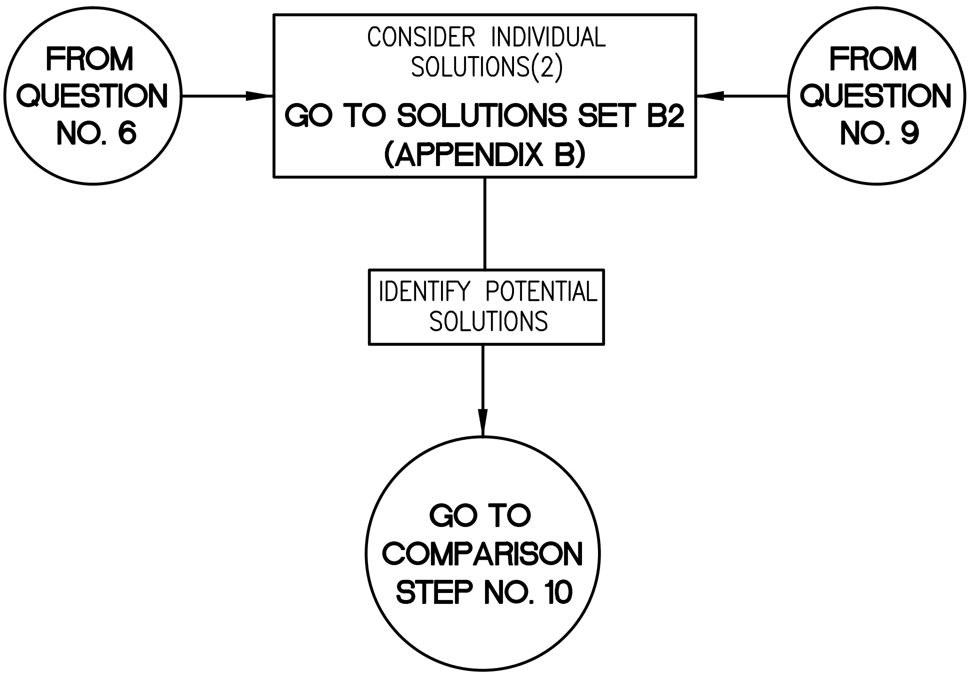
QUESTION NO. 4

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



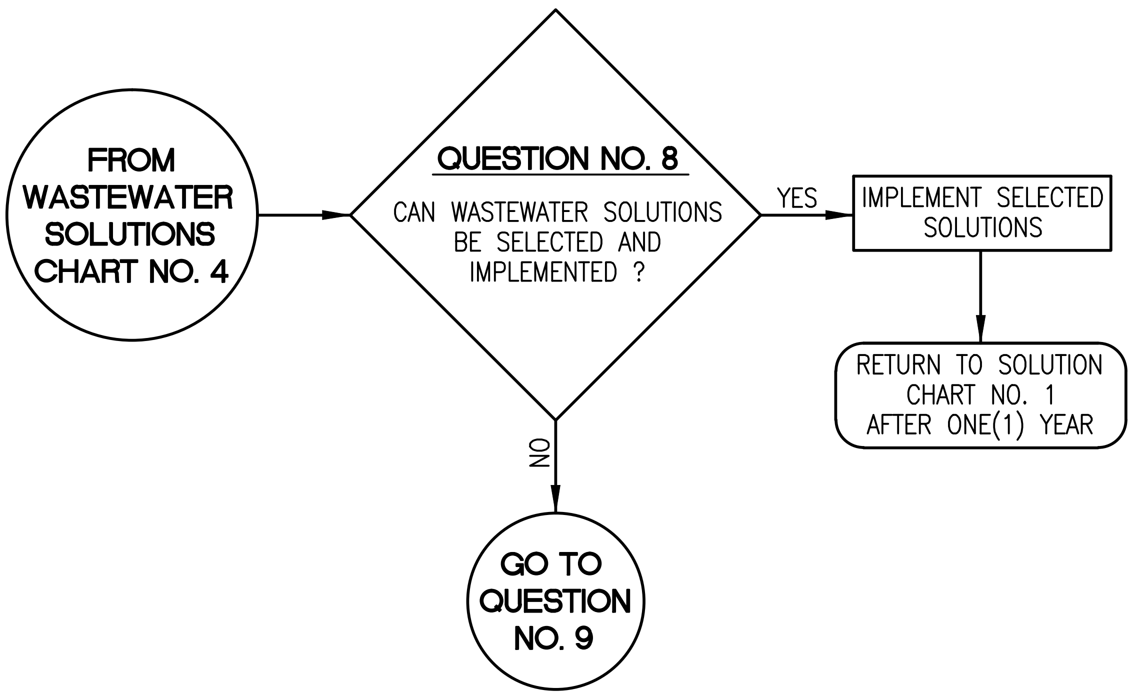
QUESTIONS NO. 5 AND NO. 6

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



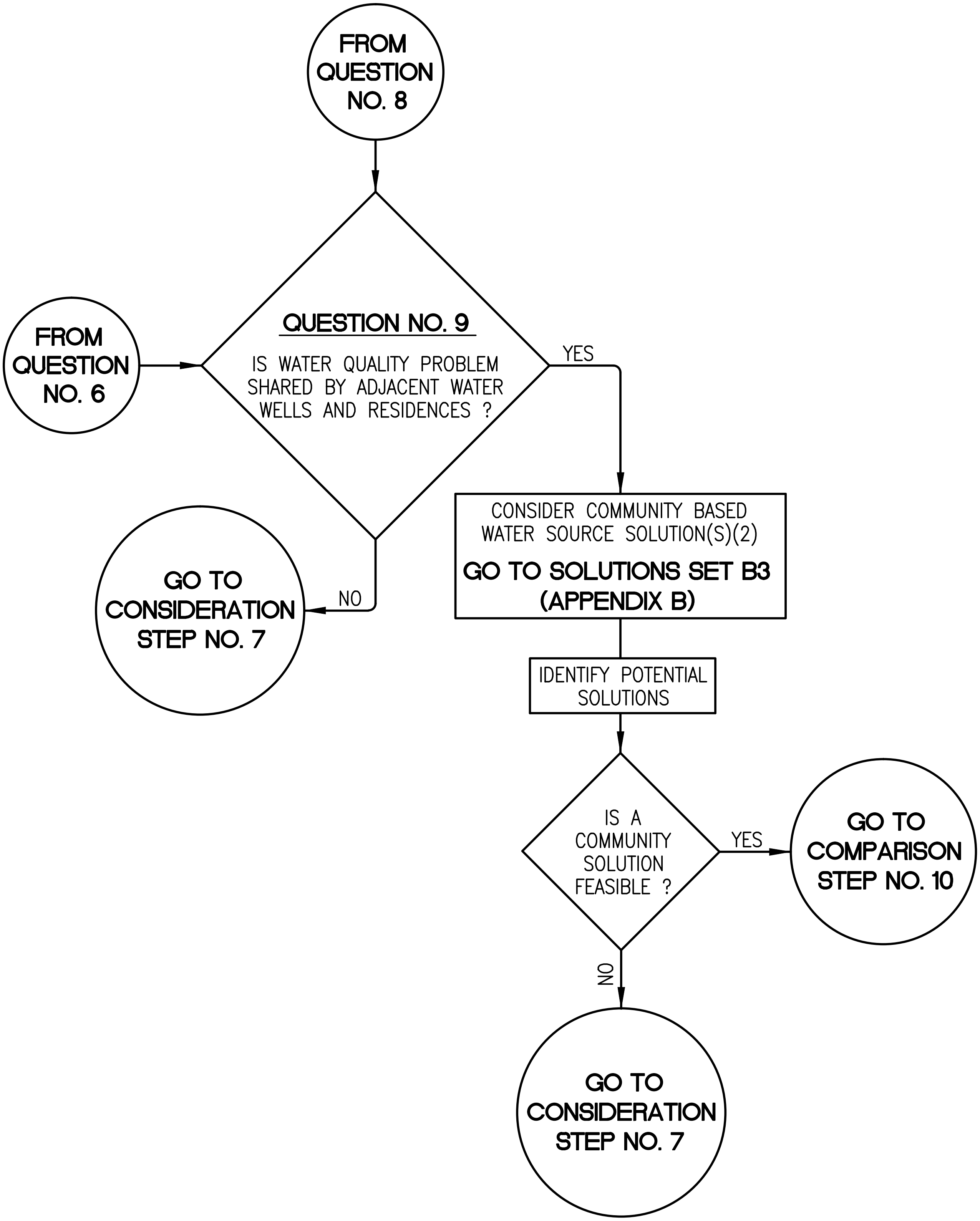
CONSIDERATION STEP NO. 7

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



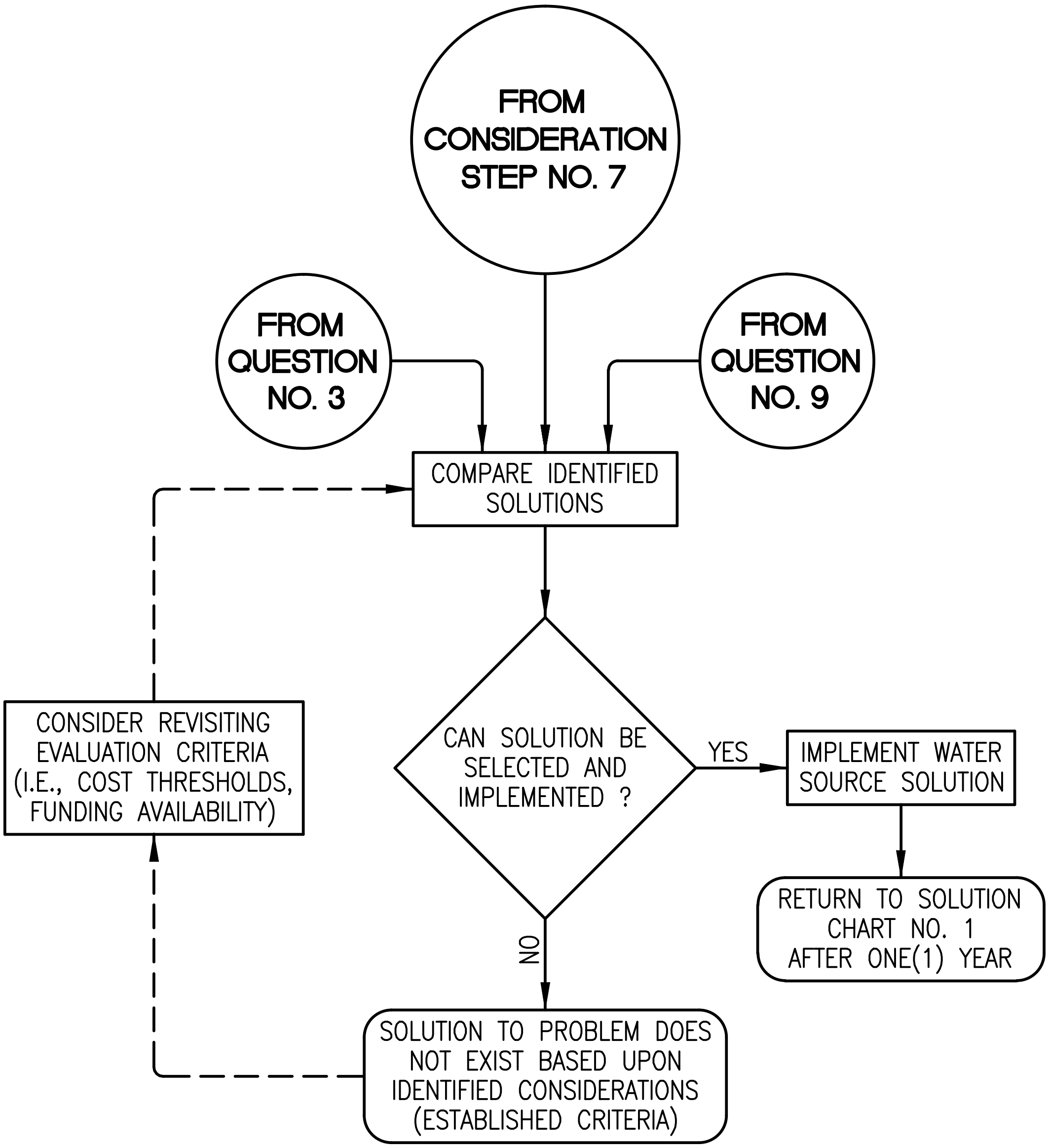
QUESTION NO. 8

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



QUESTION NO. 9

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



COMPARISON STEP NO. 10

SOLUTION SERIES NO. 2A - WATER QUALITY SOLUTIONS - NUTRIENTS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

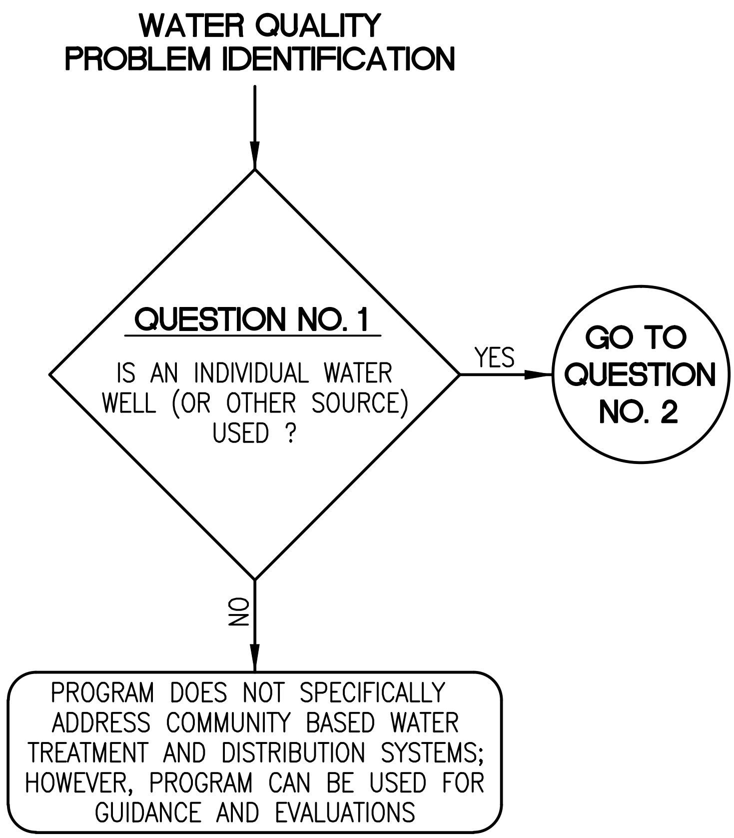
L:\TCDC\(10) NUTRIENTS-SOLUTION CHART 2A.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 2B – BACTERIOLOGICAL

This series of solution charts is specifically prepared to address water quality problems associated with bacteriological contaminants (e.g. Fecal Coliform, E. Coli or cysts).

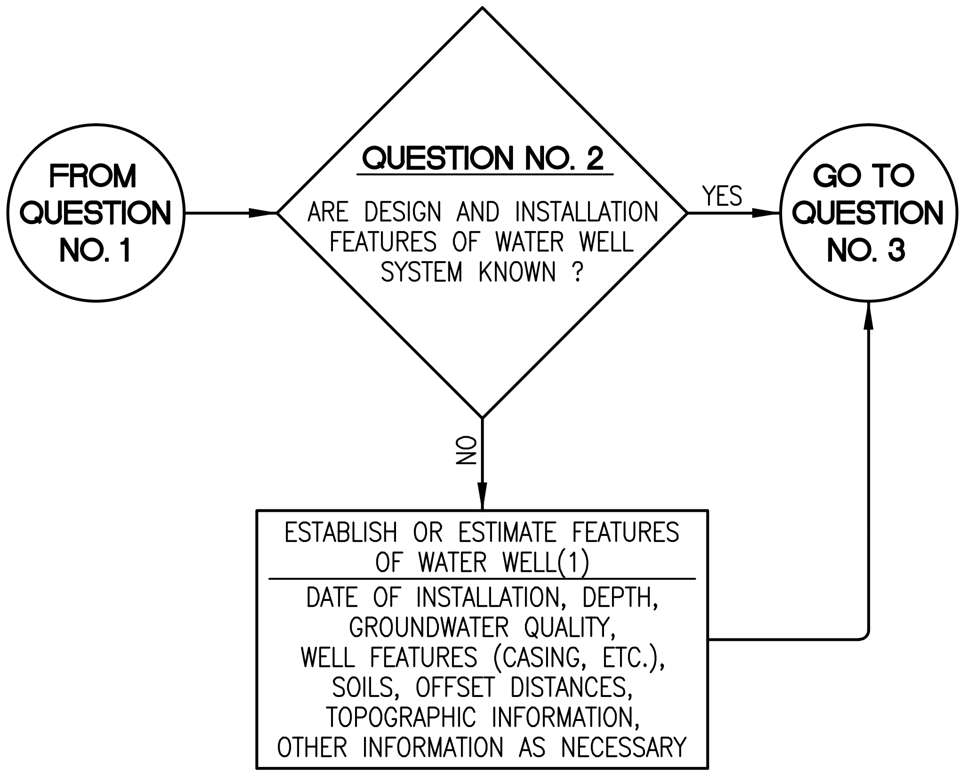
The solution sets referenced in the charts can be found in Appendix B – Solution Sets.



QUESTION NO. 1

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(1) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg

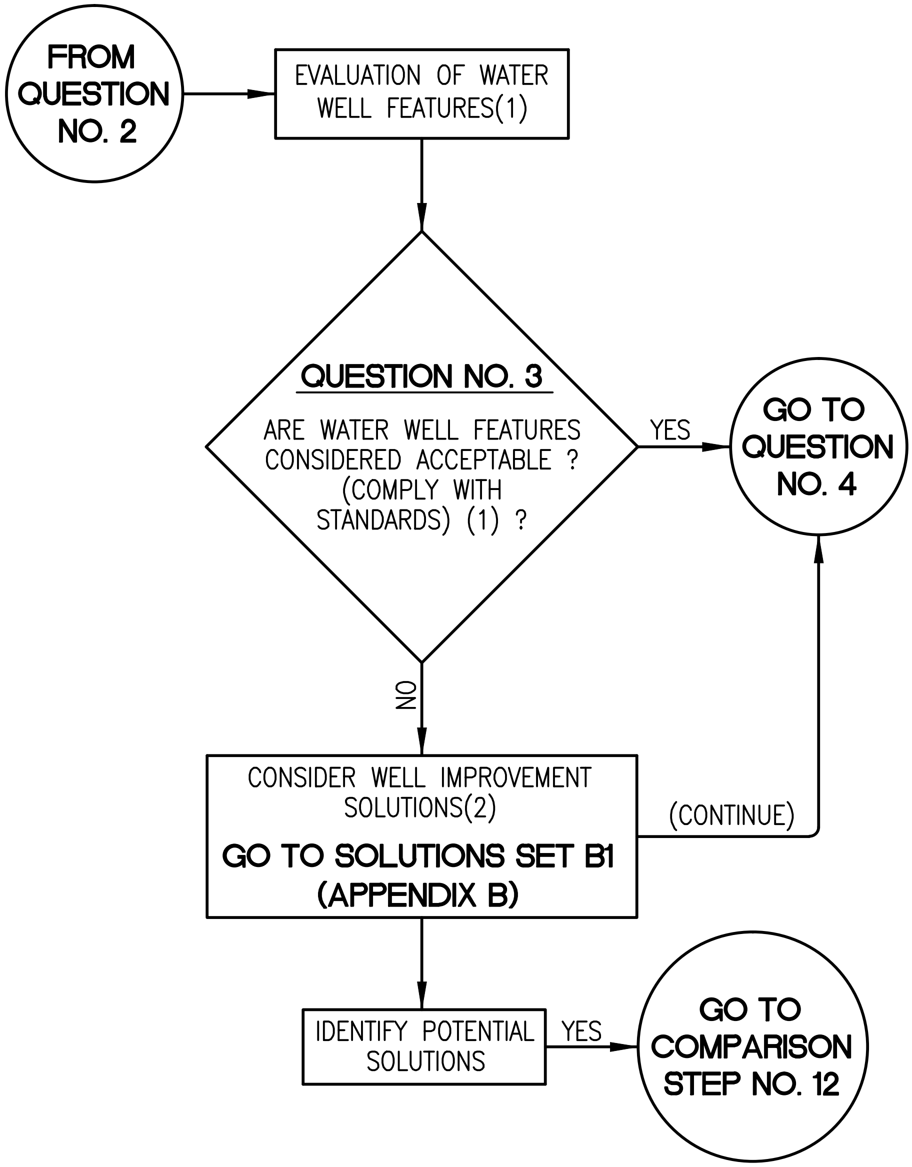


NOTE:
1. EVALUATION SHOULD BE CONDUCTED BY INDIVIDUAL WITH EXPERIENCE IN WATER WELL DESIGN AND INSTALLATION.

QUESTION NO. 2

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(2) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg



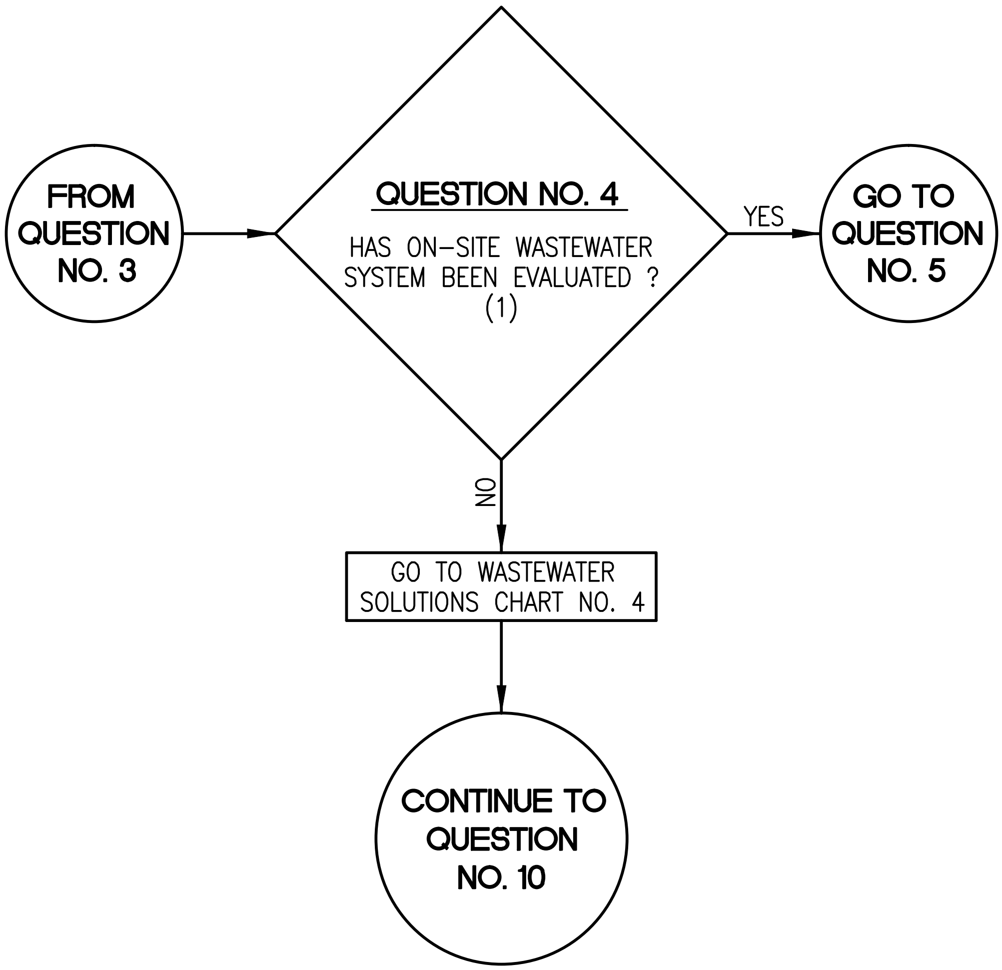
NOTES:

1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN WATER WELL DESIGN, INSTALLATION AND REGULATORY REQUIREMENTS.

2. SOLUTIONS SHOULD BE EVALUATED AND ESTABLISHED BY PERSON(S) EXPERIENCED IN DRINKING WATER TREATMENT. EXAMPLES: DRINKING WATER TREATMENT CONSULTANTS, HEALTH DEPARTMENT REPRESENTATIVES AND WATER TREATMENT EQUIPMENT MANUFACTURERS.

QUESTION NO. 3

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



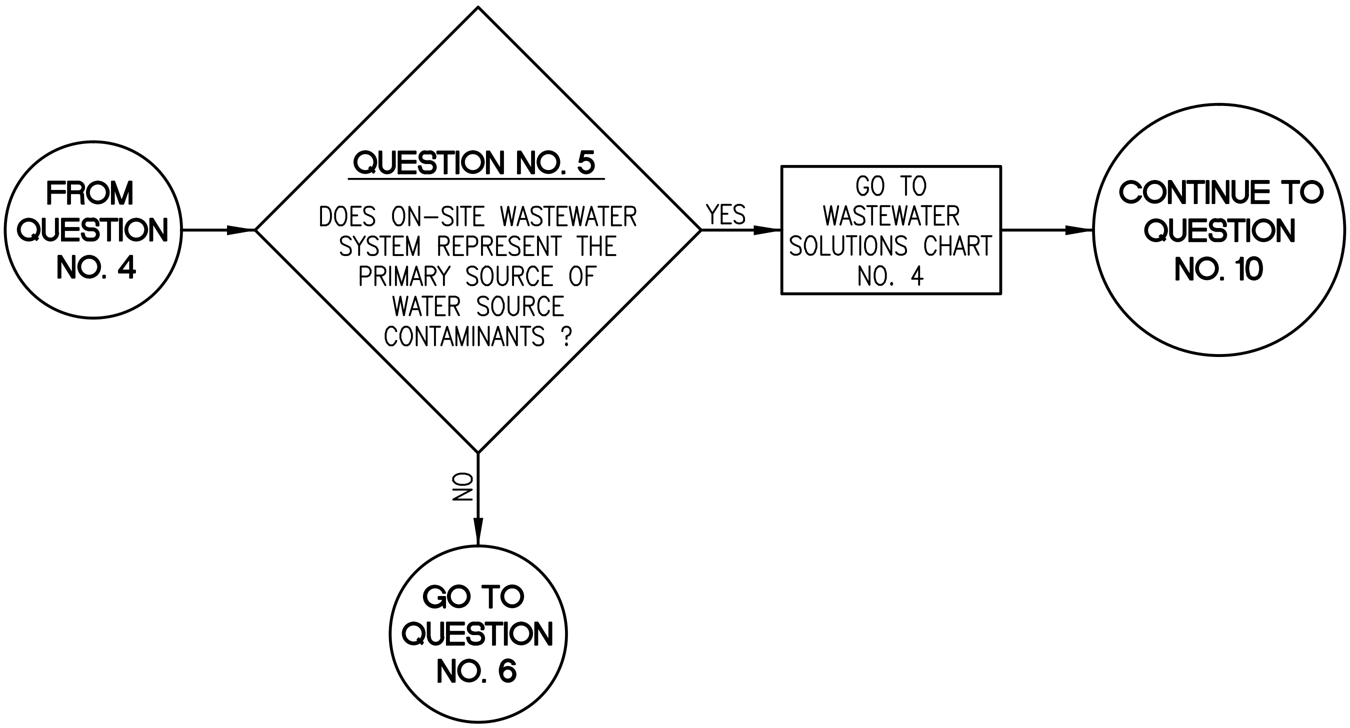
NOTE:

1. IF NO ON-SITE WASTEWATER SYSTEM EXISTS, GO TO QUESTION NO. 6.

QUESTION NO. 4

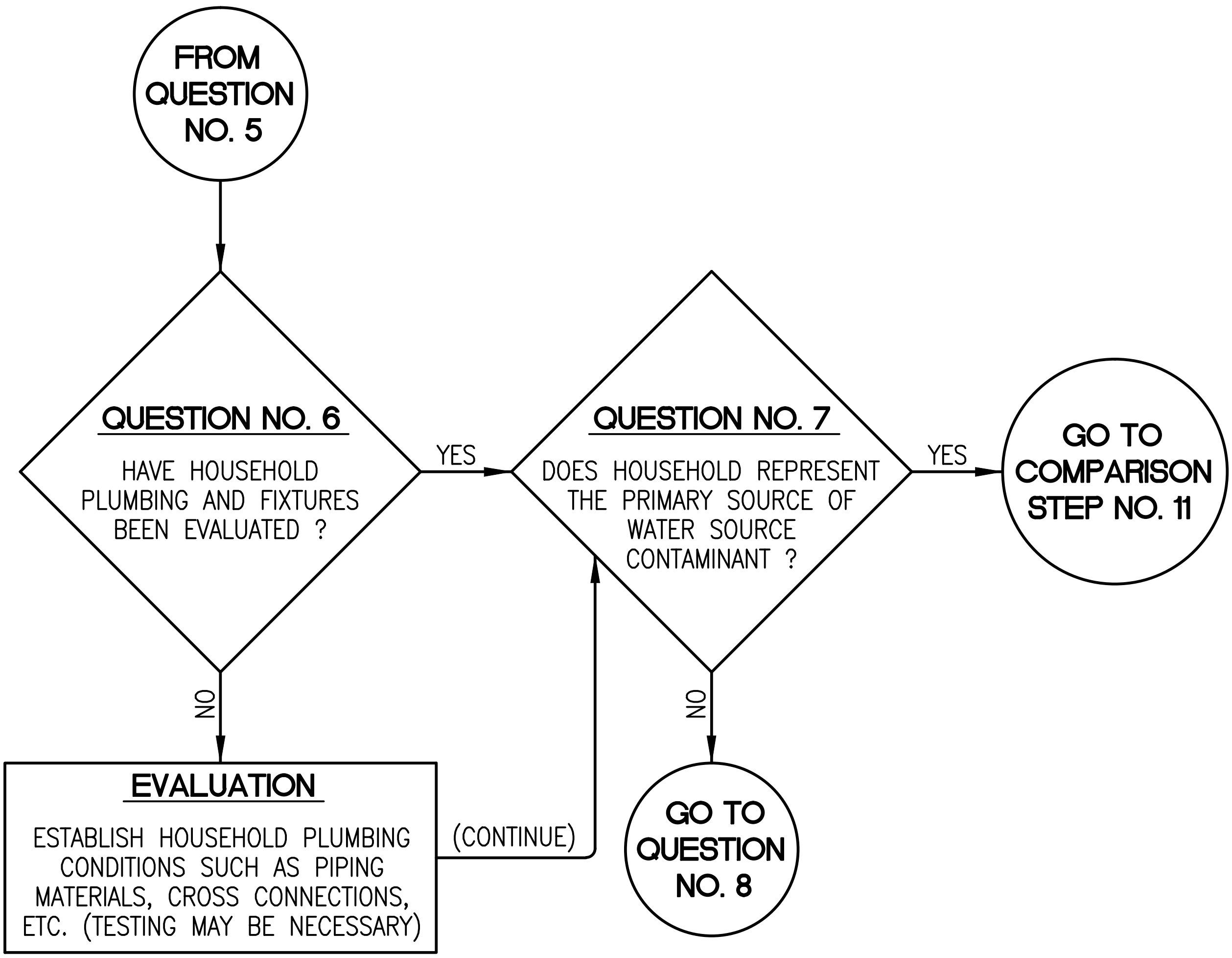
SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(4) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg



QUESTION NO. 5

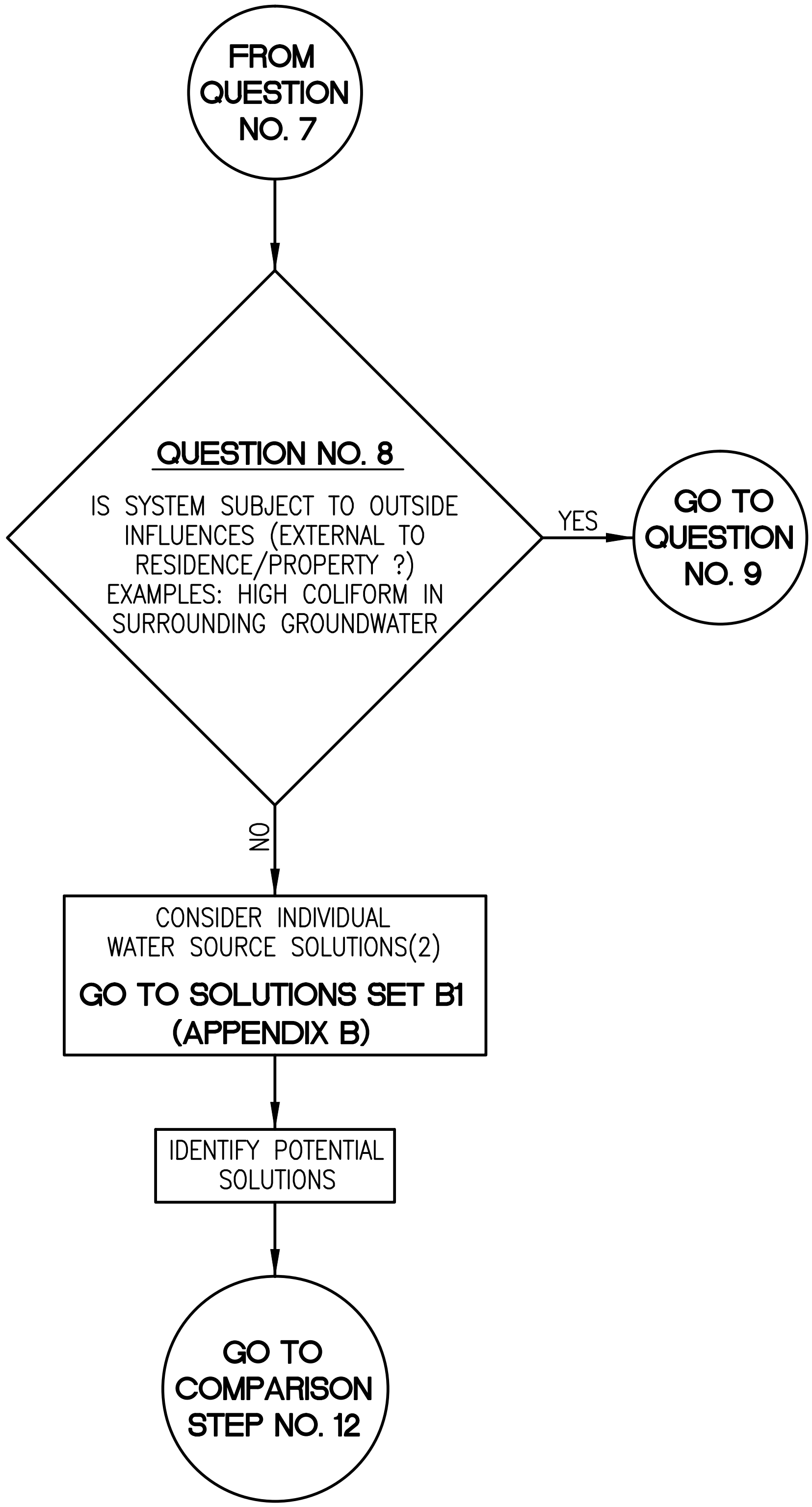
SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



QUESTIONS NO. 6 AND NO. 7

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

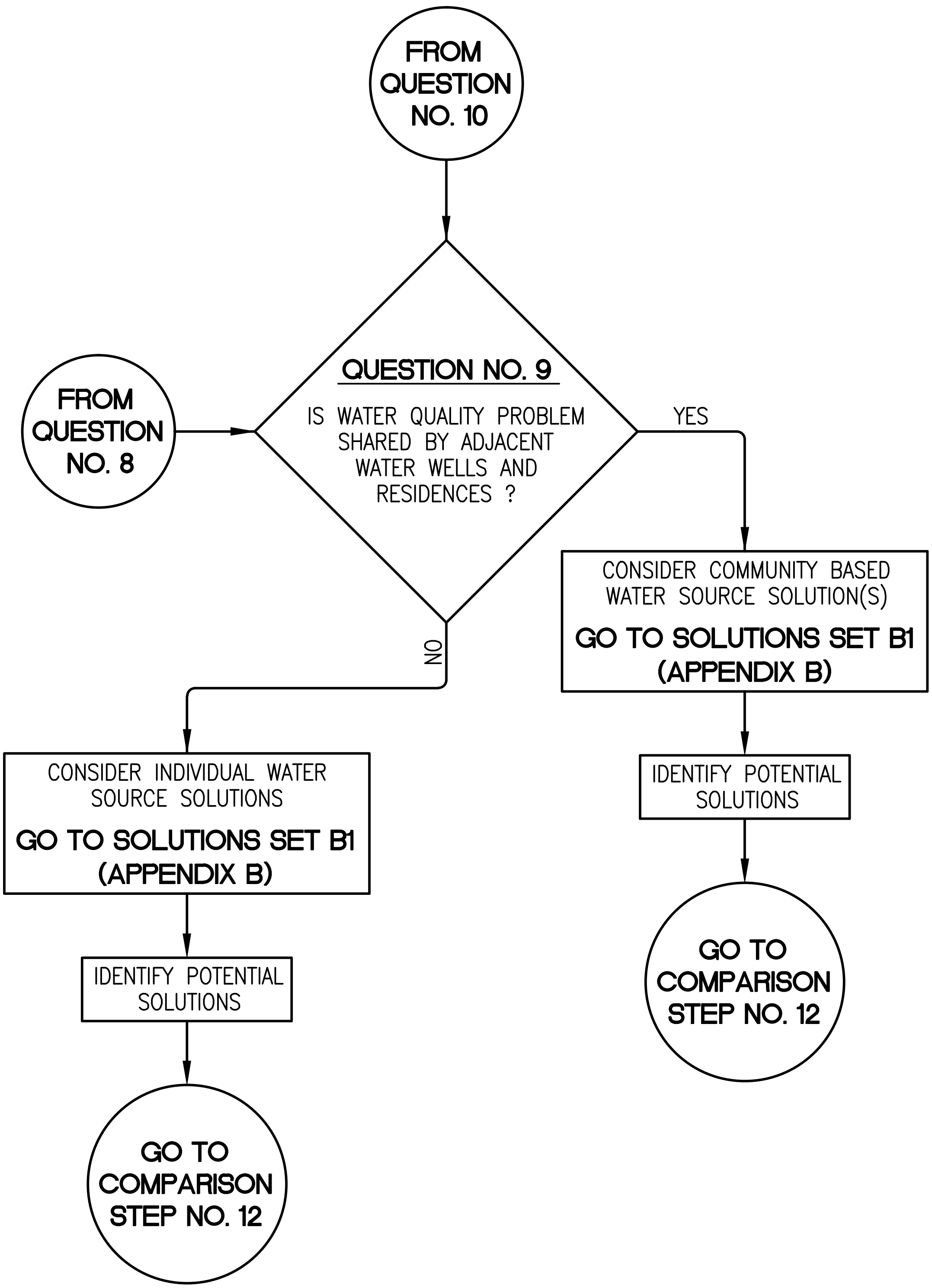
L:\TCDC\(6 AND 7) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg



QUESTION NO. 8

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

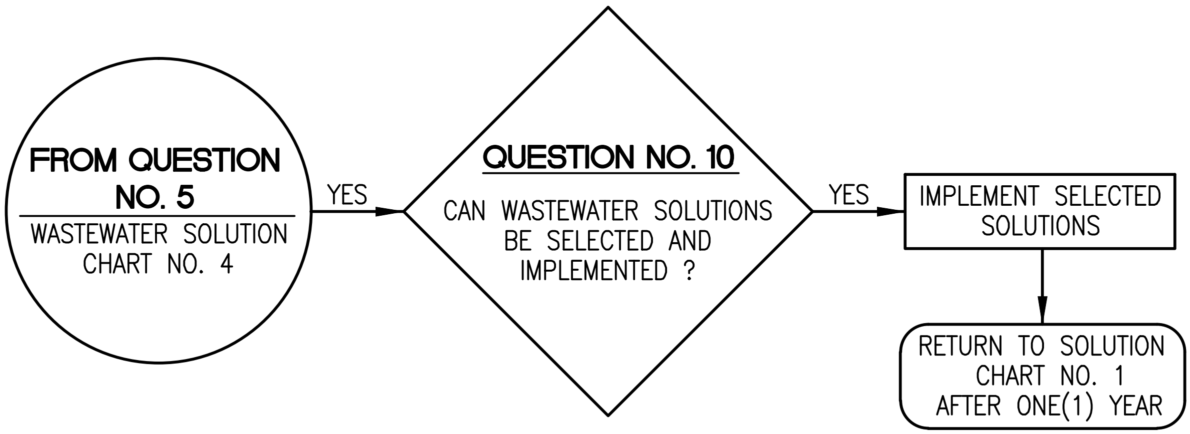
L:\TCDC\(8) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg



QUESTION NO. 9

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

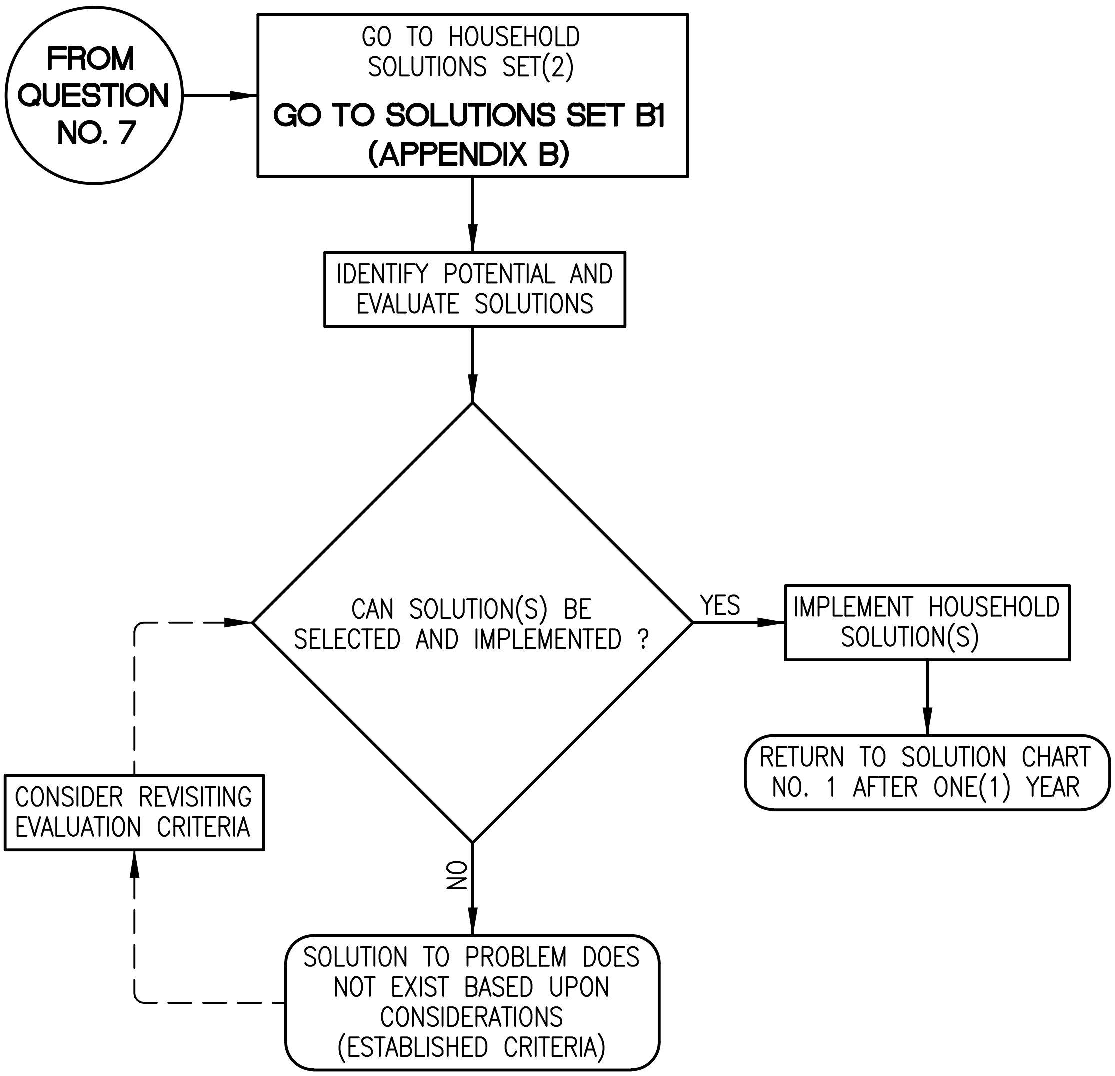
L:\TCDC\(9) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg



QUESTION NO. 10

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

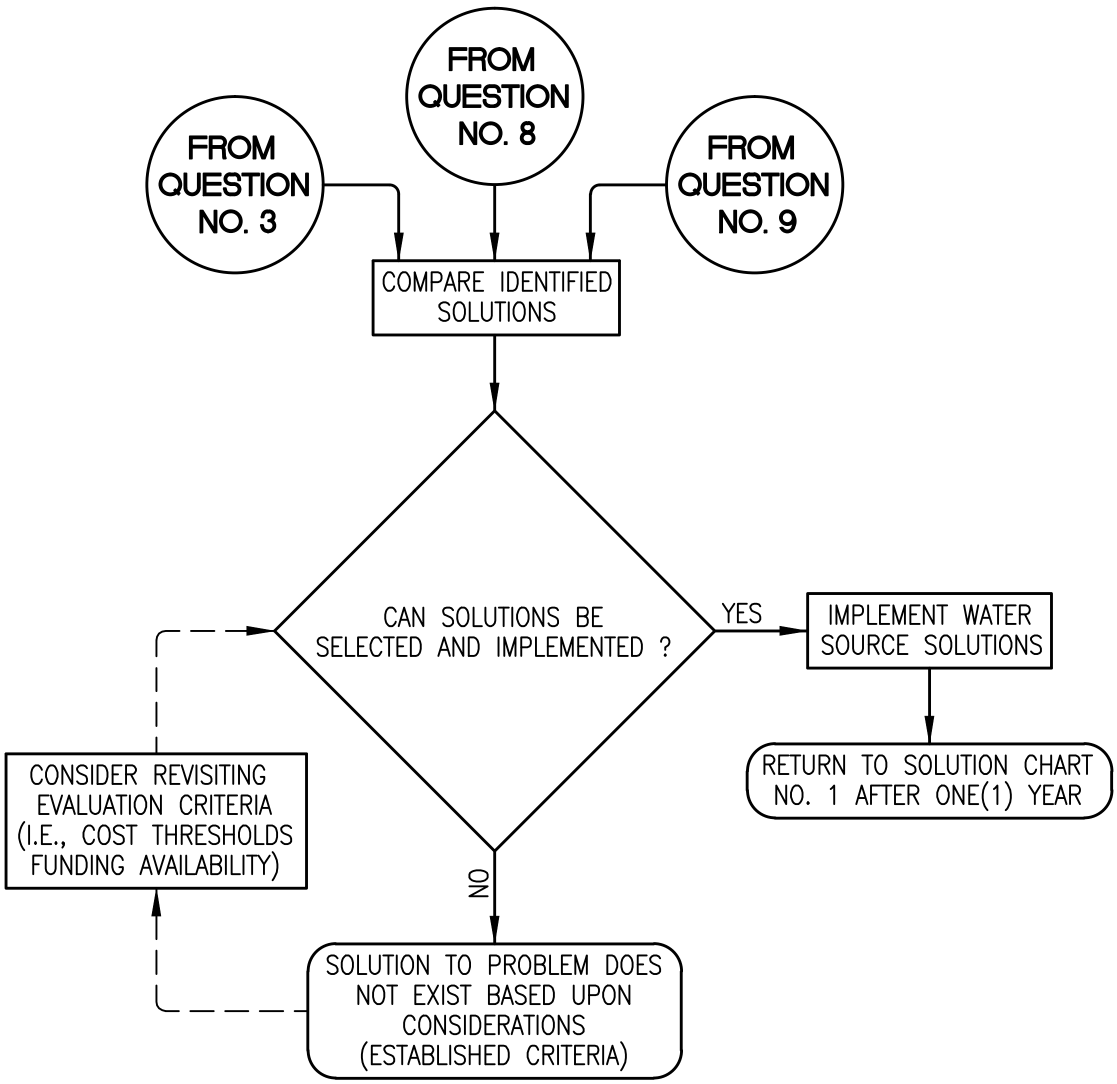
L:\TCDC\(10) BACTERIOLOGICAL–SOLUTION CHART 2B.Dwg



COMPARISON STEP NO. 11

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(11) BACTERIOLOGICAL–SOLUTION CHART 2B.Dwg



COMPARISON STEP NO. 12

SOLUTION CHART NO. 2B - WATER QUALITY SOLUTIONS - BACTERIOLOGICAL
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

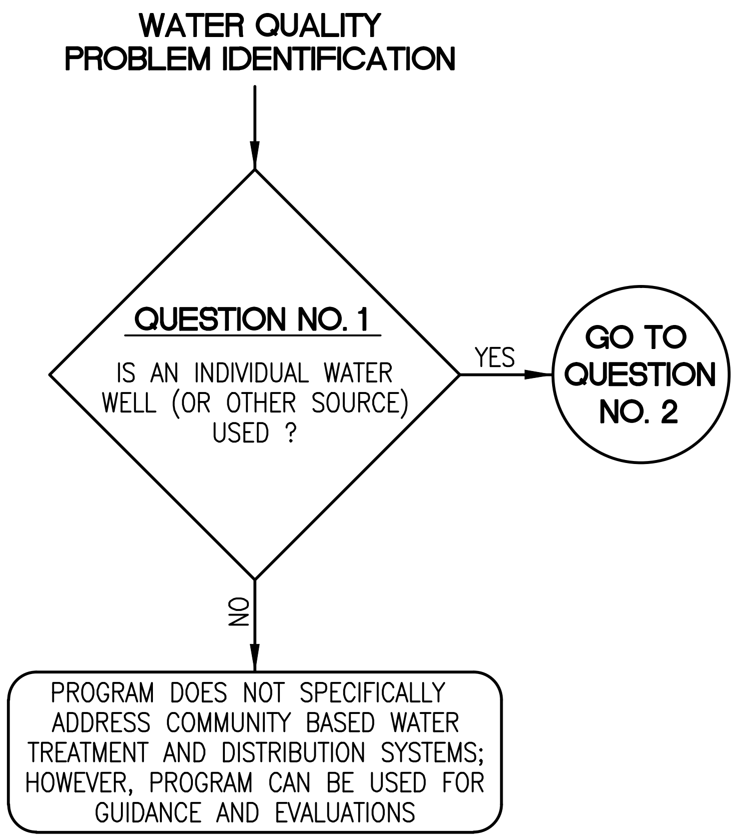
L:\TCDC\(12) BACTERIOLOGICAL-SOLUTION CHART 2B.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 2C – INORGANIC

This series of solution charts is specifically prepared to address water quality problems associated with inorganic constituents (e.g. arsenic, copper, lead or chromium).

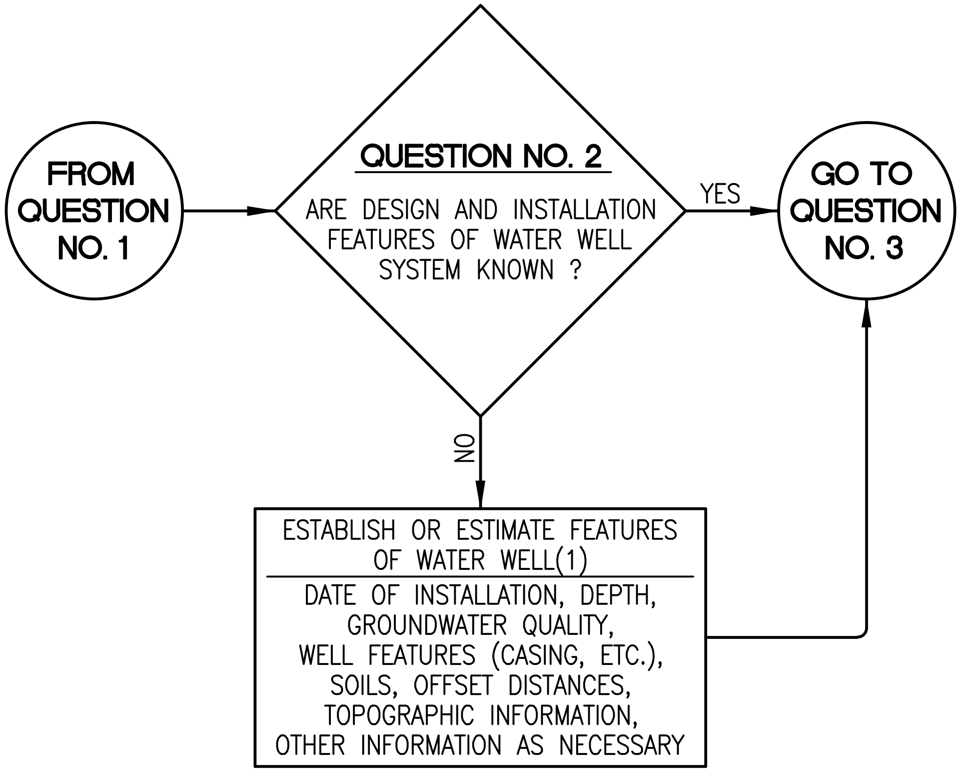
The solution sets referenced in the charts can be found in Appendix B – Solution Sets.



QUESTION NO. 1

SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(1) INORGANICS-SOLUTION CHART 2C.Dwg



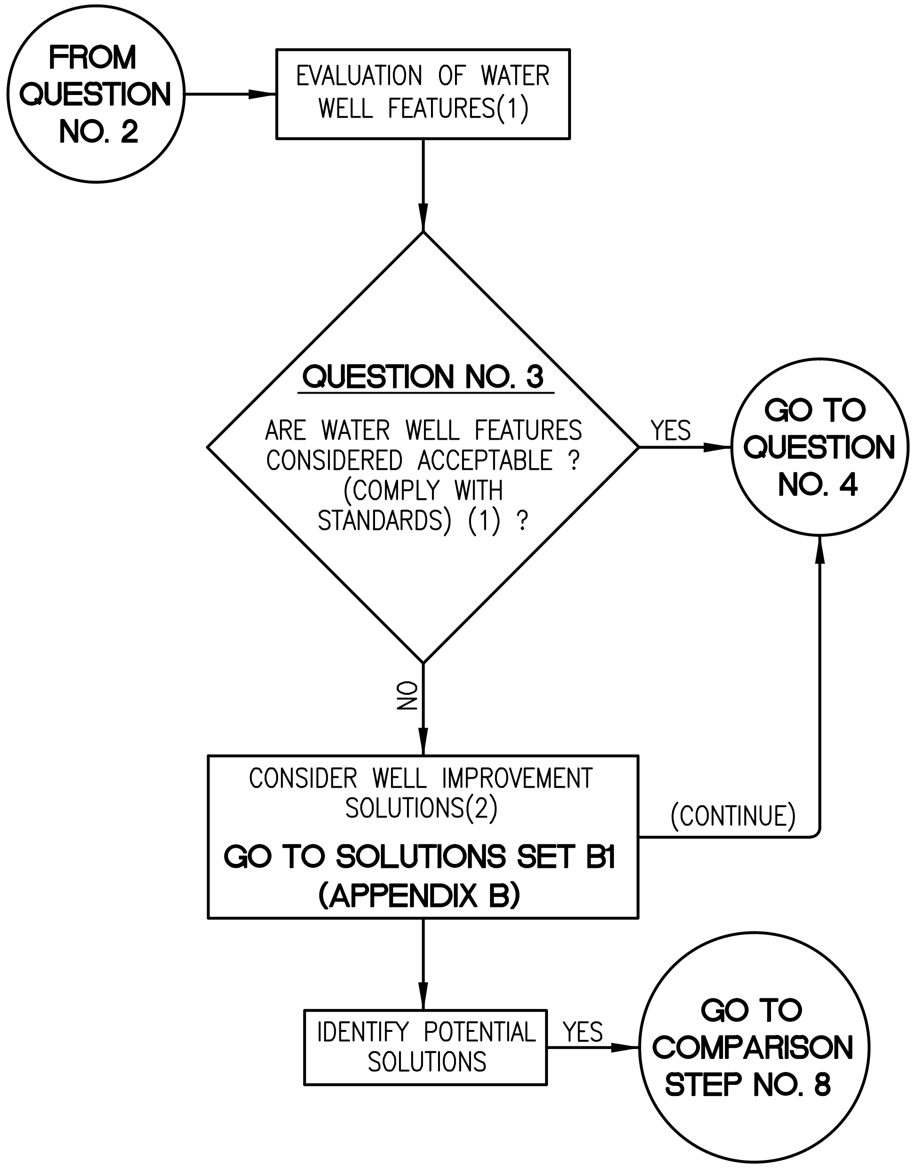
NOTE:

1. EVALUATION SHOULD BE CONDUCTED BY INDIVIDUAL WITH EXPERIENCE IN WATER WELL DESIGN AND INSTALLATION.

QUESTION NO. 2

SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(2) INORGANICS-SOLUTION CHART 2C.Dwg



NOTES:

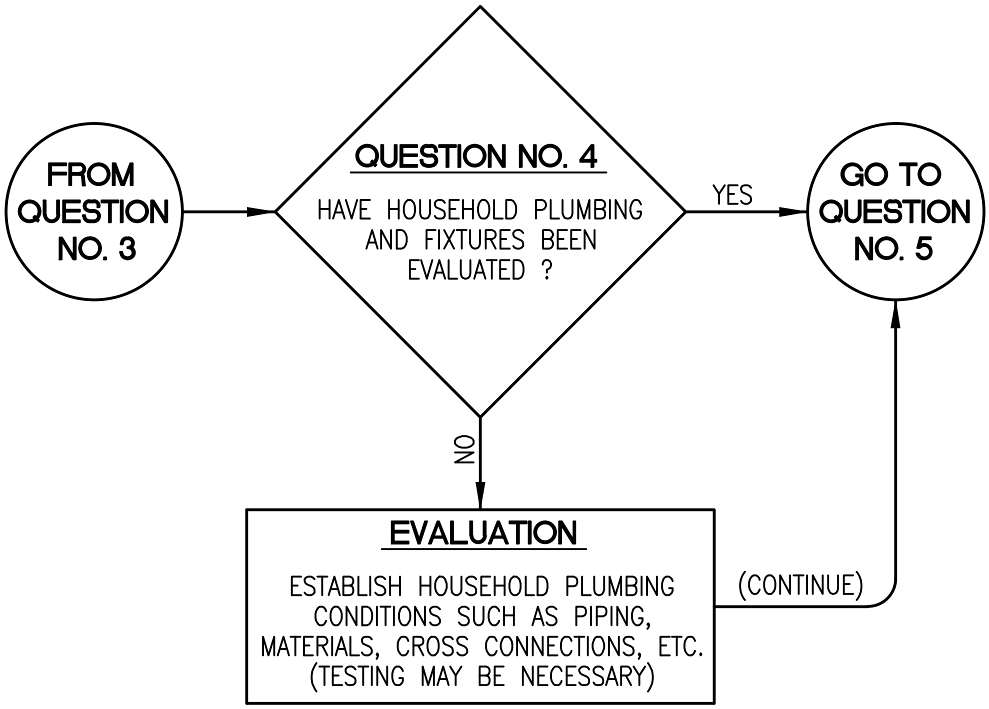
1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN WATER WELL DESIGN, INSTALLATION AND REGULATORY REQUIREMENTS.

2. SOLUTIONS SHOULD BE EVALUATED AND ESTABLISHED BY PERSON(S) EXPERIENCED IN DRINKING WATER TREATMENT. EXAMPLES: DRINKING WATER TREATMENT CONSULTANTS, HEALTH DEPARTMENT REPRESENTATIVES AND WATER TREATMENT EQUIPMENT MANUFACTURERS.

QUESTION NO. 3

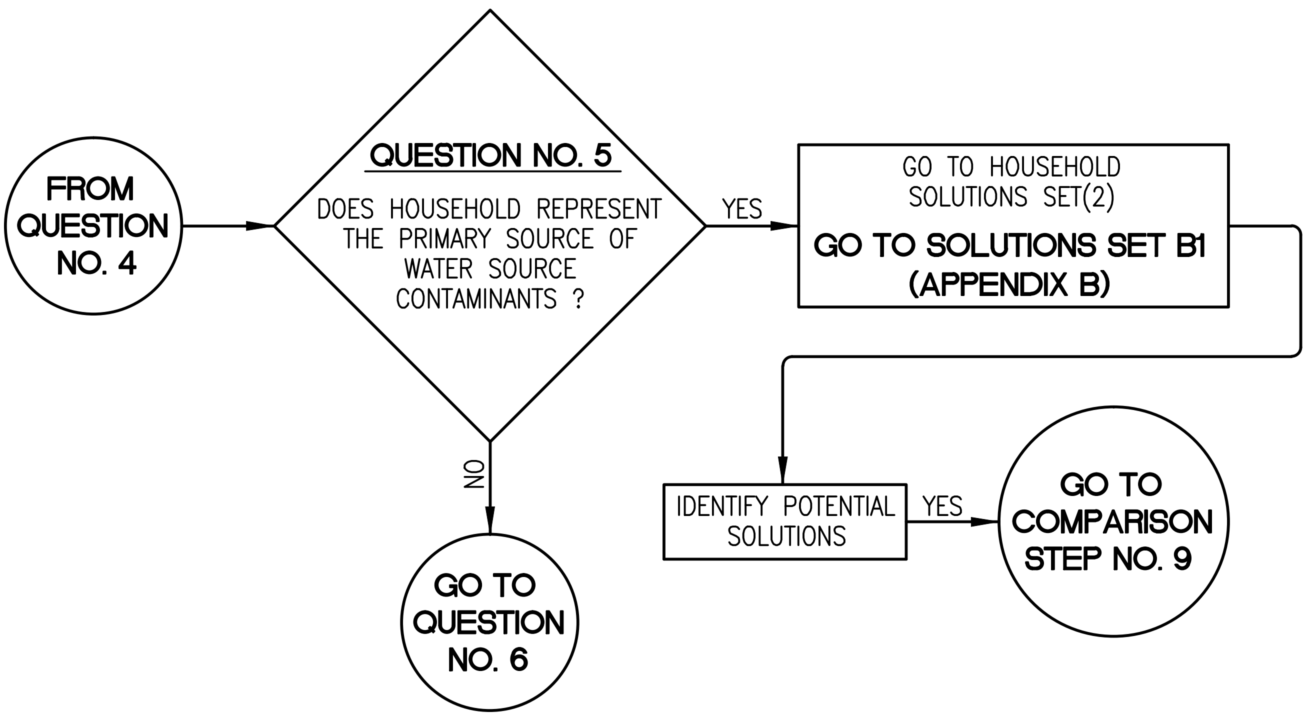
SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(3) INORGANICS-SOLUTION CHART 2C.Dwg



QUESTION NO. 4

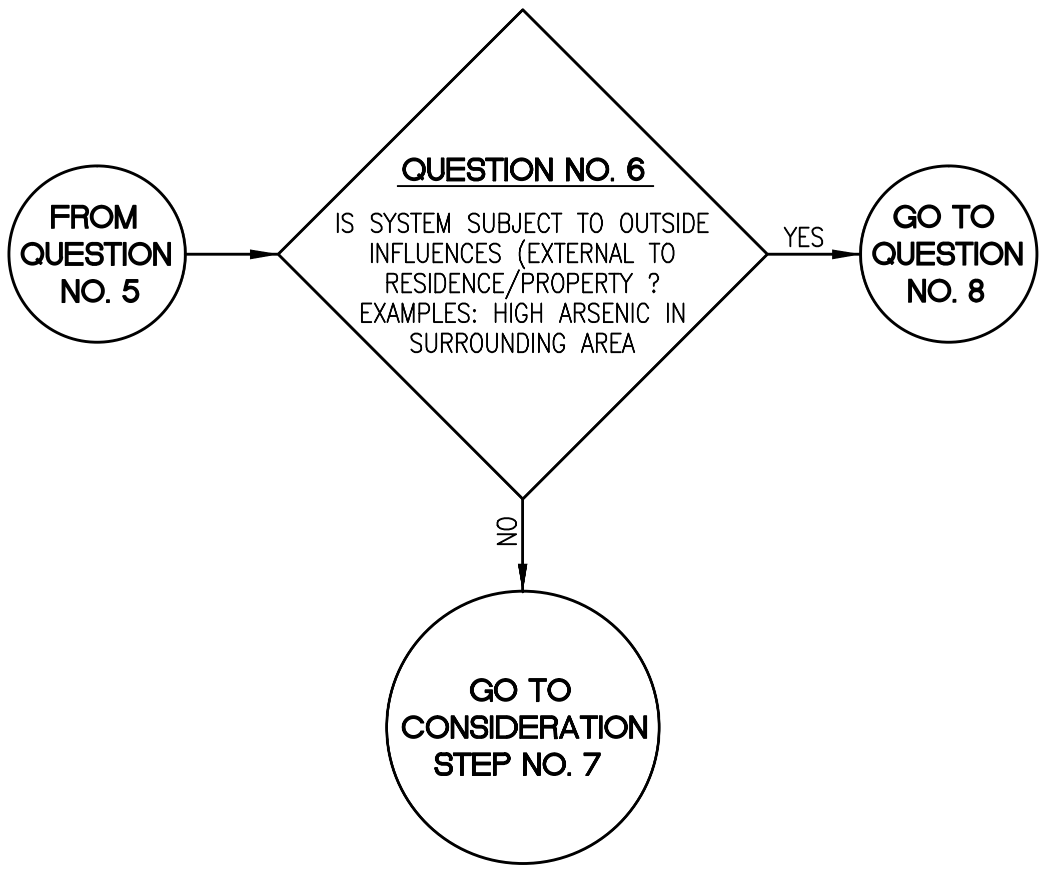
SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



QUESTION NO. 5

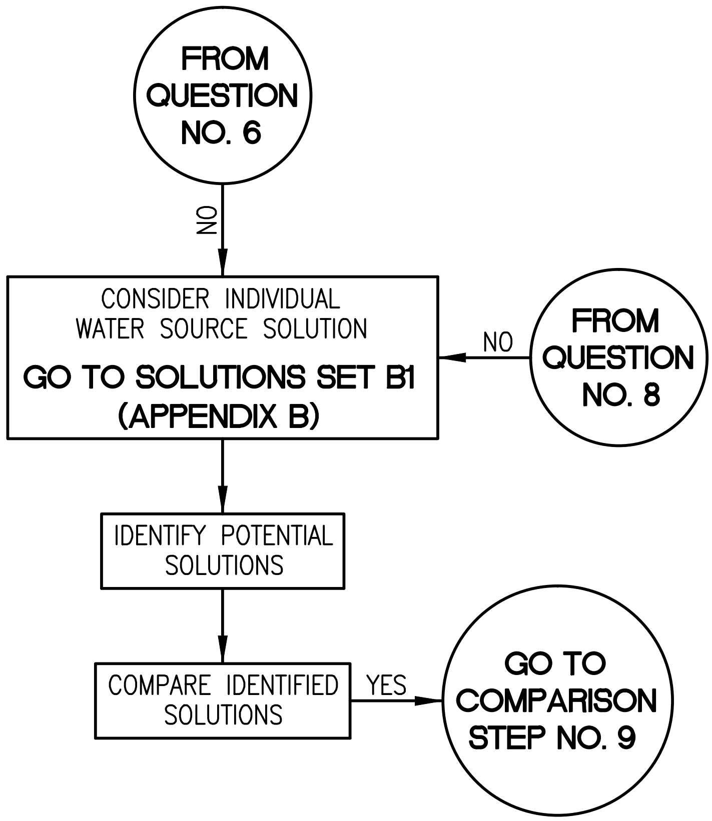
SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(5) INORGANICS-SOLUTION CHART 2C.Dwg



QUESTION NO. 6

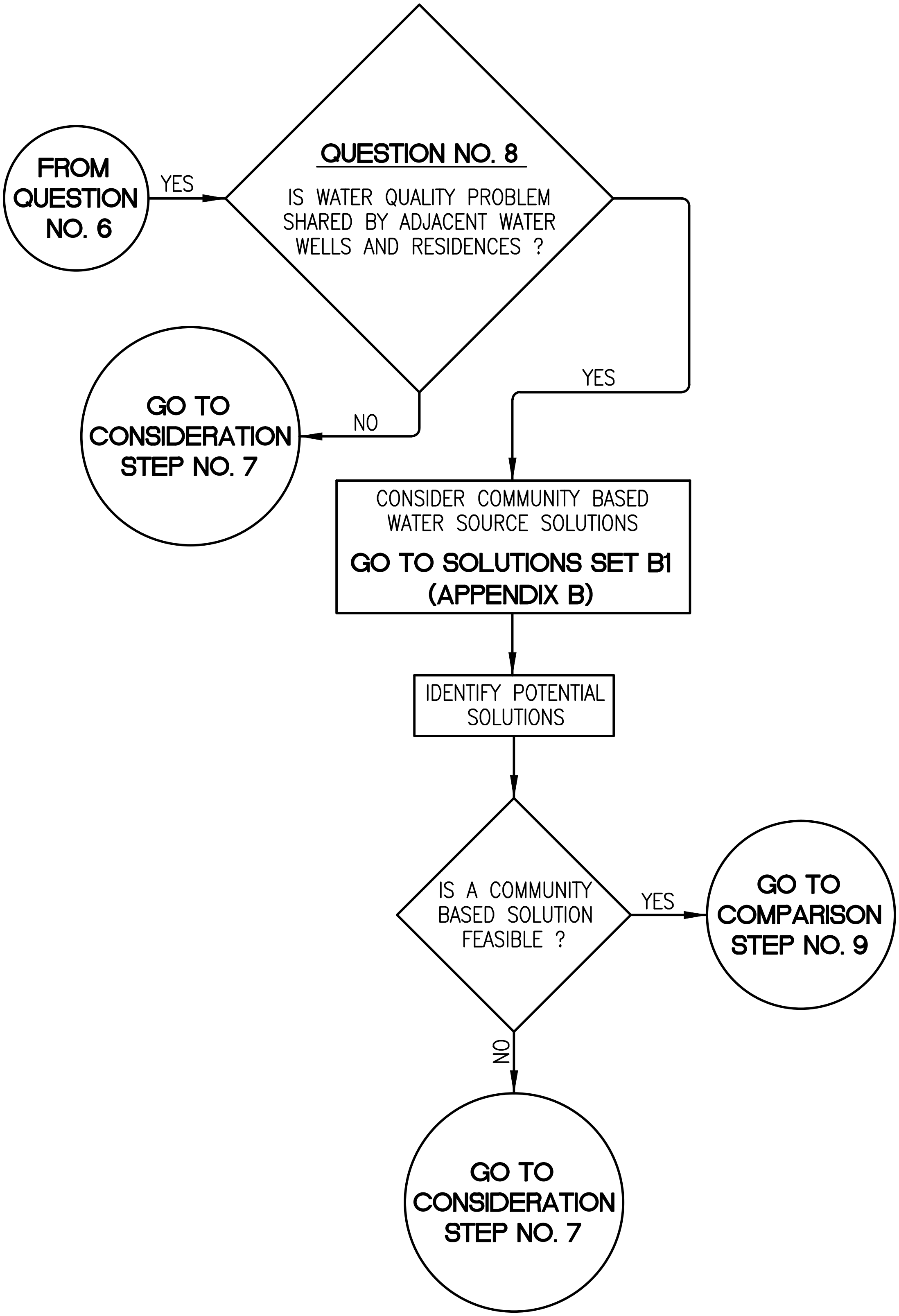
SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



CONSIDERATION STEP NO. 7

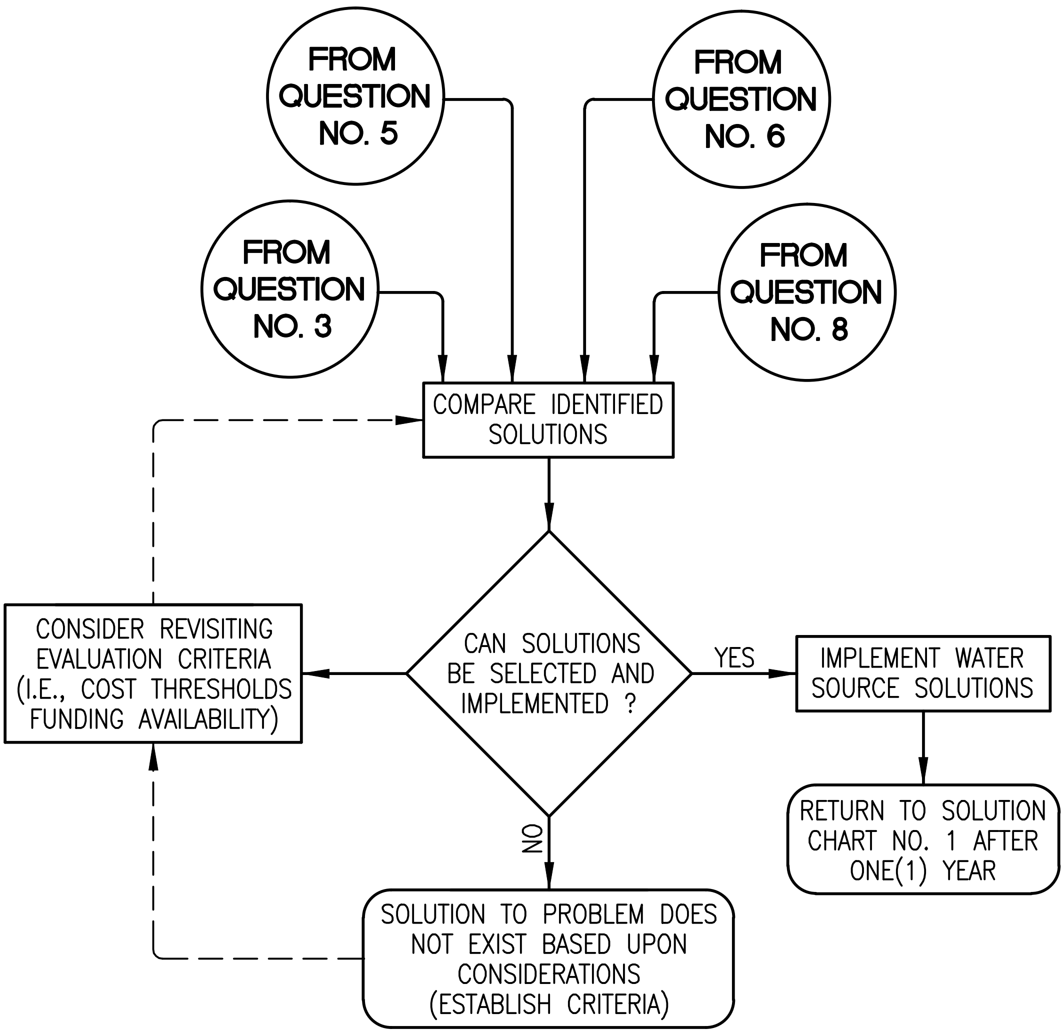
SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(7) INORGANICS-SOLUTION CHART 2C.Dwg



QUESTION NO. 8

SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



COMPARISON STEP NO. 9

SOLUTION SERIES NO. 2C - WATER QUALITY SOLUTIONS - INORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

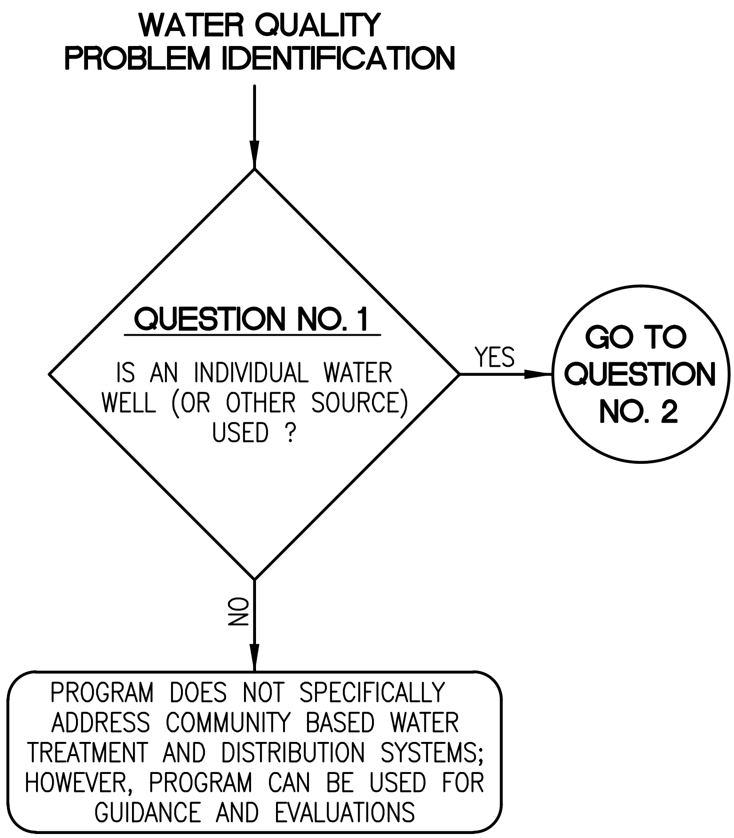
L:\TCDC\(9) INORGANICS-SOLUTION CHART 2C.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 2D – ORGANICS

This series of solution charts is specifically prepared to address water quality problems associated with organic contaminants (e.g. DBCP).

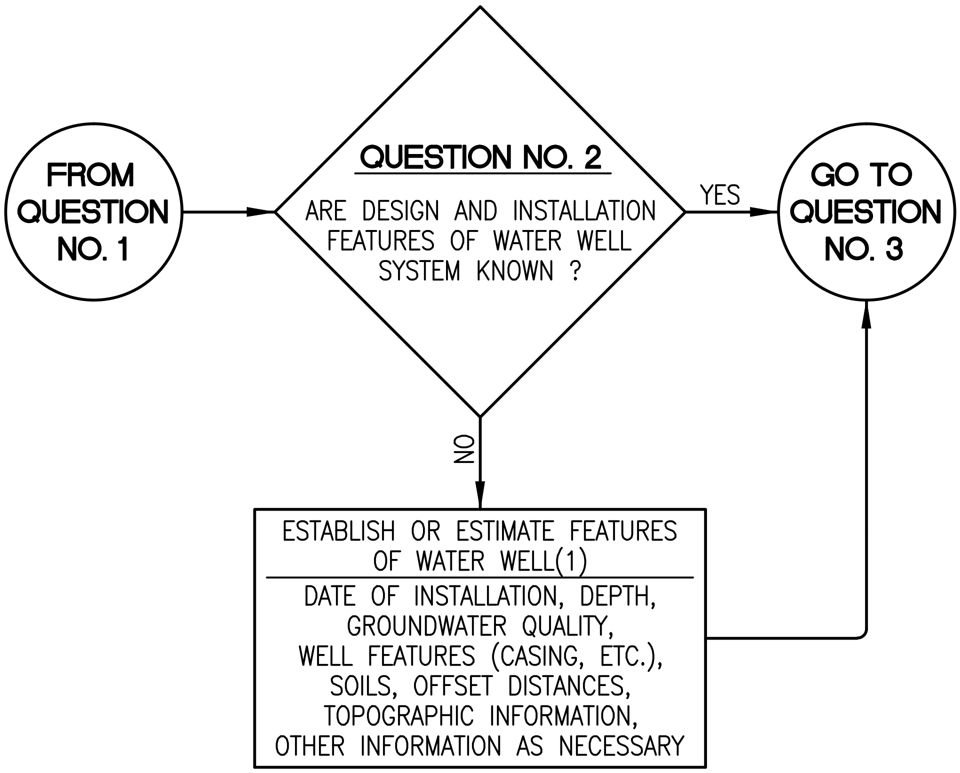
The solution sets referenced in the charts can be found in Appendix B – Solution Sets.



QUESTION NO. 1

SOLUTION CHART NO. 2D - WATER QUALITY SOLUTIONS - ORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(1) ORGANICS- CHART 2D.Dwg

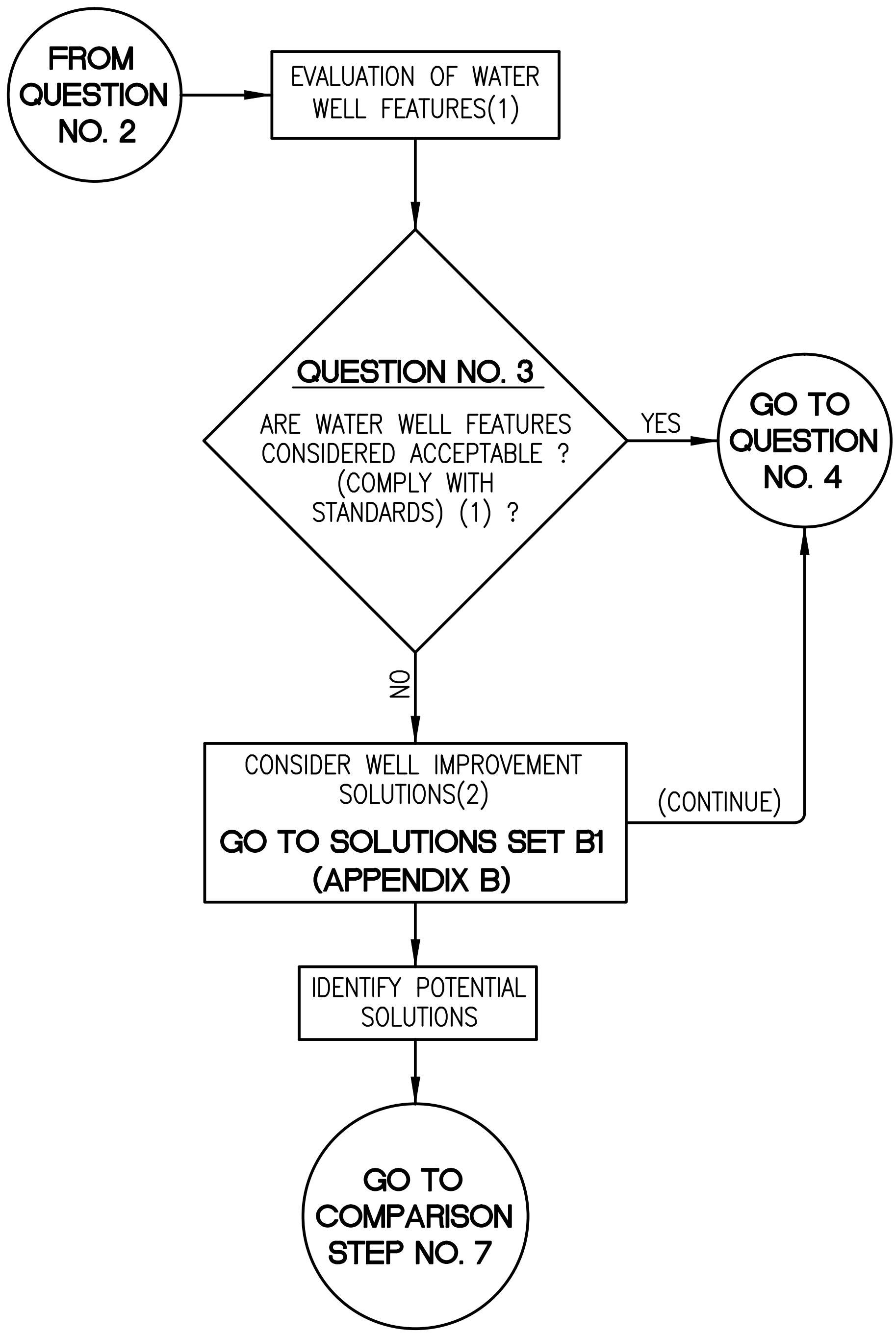


NOTE:
1. EVALUATION SHOULD BE CONDUCTED BY INDIVIDUAL WITH EXPERIENCE IN WATER WELL DESIGN AND INSTALLATION.

L:\TCDC\(2) ORGANICS-CHART 2D.Dwg

QUESTION NO. 2

SOLUTION CHART NO. 2D - WATER QUALITY SOLUTIONS - ORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



NOTES:

1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN WATER WELL DESIGN, INSTALLATION AND REGULATORY REQUIREMENTS.

2. SOLUTIONS SHOULD BE EVALUATED AND ESTABLISHED BY PERSON(S) EXPERIENCED IN DRINKING WATER TREATMENT. EXAMPLES: DRINKING WATER TREATMENT CONSULTANTS, HEALTH DEPARTMENT REPRESENTATIVES AND WATER TREATMENT EQUIPMENT MANUFACTURERS.

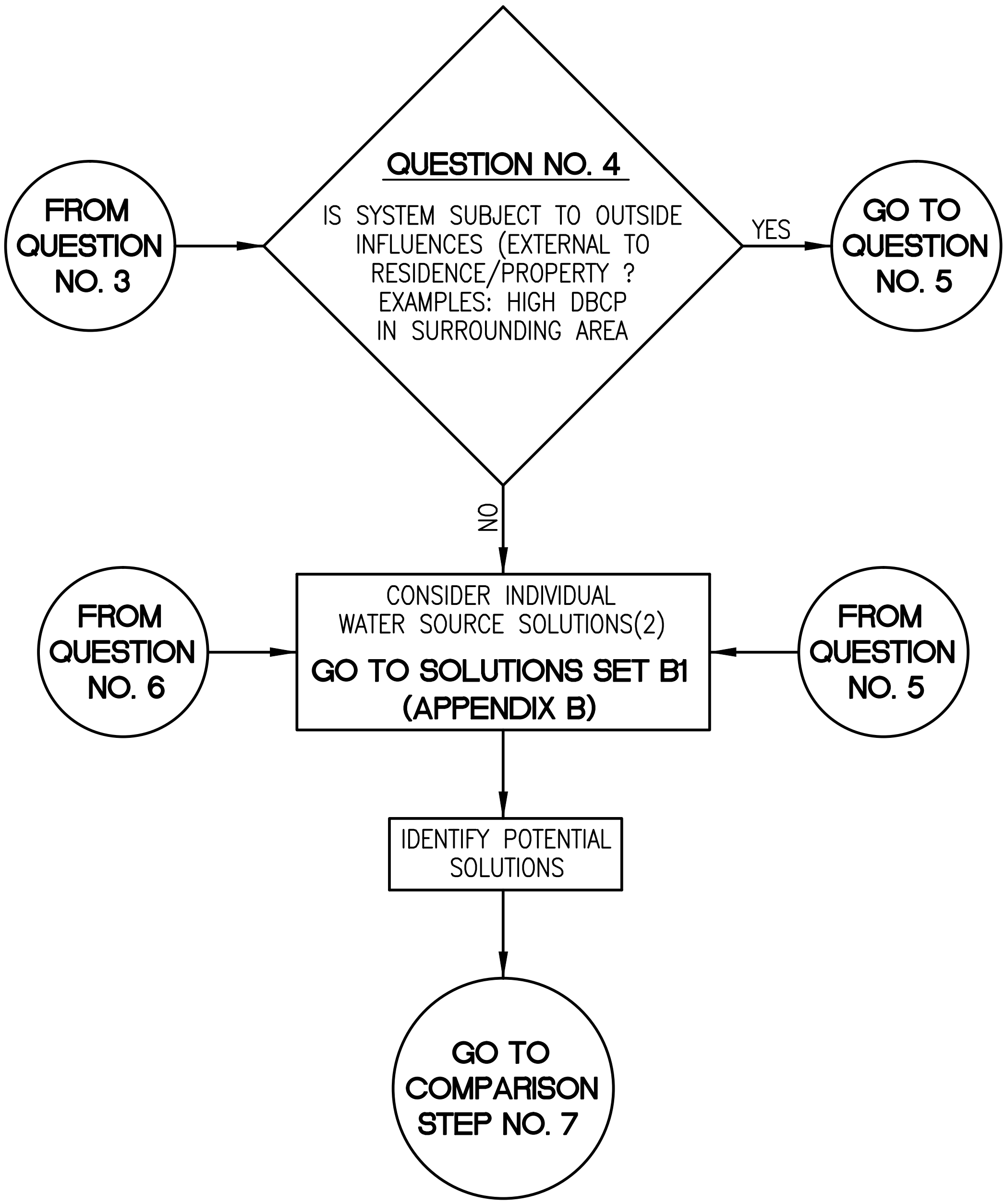
QUESTION NO. 3

SOLUTION CHART NO. 2D - WATER QUALITY SOLUTIONS - ORGANICS

INDIVIDUAL HOUSEHOLD PILOT STUDY

TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

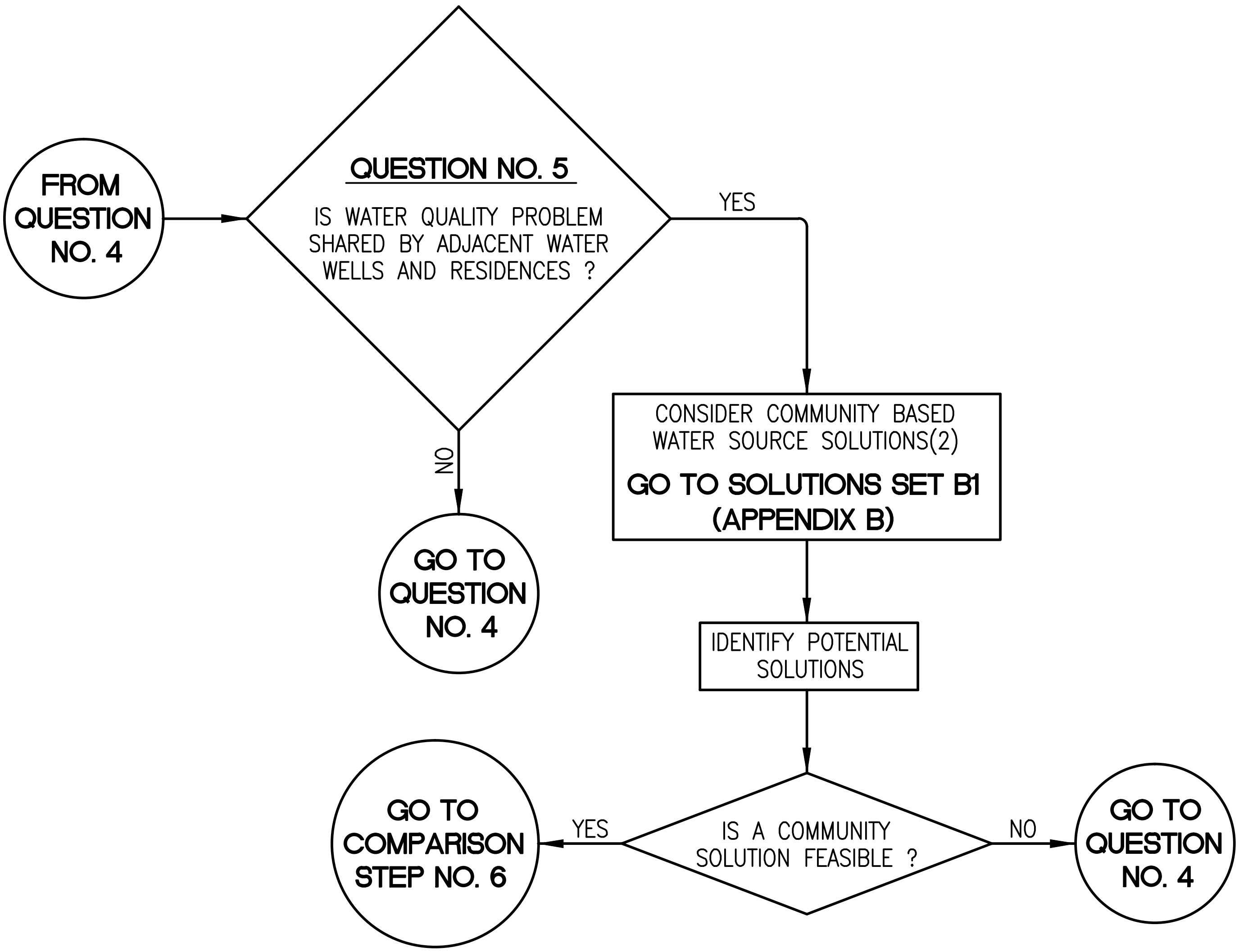
L:\TCDC\(3) ORGANICS-CHART 2D.Dwg



QUESTION NO. 4

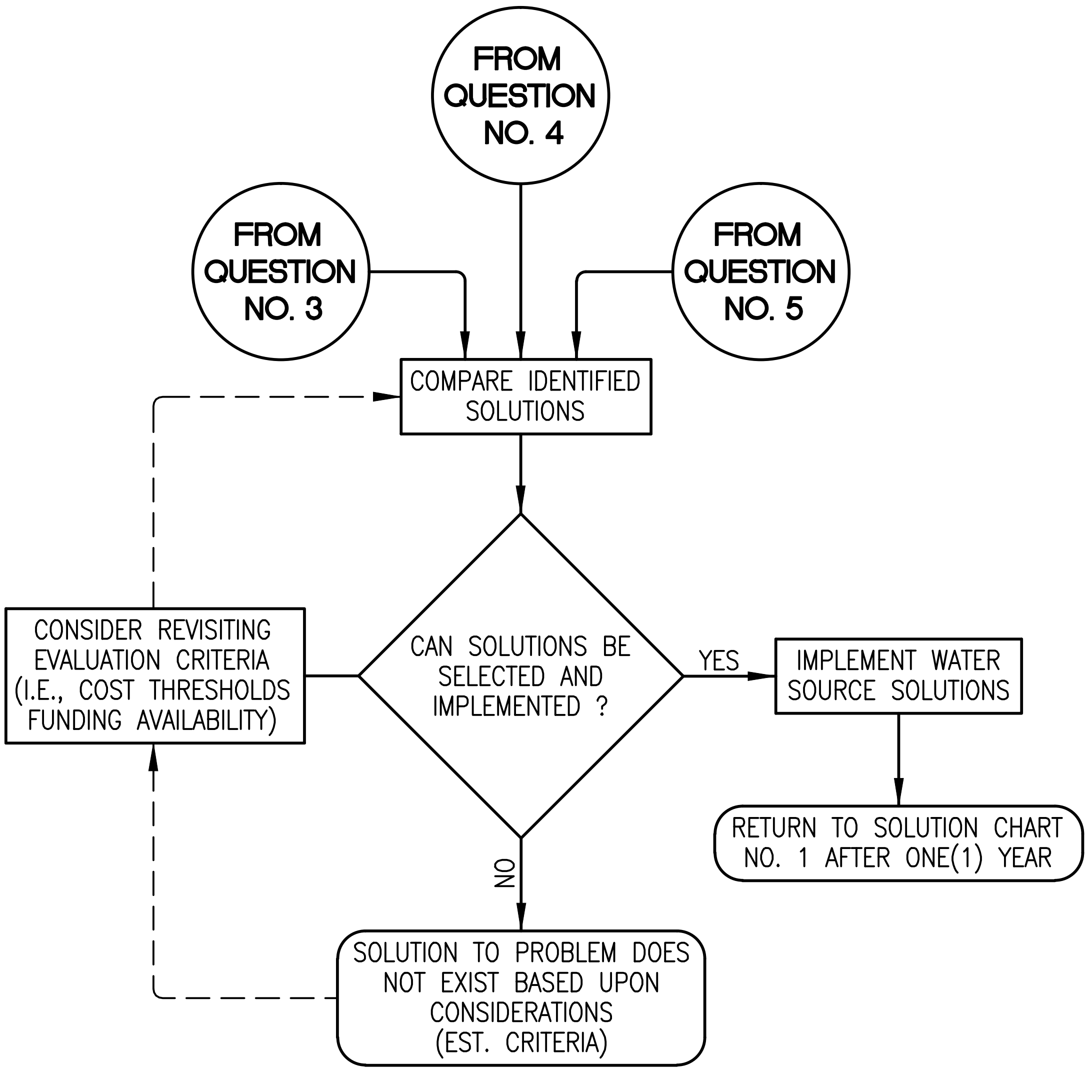
SOLUTION CHART NO. 2D - WATER QUALITY SOLUTIONS - ORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(4) ORGANICS-CHART 2D.Dwg



QUESTION NO. 5

SOLUTION CHART NO. 2D - WATER QUALITY SOLUTIONS - ORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



COMPARISON STEP NO. 6

SOLUTION CHART NO. 2D - WATER QUALITY SOLUTIONS - ORGANICS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

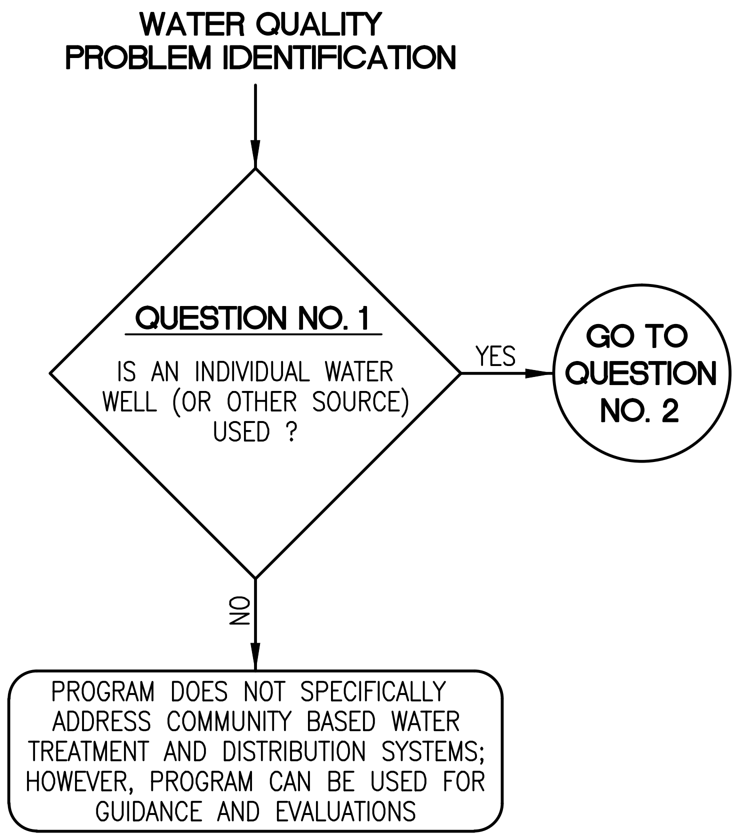
L:\TCDC\(6) ORGANICS-CHART 2D.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 2E – GENERAL WATER QUALITY

This series of solution charts is specifically prepared to address water quality problems associated with other general water quality constituents (e.g. total dissolved solids).

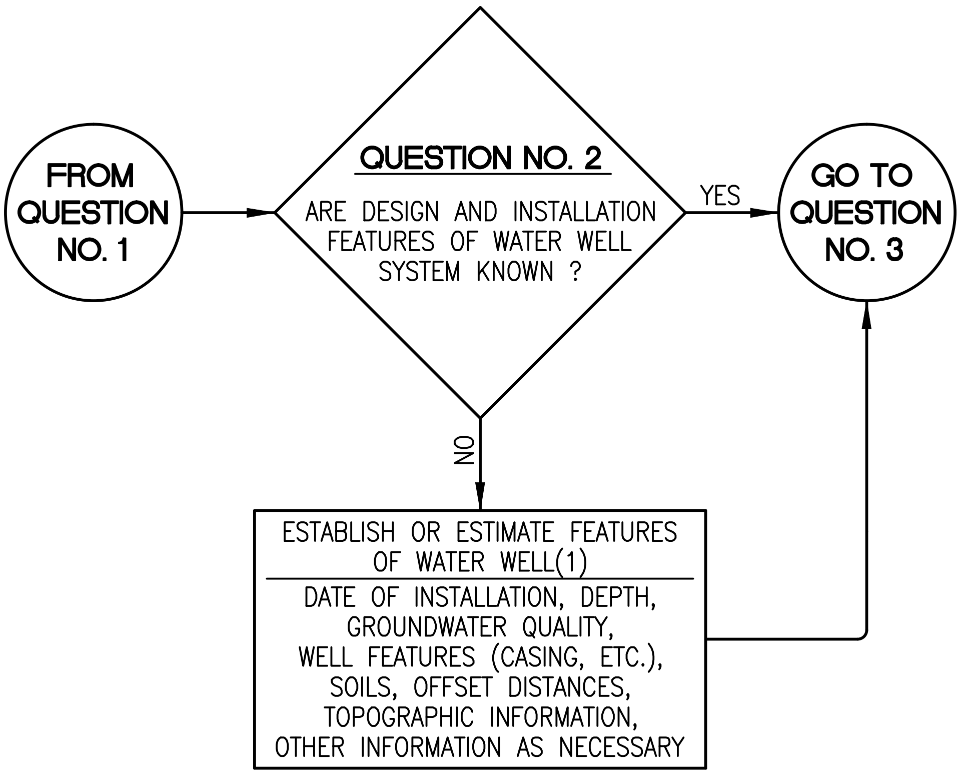
The solution sets referenced in the charts can be found in Appendix B – Solution Sets.



QUESTION NO. 1

SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(1) GENERAL WATER QUALITY- CHART 2E.Dwg



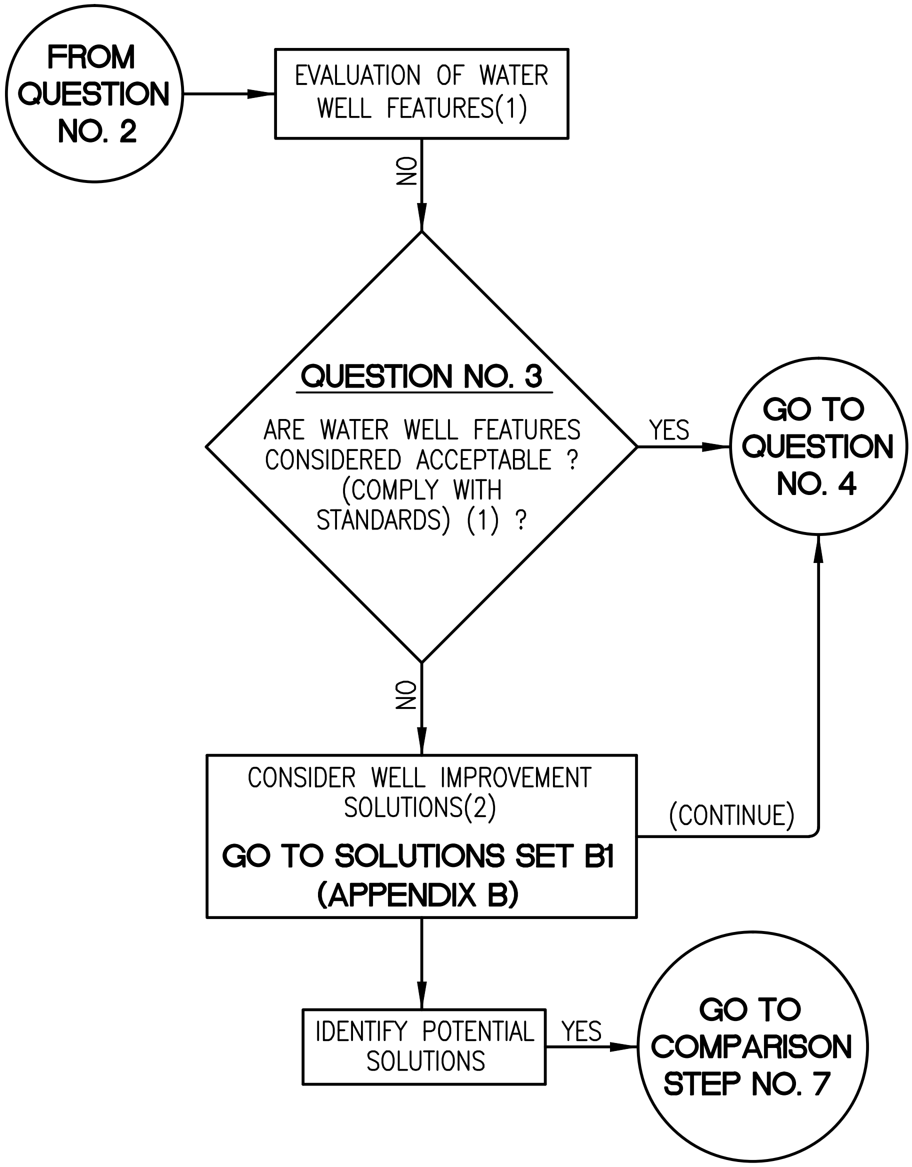
NOTE:

1. EVALUATION SHOULD BE CONDUCTED BY INDIVIDUAL WITH EXPERIENCE IN WATER WELL DESIGN AND INSTALLATION.

QUESTION NO. 2

SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(2) GENERAL WATER QUALITY- CHART 2E.Dwg



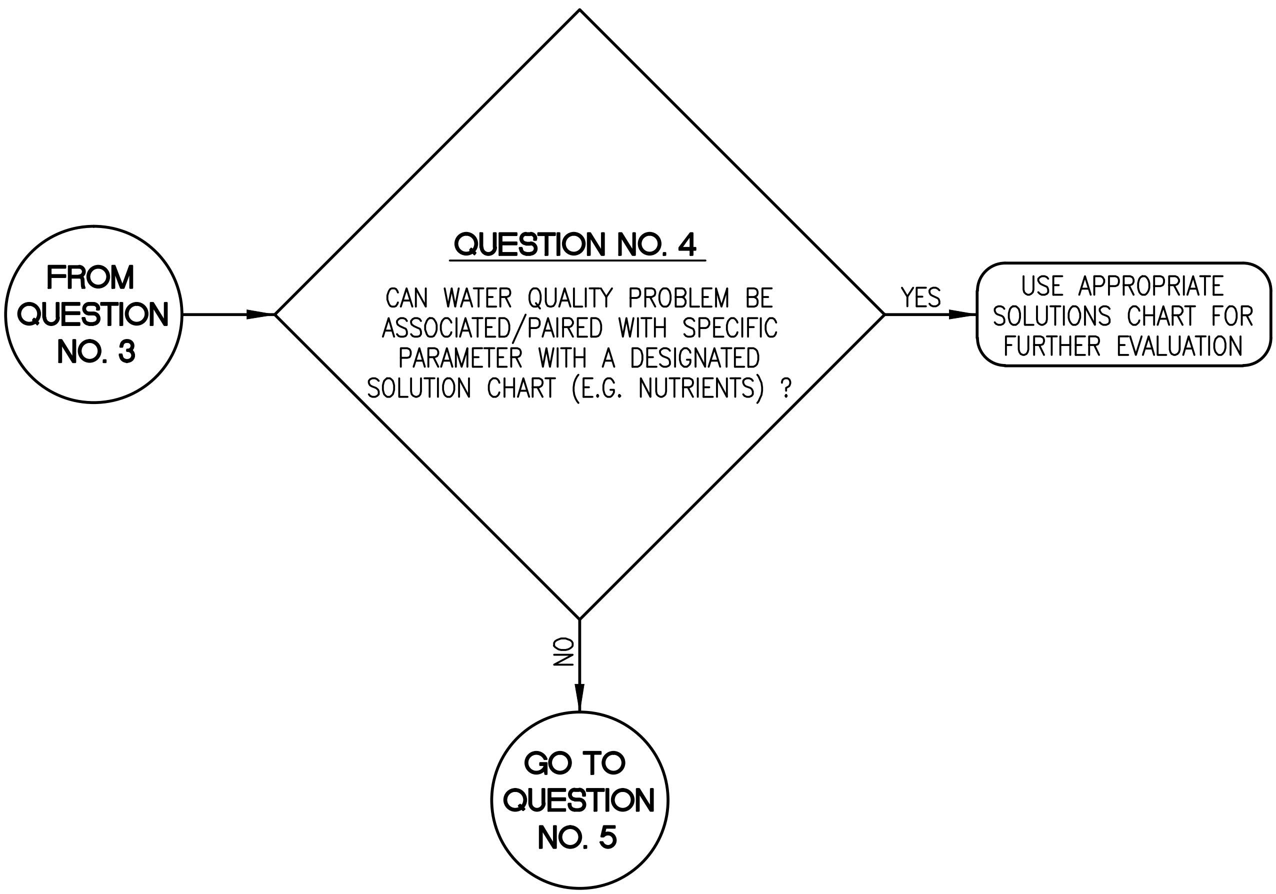
NOTES:

1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN WATER WELL DESIGN, INSTALLATION AND REGULATORY REQUIREMENTS.
2. SOLUTIONS SHOULD BE EVALUATED AND ESTABLISHED BY PERSON(S) EXPERIENCED IN DRINKING WATER TREATMENT. EXAMPLES: DRINKING WATER TREATMENT CONSULTANTS, HEALTH DEPARTMENT REPRESENTATIVES AND WATER TREATMENT EQUIPMENT MANUFACTURERS.

QUESTION NO. 3

SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

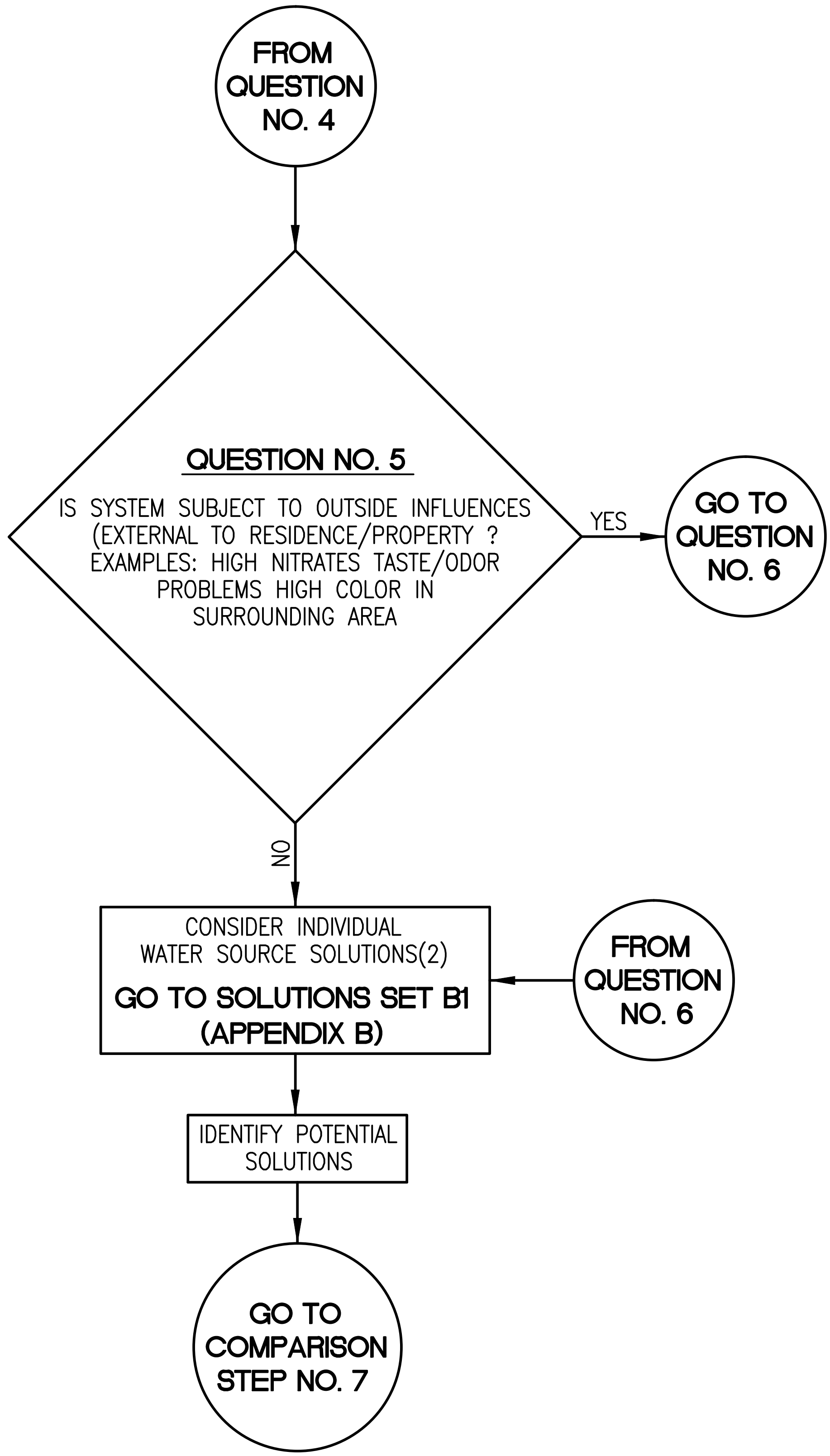
L:\TCDC\(3) GENERAL WATER QUALITY-CHART 2E.Dwg



QUESTION NO. 4

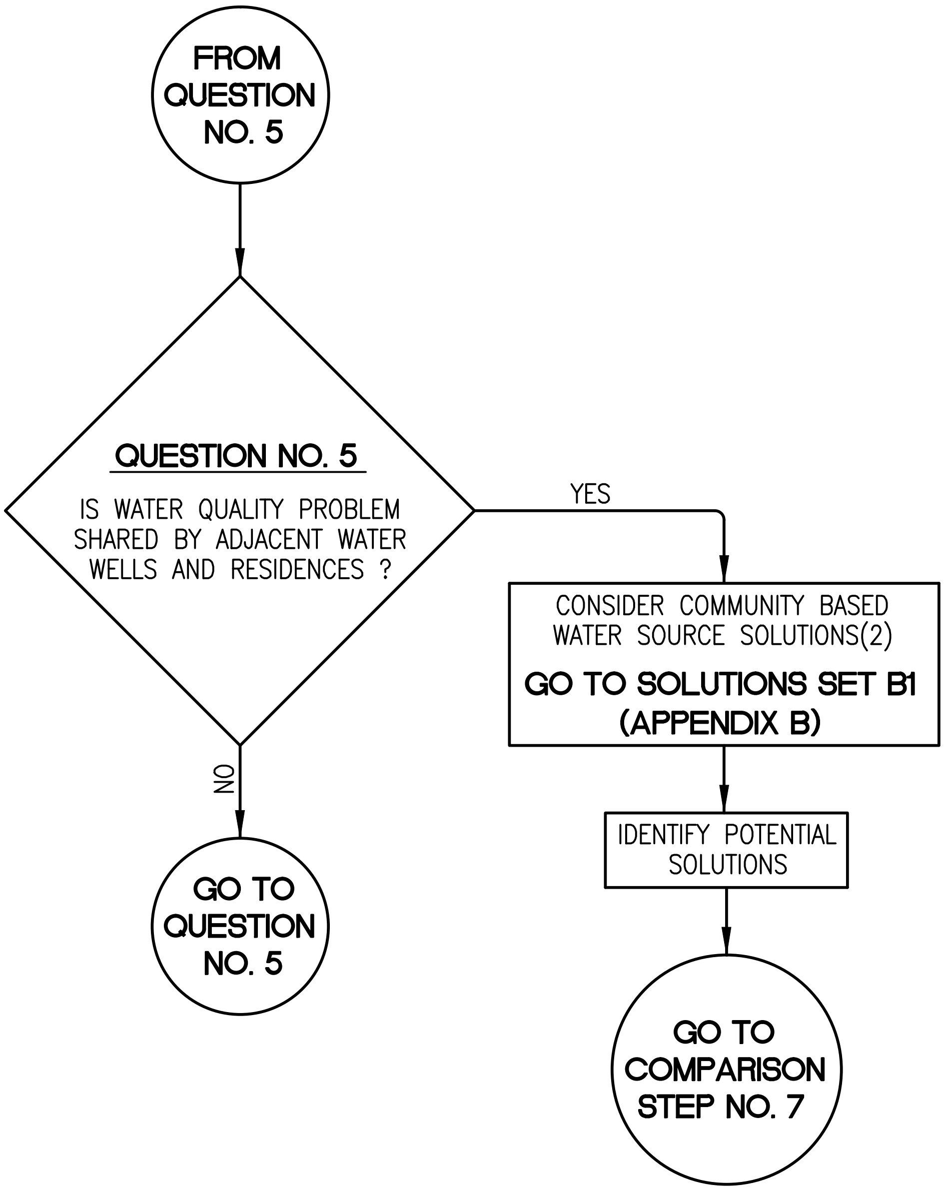
SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(4) GENERAL WATER QUALITY-CHART 2E.Dwg



QUESTION NO. 5

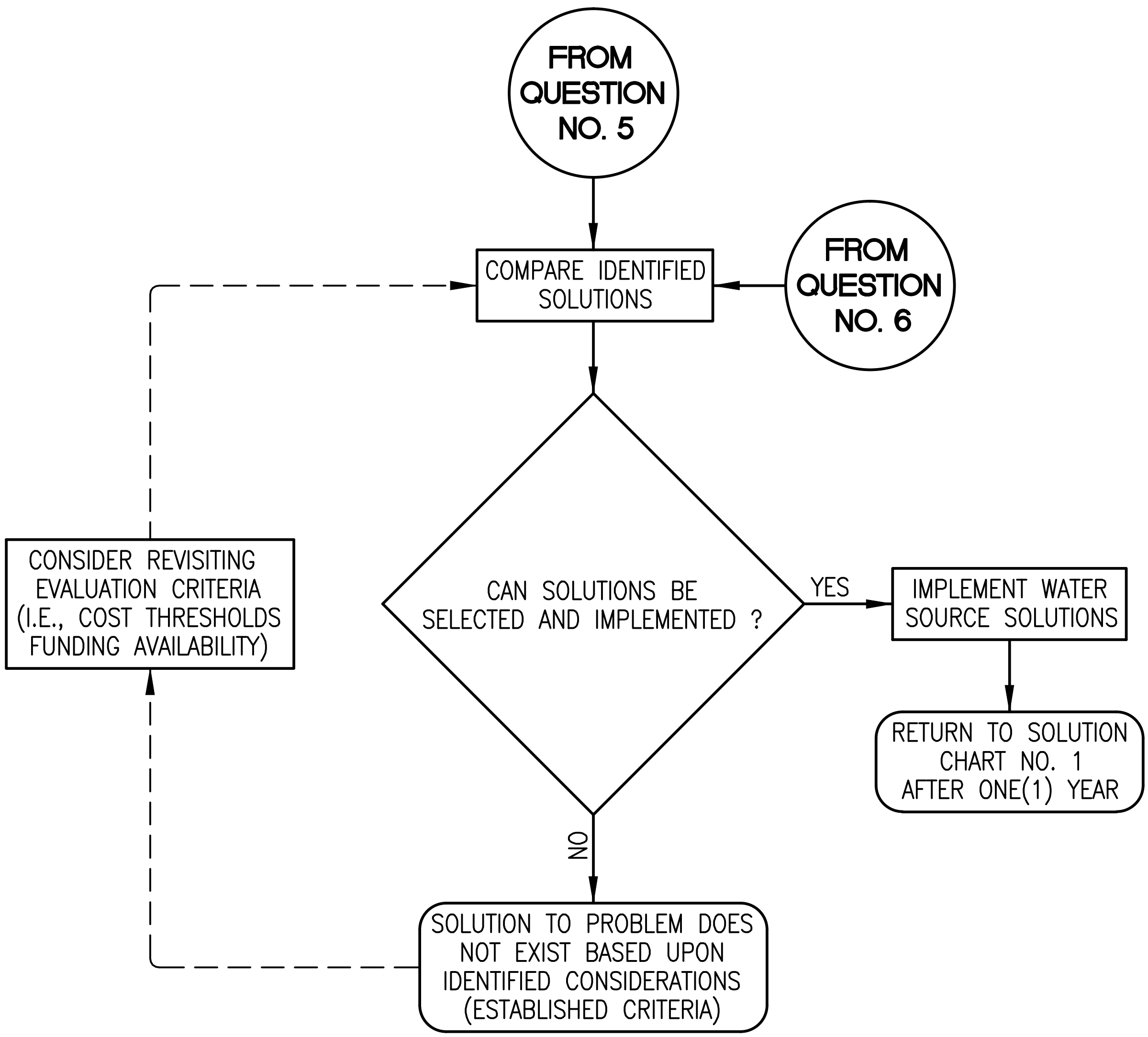
SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



QUESTION NO. 6

SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(6) GENERAL WATER QUALITY-CHART 2E.Dwg



COMPARISON STEP NO. 7

SOLUTION CHART NO. 2E - WATER QUALITY SOLUTIONS - GENERAL WATER QUALITY
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

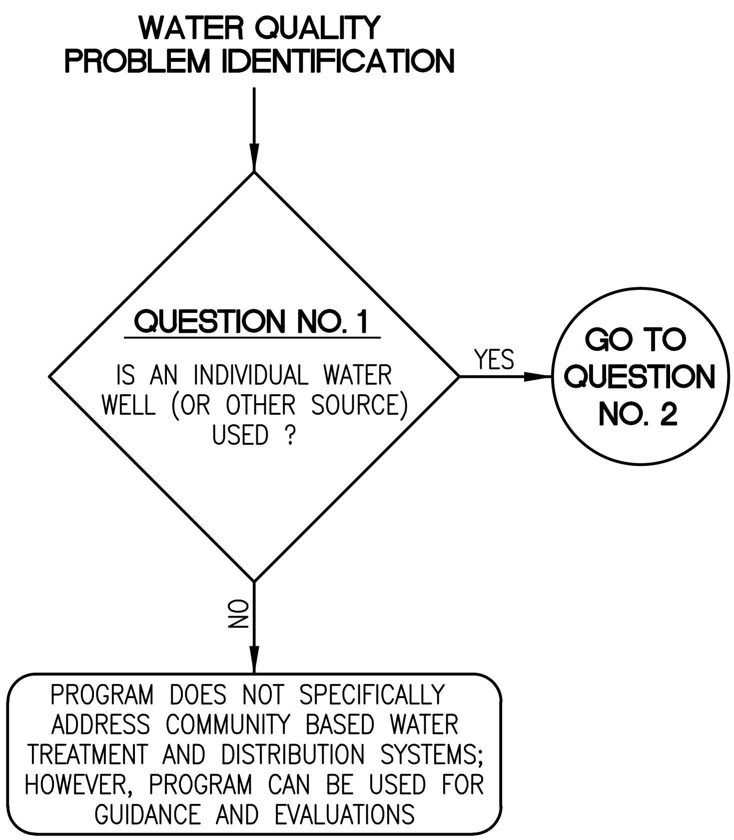
L:\TCDC\(7) GENERAL WATER QUALITY- CHART 2E.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 3 – WATER SUPPLY AND DELIVERY

This series of solution charts is specifically prepared to address problems associated with water supply and delivery conditions.

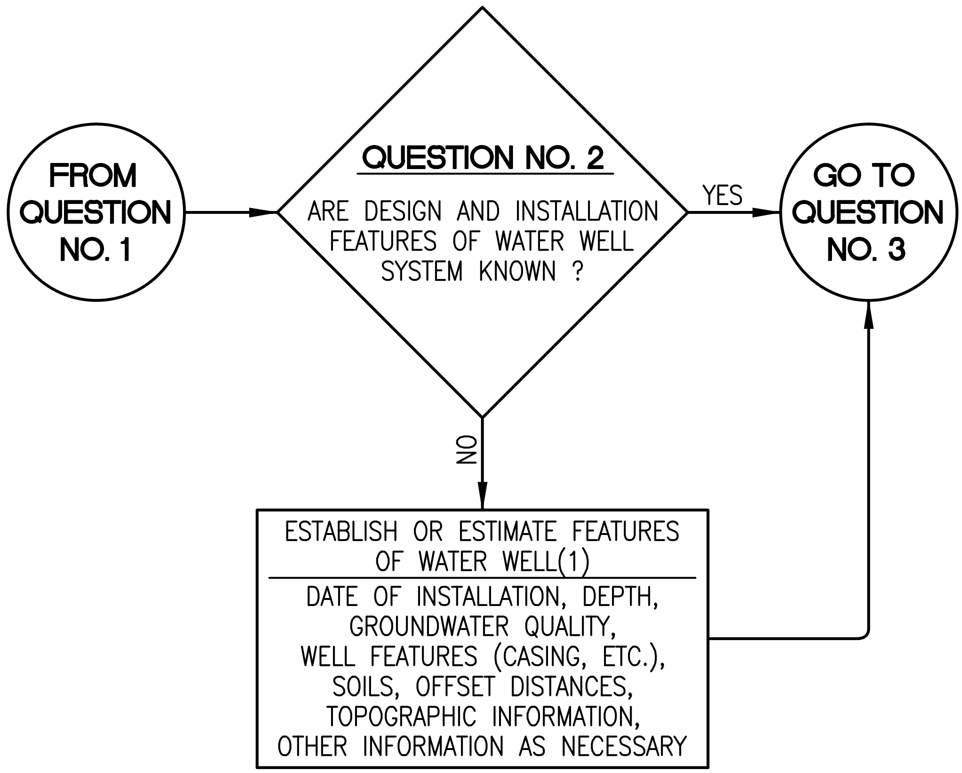
The solution sets referenced in the charts can be found in Appendix B – Solution Sets.



QUESTION NO. 1

SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(1) WATER SUPPLY SOLUTIONS- CHART 3.Dwg

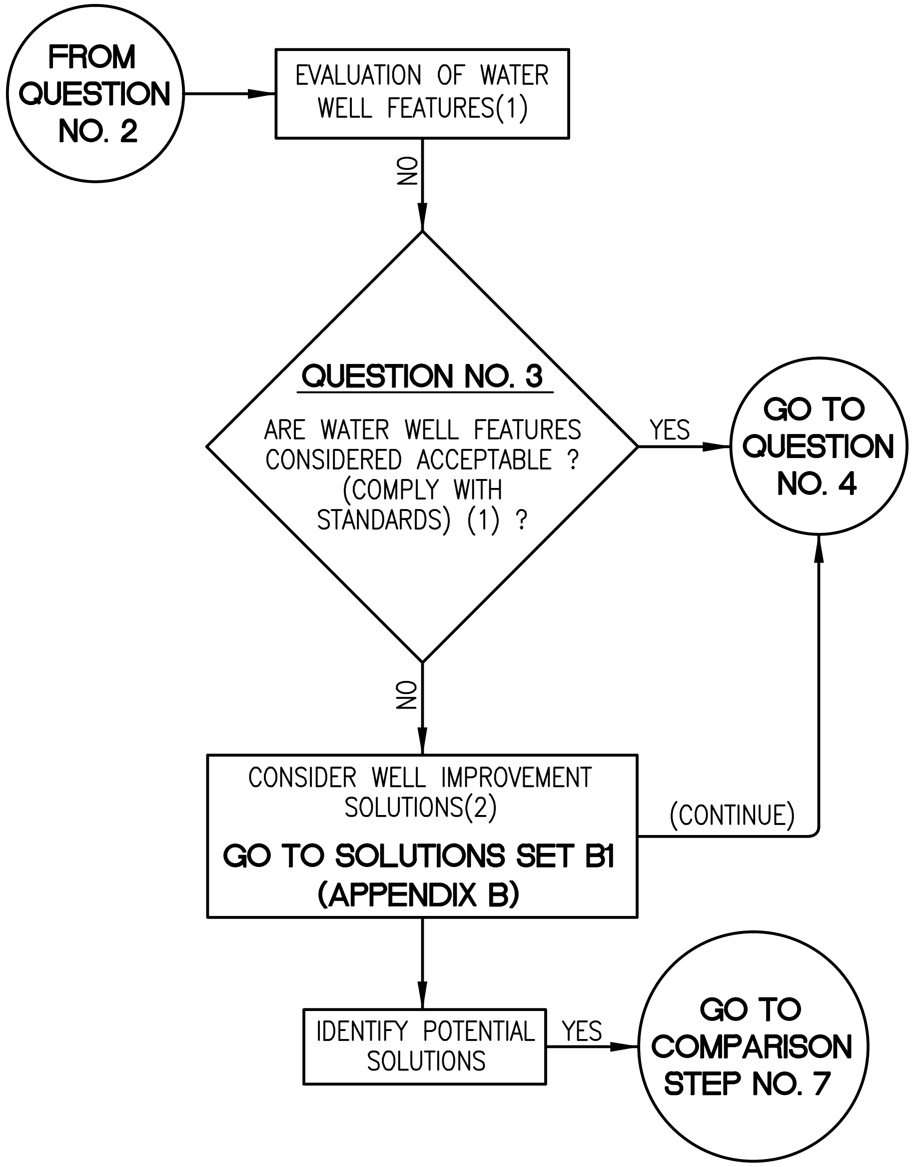


NOTE:
1. EVALUATION SHOULD BE CONDUCTED BY INDIVIDUAL WITH EXPERIENCE IN WATER WELL DESIGN AND INSTALLATION.

QUESTION NO. 2

SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(2) WATER SUPPLY SOLUTIONS- CHART 3.Dwg



NOTES:

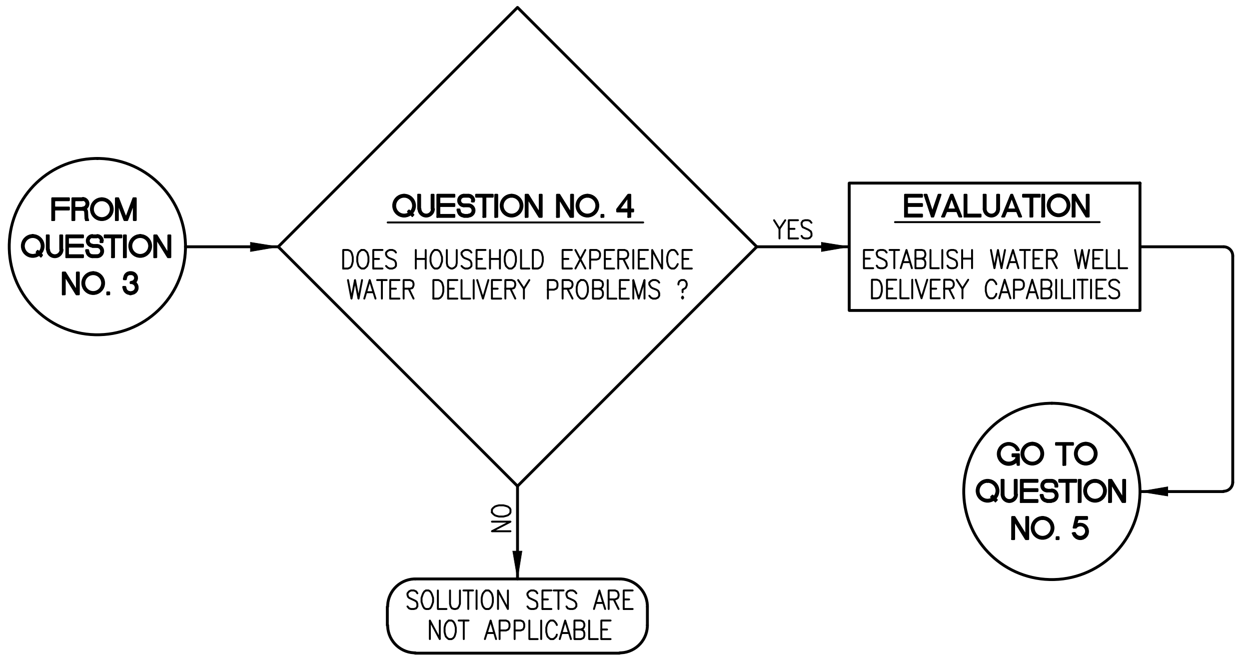
1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN WATER WELL DESIGN, INSTALLATION AND REGULATORY REQUIREMENTS.

2. SOLUTIONS SHOULD BE EVALUATED AND ESTABLISHED BY PERSON(S) EXPERIENCED IN DRINKING WATER TREATMENT. EXAMPLES: DRINKING WATER TREATMENT CONSULTANTS, HEALTH DEPARTMENT REPRESENTATIVES AND WATER TREATMENT EQUIPMENT MANUFACTURERS.

QUESTION NO. 3

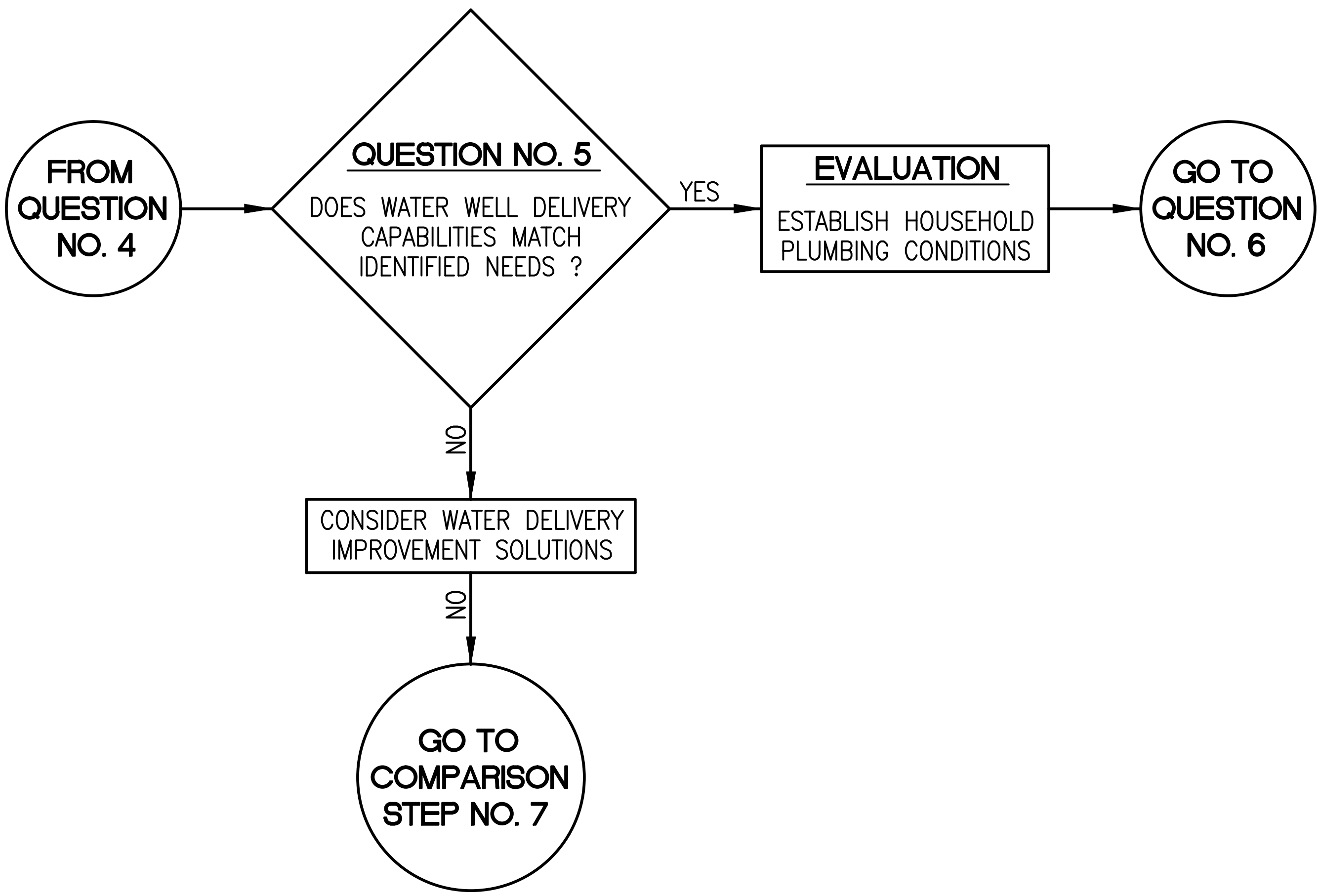
SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(3) WATER SUPPLY SOLUTIONS-CHART 3.Dwg



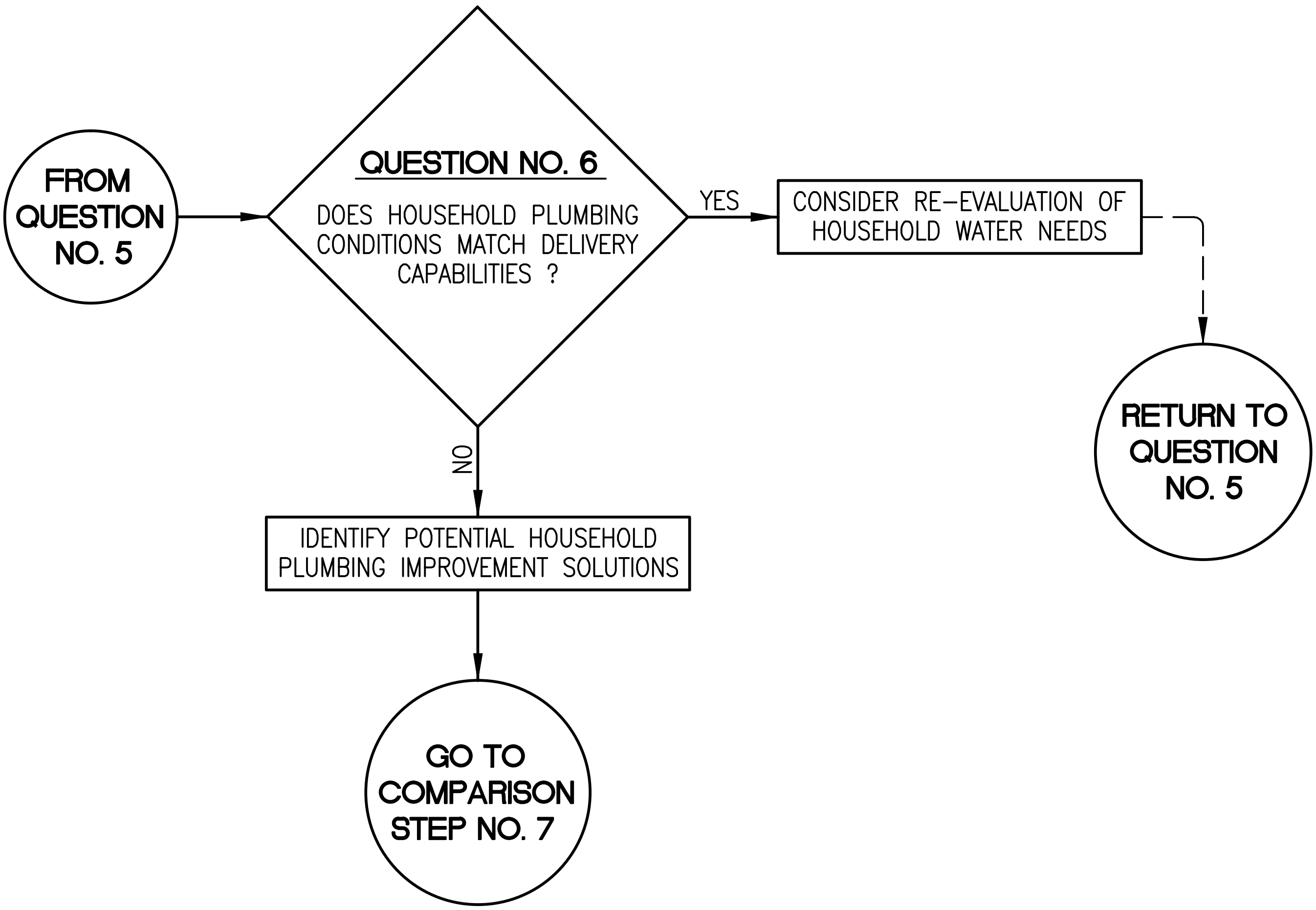
QUESTION NO. 4

SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



QUESTION NO. 5

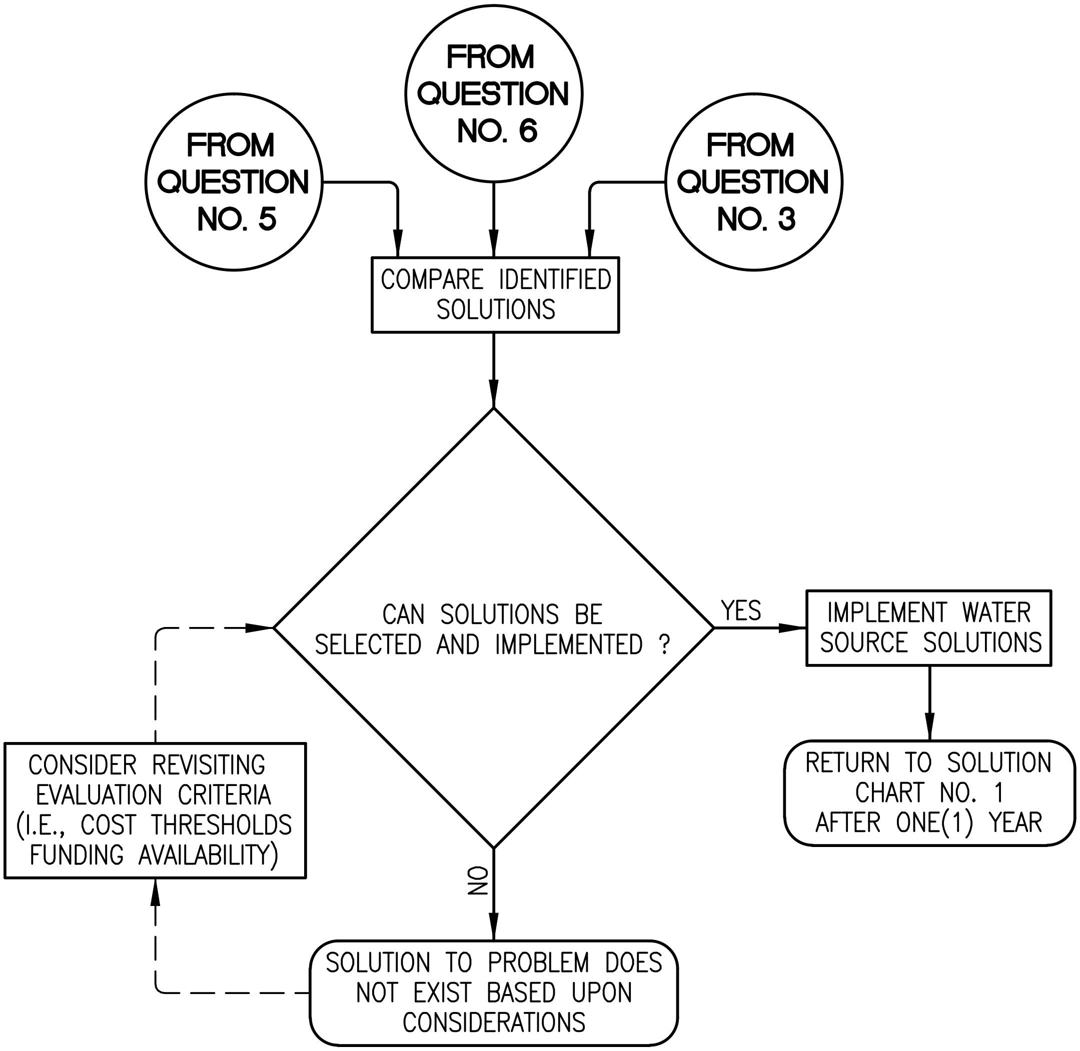
SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY



QUESTION NO. 6

SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(6) WATER SUPPLY SOLUTIONS–CHART 3.Dwg



COMPARISON STEP NO. 7

SOLUTION CHART NO. 3 - WATER SUPPLY SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

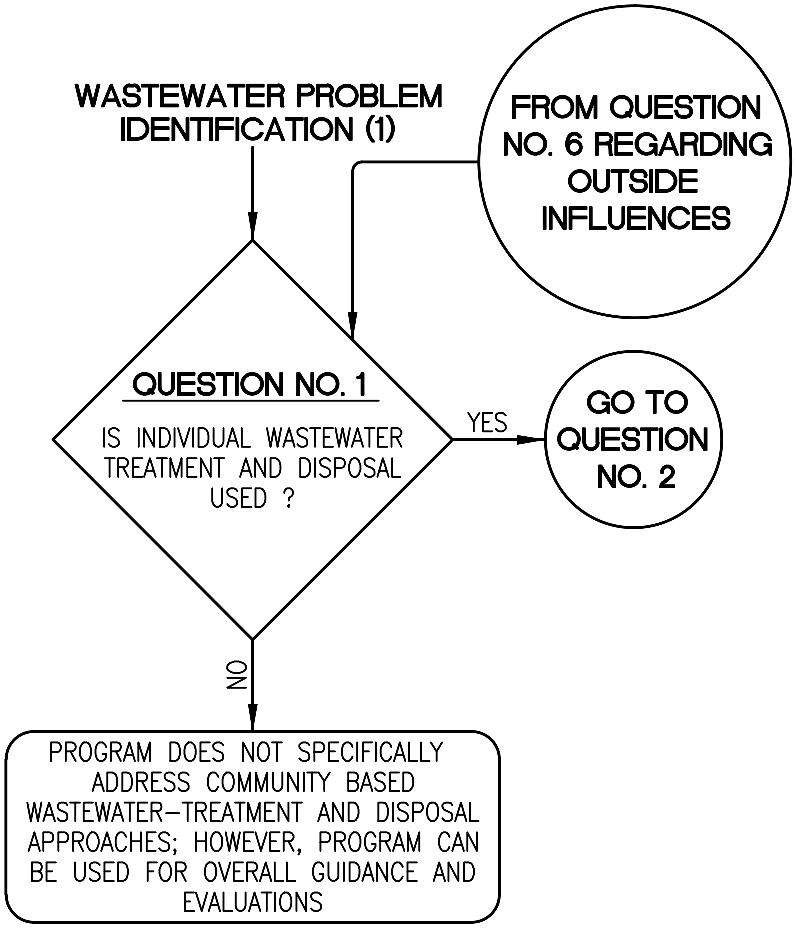
L:\TCDC\(7) WATER SUPPLY SOLUTIONS–CHART 3.Dwg

APPENDIX A – SOLUTION CHARTS

SOLUTION CHART SERIES 4 – WASTEWATER TREATMENT AND DISPOSAL

This series of solution charts is specifically prepared to address problems associated with individual, onsite wastewater treatment and disposal systems.

The solution sets referenced in the charts can be found in Appendix B – Solution Sets.

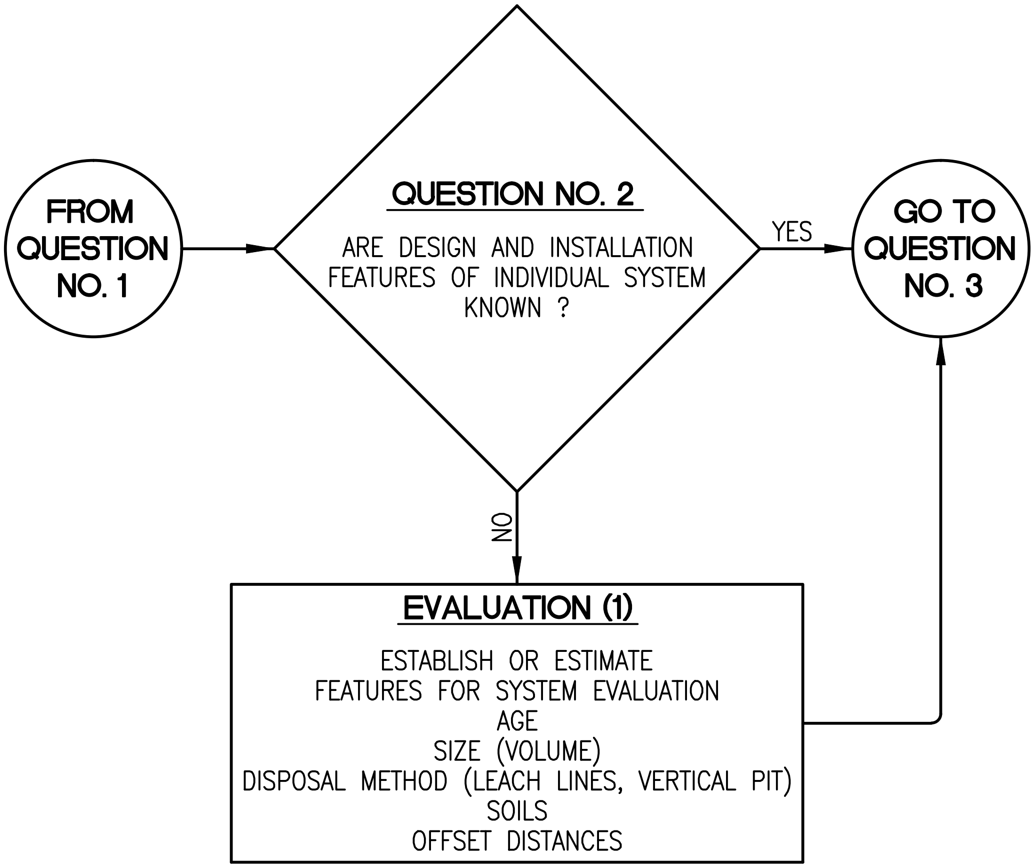


NOTE:
1. THIS SOLUTION CHART ADDRESSES DEFICIENCIES IN INDIVIDUAL WASTEWATER SYSTEMS.

QUESTION NO. 1

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(1) WASTEWATER SOLUTIONS– CHART 4.Dwg



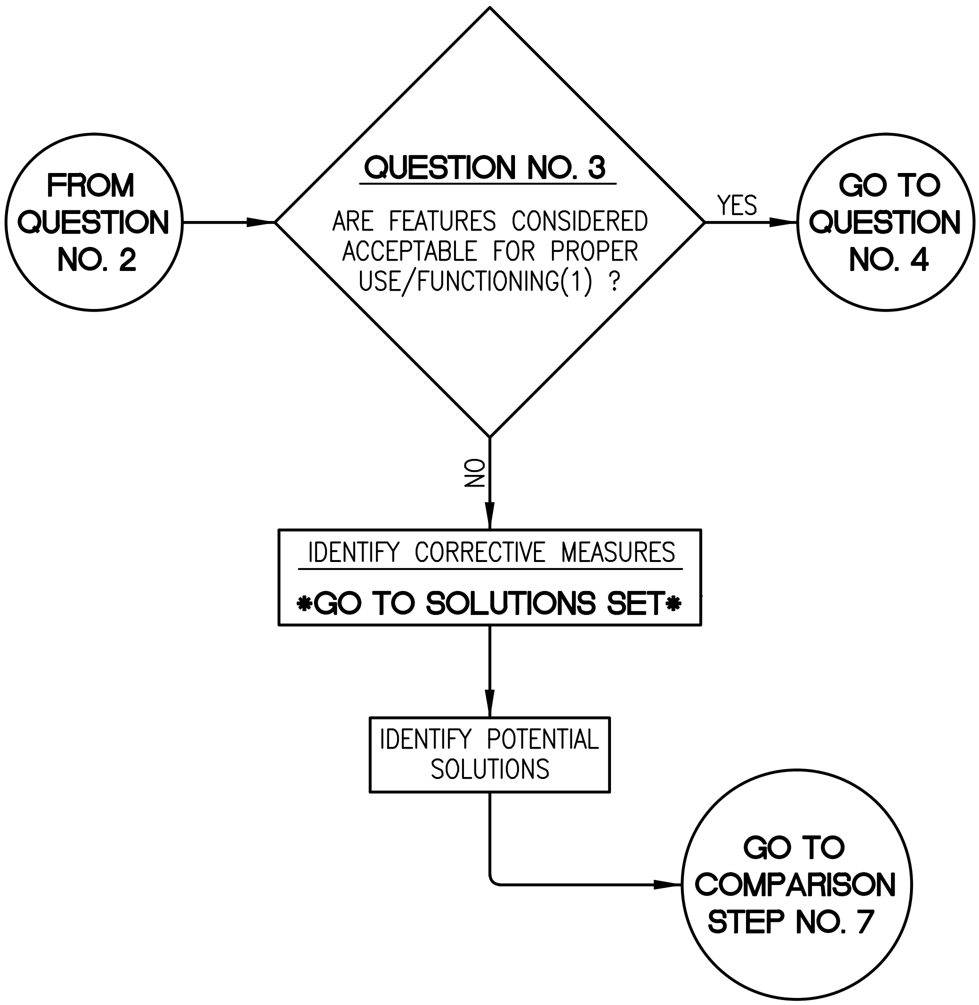
NOTE:

1. EVALUATION SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN ON–SITE WASTEWATER TREATMENT AND DISPOSAL SYSTEM DESIGN AND INSTALLATION.

QUESTION NO. 2

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(2) WASTEWATER SOLUTIONS–CHART 4.Dwg

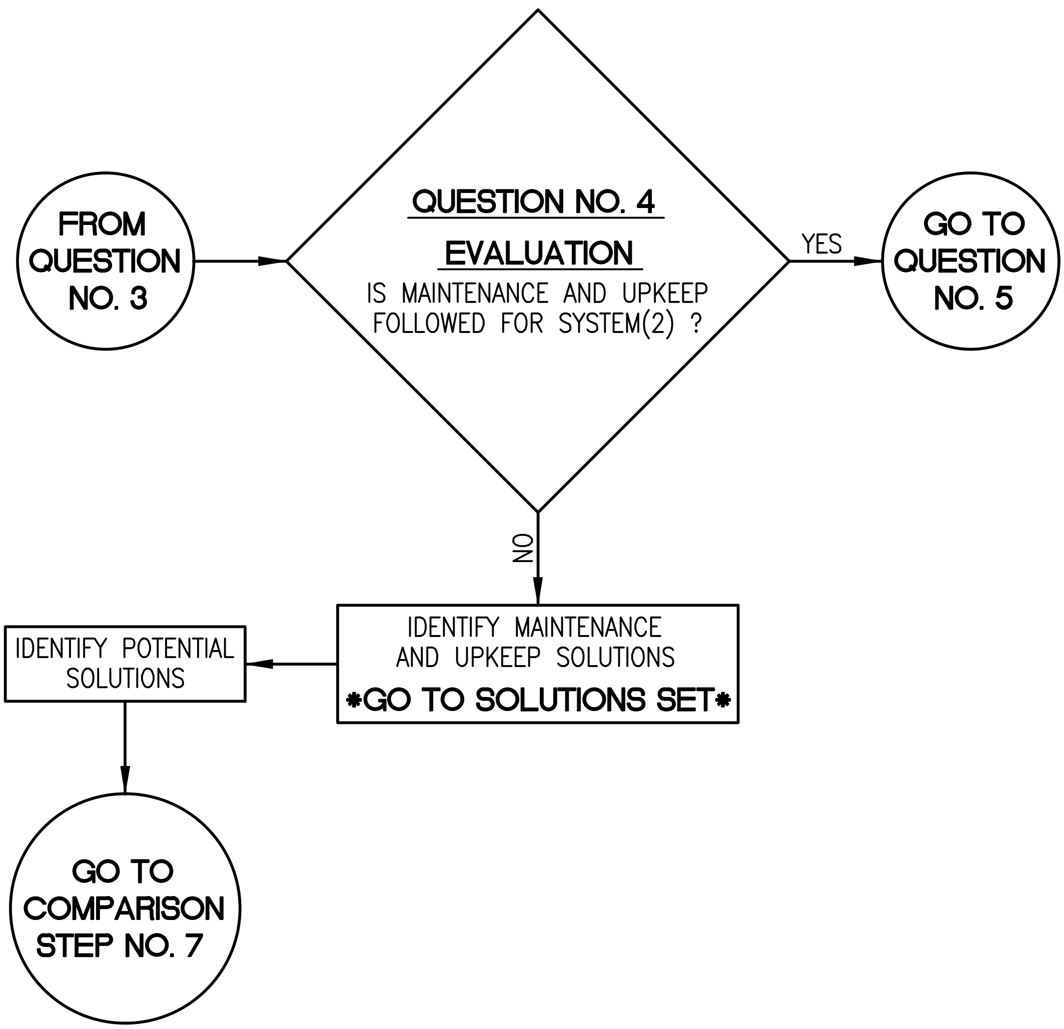


NOTE:
1. INDIVIDUAL SYSTEM EVALUATIONS SHOULD BE CONDUCTED BY PROFESSIONAL WITH EXPERIENCE IN ON-SITE WASTEWATER TREATMENT AND DISPOSAL SYSTEM DESIGN AND INSTALLATION.

QUESTION NO. 3

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

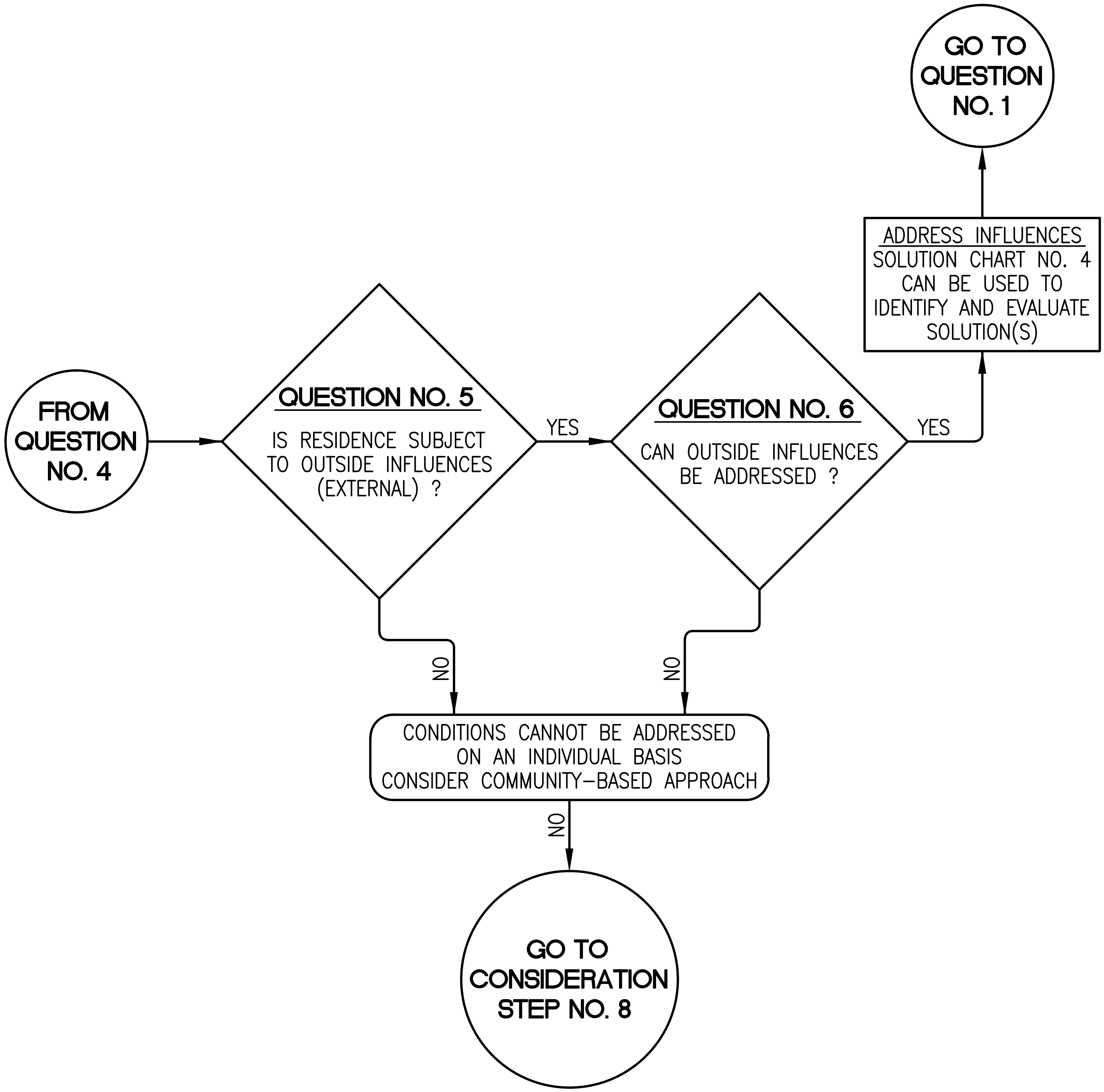
L:\TCDC\(3) WASTEWATER SOLUTIONS-CHART 4.Dwg



QUESTION NO. 4

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

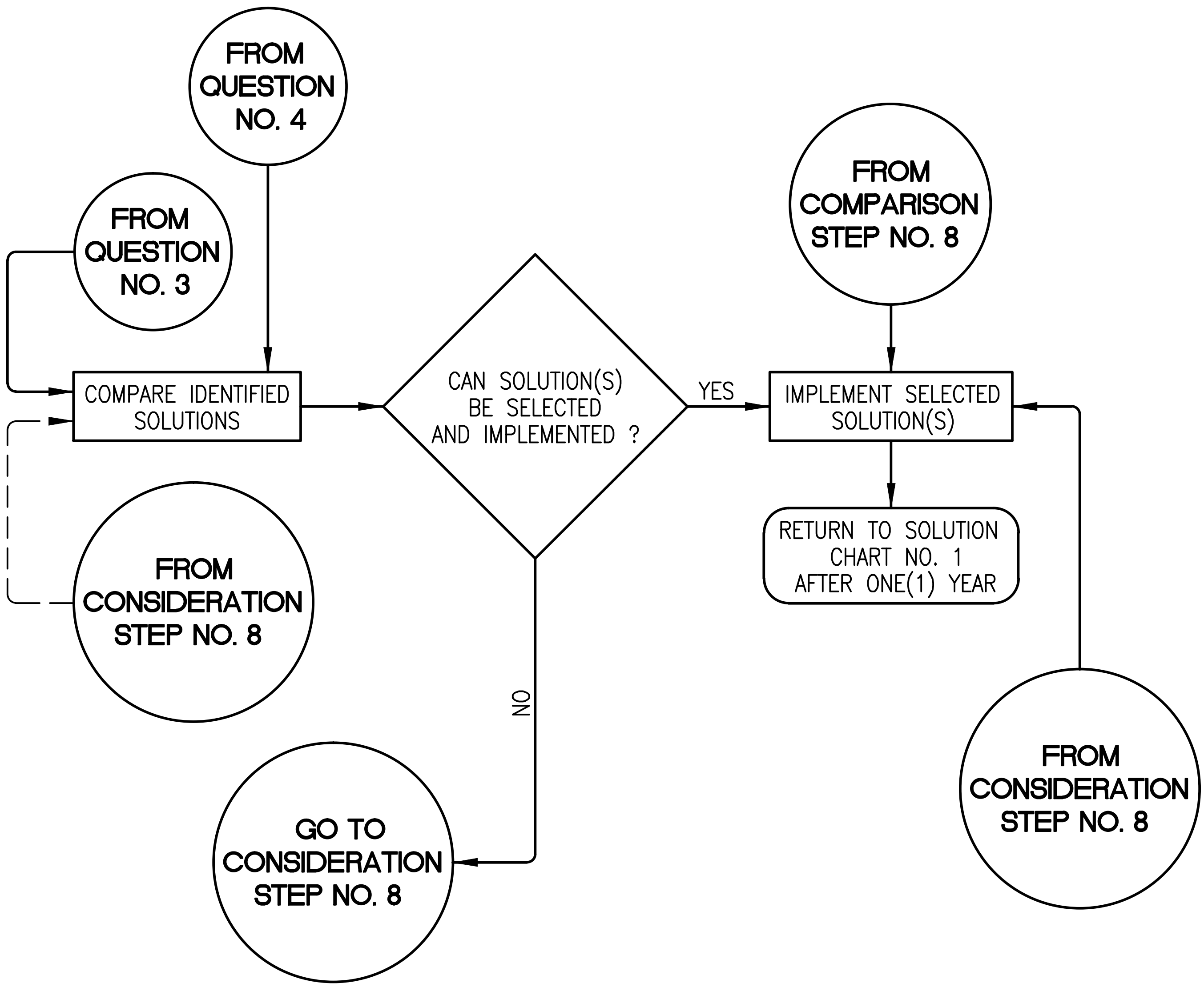
L:\TCDC\(4) WASTEWATER SOLUTIONS-CHART 4.Dwg



QUESTIONS NO. 5 AND NO. 6

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

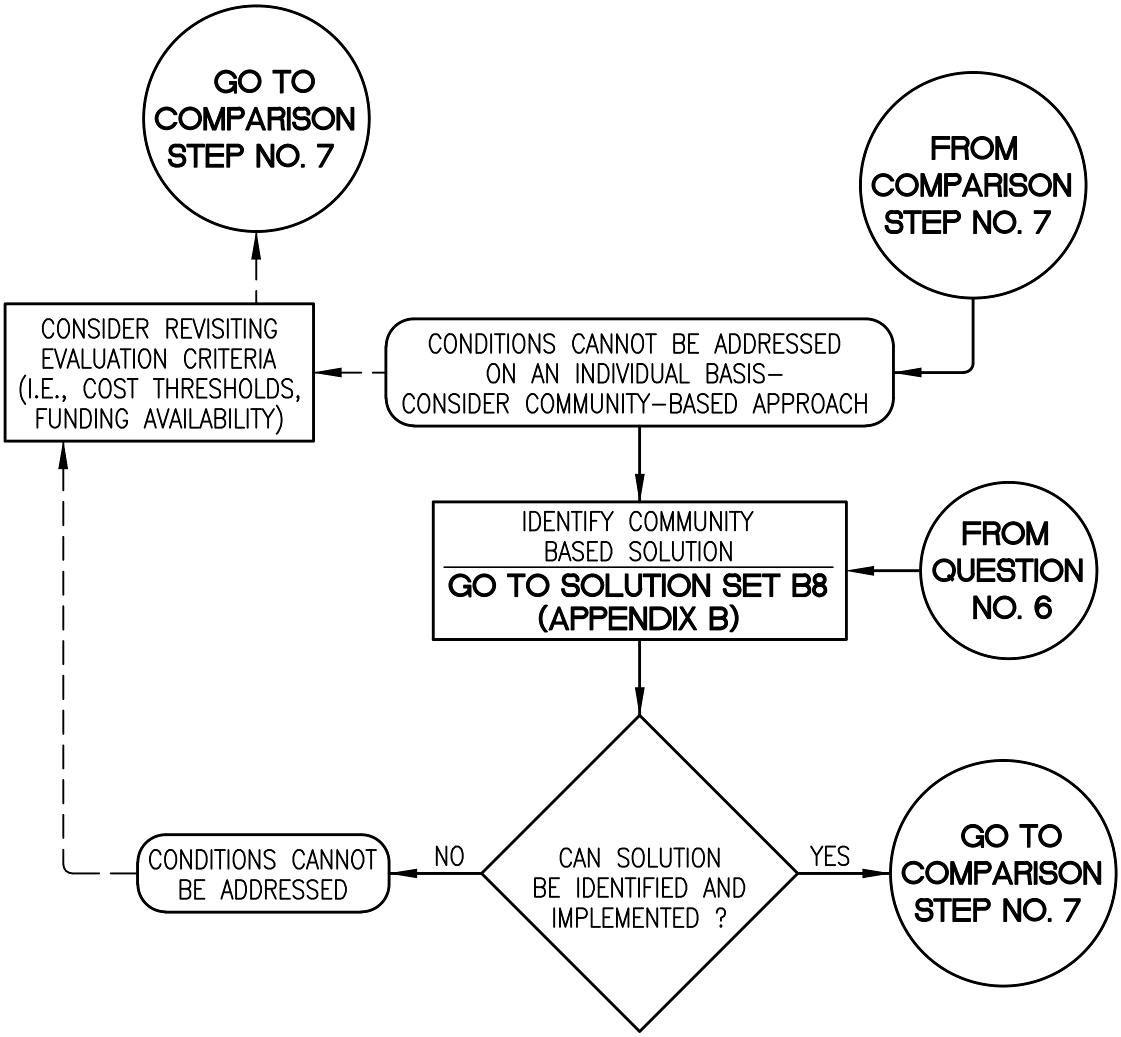
L:\TCDC\(5 AND 6) WASTEWATER SOLUTIONS-CHART 4.Dwg



COMPARISON STEP NO. 7

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(7) WASTEWATER SOLUTIONS-CHART 4.Dwg



CONSIDERATION STEP NO. 8

SOLUTION CHART NO. 4 - WASTEWATER SOLUTIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\(8) WASTEWATER SOLUTIONS–CHART 4.Dwg

APPENDIX B – SOLUTION SETS

APPENDIX B – SOLUTION SETS

B.1. General

The solution sets have been color coded to assist the individual household or renter in locating the appropriate solution. The solution sets are color coded as follows:

- Yellow – Water Quality;
- Blue – Water Supply; and
- Green – Wastewater.

APPENDIX B – SOLUTION SETS

Contents Page

APPENDIX B – SOLUTION SETS

WASTEWATER (GREEN)

APPENDIX B – SOLUTION SETS

B.1 WELL IMPROVEMENT SOLUTIONS

In a rural setting, the domestic groundwater extraction water well represents the typical and primary water supply source for the individual household. Typical features of a groundwater well are shown on Figure B.1-1.

The first step in addressing identified problems associated with a groundwater well is establishing the physical features and construction considerations of the well. Specific well information is needed to determine the appropriate solution(s). Well information can originate from the drilling contractor that installed the well, however, this information may not be readily available due to the circumstances related to the property such as the current owner is not the original owner. A qualified professional and in depth research may be necessary to determine the specific features of the well.

The Well Improvement Solution set addresses problems specific to a groundwater well. Four main categories of solutions exist: disinfection, repairs, modifications and new well construction. These solutions should address problems facing an individual household with a well source problem. Table B.1-1 summarizes the applicability of each solution.

In general, trained professionals and qualified contractors will be required to implement these solutions.

APPENDIX B – SOLUTION SETS

TABLE B.1-1

APPLICABILITY OF WELL IMPROVEMENTS

INDIVIDUAL HOUSEHOLD PILOT STUDY

Solution	Problem/Applicability		
	Water Quality	Water Supply	Wastewater
1. Well disinfection	X (Bacteriological only)	-	-
2. Well Repairs			
a. Sanitary seal	X	-	-
b. Well repairs – casing	-	X	-
3. Well modifications			
a. New wellhead seal (sanitary seal)	X	-	-
b. New casing	-	X	-
c. Deeper well and or casing	X	X	-
d. Strata isolation	X	-	-
e. New pump	-	X	-
4. New domestic well	X	X	Potential to eliminate influence of wastewater system

APPENDIX B – SOLUTION SETS

B.1.1 Well Disinfection

This solution addresses bacteriological (Coliform) contamination of a well. This solution consists of the introduction of a disinfectant, usually chlorine, to the well. This solution can be implemented by professional or by the party responsible for individual household. Basic math skills and limited knowledge of chemistry is needed to ensure that the proper amount of chlorine is utilized. Bacteriological test samples need to be collected and analyzed by a certified analytical laboratory to demonstrate that disinfecting the well achieved its purpose.

B.1.1.A Considerations

Advantages: Implementation is straightforward. The solution can be implemented quickly. Compared to other well improvements, the costs associated with this solution are relatively low.

Disadvantages: Solution may not address causative factor of bacteriological contamination, such as no well sanitary seal. Frequency of solution use may prove prohibitive, if causative factor is not addressed. In addition, the area for disposal of water may be limited.

B.1.1.B Costs

Table B.1-2 summarizes cost considerations related to disinfection.

APPENDIX B – SOLUTION SETS

TABLE B-1.2

SOLUTION COSTS – WELL DISINFECTION

INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes/Considerations
Chemicals	Very Low to Low	Cost dependent on quantity
Pumping	Variable	Pumping required for flushing
Testing	Very Low to Low	Cost dependent on quantity
Operation/Maintenance	None	Solution may need to be repeated, if causative factor is not satisfactorily addressed

B.1.1.C Supplemental Considerations

The use of input from local agencies such as the County health department, qualified community organizations or professional services may be warranted to ensure that a solution is correctly implemented. The use of professional services will increase the cost of this solution. Testing will be required to demonstrate the successful implementation of this solution.

B.1.1.D Useful Information

The following information will be useful when considering this solution:

1. Diameter of well;
2. Depth of well;
3. Depth to standing water;
4. Water level drawdown during pumping (flow);
5. Pump capacity (flow); and
6. Testing laboratory information and protocols.

APPENDIX B – SOLUTION SETS

B.1.2 Well Repairs

This set of solutions addresses items related to groundwater wells that are damaged where those damages are contributing to water quality problems. A sanitary seal is a layer of concrete or other impervious material surrounding the well casing that prevents surface water from getting into the well. A cracked sanitary seal provides an opportunity for well contamination.

Damaged well casing can cause water quality problems, as well as water supply problems. Well casings can become damaged through deterioration from age and/or subsurface changes in soil conditions such as those related to an earthquake. The solutions outlined herein, call for repairs to be made to the damaged portion of the well. In general, well repairs require the services of an experienced contractor.

B.1.2.A Considerations

Advantages: Repairs allow for continued use of a good production well.

Disadvantages: Extensive repairs may not be cost effective or present significant cost savings over facility replacement.

APPENDIX B – SOLUTION SETS

B.1.2.B Costs

TABLE B.1-3
SOLUTION COSTS – WELL REPAIRS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Solution	Cost	Notes
Well head/sanitary seal repair	Low – Moderate	Cost dependent on extent of required repairs
Casing repairs	Moderate – High	Cost dependent on extent of required repairs
Operation/Maintenance	None	Not applicable

B.1.2.C Supplemental Considerations

The implementation of this solution will require the use of properly trained contractors and installers. Individuals or companies under consideration should have the capability to evaluate the existing conditions and provide recommendations and anticipated costs for comparative purposes. This information will establish the feasibility of implementing the solution as compared to other alternatives, such as a new well.

B.1.2.D Useful Information

The following information will be useful when considering this solution:

1. Well drillers log;
2. Well construction plans or details;
3. Date of construction;
4. Well casing details; and
5. Site access conditions.

APPENDIX B – SOLUTION SETS

B.1.3. Well Modifications

Well modifications consist of enhancements or improvements to an existing well. Table B.1-4 summarizes potential well modifications. In general, the party associated with the individual household will have to use trained professionals and contractors to implement any of these solutions.

The primary disadvantage to pursuing well modifications as a solution is that they present moderate to very high cost impacts for the individual household.

B.1.3.A Considerations

Considerations for each type of well modification are summarized in Table B.1-5. In general, modifying an existing well presents its own characteristic specific considerations and challenges.

B.1.3.B Costs

Table B.1-5 summarizes cost considerations. Well modifications result in the expenditure of moderate to very high amounts due to the relative complexity of the modifications. In general, well modifications do not result in increases in annual costs.

B.1.3. C Other Considerations

The potential for well modifications will need to be established by licensed professionals and contractors experienced in well modifications. Detailed investigations,

APPENDIX B – SOLUTION SETS

such as video inspections, may be required to establish the potential for certain modifications.

B.1.3.D Useful Information

The following information will be useful when considering this solution:

1. Well drillers log;
2. Well construction plans or details;
3. Date of construction;
4. Well casing details; and
5. Well site access.

TABLE B.1-4

WELL MODIFICATIONS

INDIVIDUAL HOUSEHOLD PILOT STUDY

New well (sanitary seal)	Existing well may not have a sanitary seal
New casing	Existing well casing may be damaged beyond repair. Well may not use casing. Well casing may be improperly sized for available water flow.
Deeper well casing and/or Pump/motor changes (lower pump)	Water level may have dropped below current pump and/or casing level. Well may be dry and too shallow, but be above good water bearing strata.
Strata separation/Isolation	Well may be drawing from strata with poor water quality
New pump	Existing pump may not be capable of meeting water supply demands and/or conditions.
New pump motor	Existing motor may not be sufficient to allow pump to extract available water supply.

TABLE B.1-5
WELL MODIFICATION CONSIDERATIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Modification	Advantages	Disadvantages	Capital Costs	O&M	Supplemental
New Well Head (Sanitary seal)	Provides protection to groundwater source	None	Moderate	Not Applicable	None
New Casing	Can extend life of well	May be difficult to install	Moderate to High	Not Applicable	Cost dependent on depth and type of casing
Deeper Well Casing or Pump/Motor Changes	Continued use of existing location	Extensive modifications may be necessary	Moderate to Very High	Very Low to Very High	Scope of improvements may be extensive
Strata Separation/ Isolation	Isolate poor water quality	May reduce well yield	Moderate to Very High	Not Applicable	Not typically practiced for individual wells
New Pump/Motor	Can extend well life; new equipment	Pumping requirements may require additional electrical, more power costs	Moderate to High	Very Low to Moderate	Costs dependent on final pumping conditions

APPENDIX B – SOLUTION SETS

B.1.4. New Domestic Well

This solution consists of the drilling and construction of a completely new well. This solution also calls for the abandonment of all existing well features.

For the individual household, many disadvantages exist that render this approach to a last resort as a solution to water quality problems. These disadvantages include the following:

1) Uncertainty of water quality improvement if well cannot be located far enough away from the influence of the existing well;
2) The lot size may prevent the construction of a new well; and
3) The presence of an on-site wastewater disposal system could eliminate potential locations due to separation requirements.

Individual households on large lots may be able to accommodate a new well without experiencing these problems.

A new domestic well will need to be installed by a licensed well drilling contractor. In some areas, a professional hydrogeologist may be necessary to establish the necessary depth and casing characteristics of the well to ensure good water quality. Proper documentation, such as permits and drillers reports needs to be completed.

This solution represents; notwithstanding the drawback of expense, a comprehensive solution that potentially can be used to address both water quality and

APPENDIX B – SOLUTION SETS

water quantity problems. This solution does represent the most costly initial approach to the individual household quality problem.

B.1.4.A Considerations

Advantages: Provides opportunity to address all well-related issues (water quality and supply).

Disadvantages: Highest initial capital cost solution.

New location may not be available.

Deeper well may be cost prohibitive due to pumping costs.

New well may eventually experience same problems (i.e., nitrates).

B.1.4.B Costs

TABLE B.1-6
SOLUTION COSTS – NEW WELL
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
New well	High – Very High	
New pump and motor	Moderate – Very High	Cost dependent on final pumping conditions
Operation/Maintenance	Very Low – Moderate	Annual cost will have additional cost to existing O&M cost if pumping level is deeper.

APPENDIX B – SOLUTION SETS

B.1.4.C Supplemental Considerations

The implementation of this solution will require the use of licensed contractors (well drillers). Additional professionals may be necessary to facilitate the proper design and location of the well. Permitting in accordance with local agency requirements will also need to be accomplished.

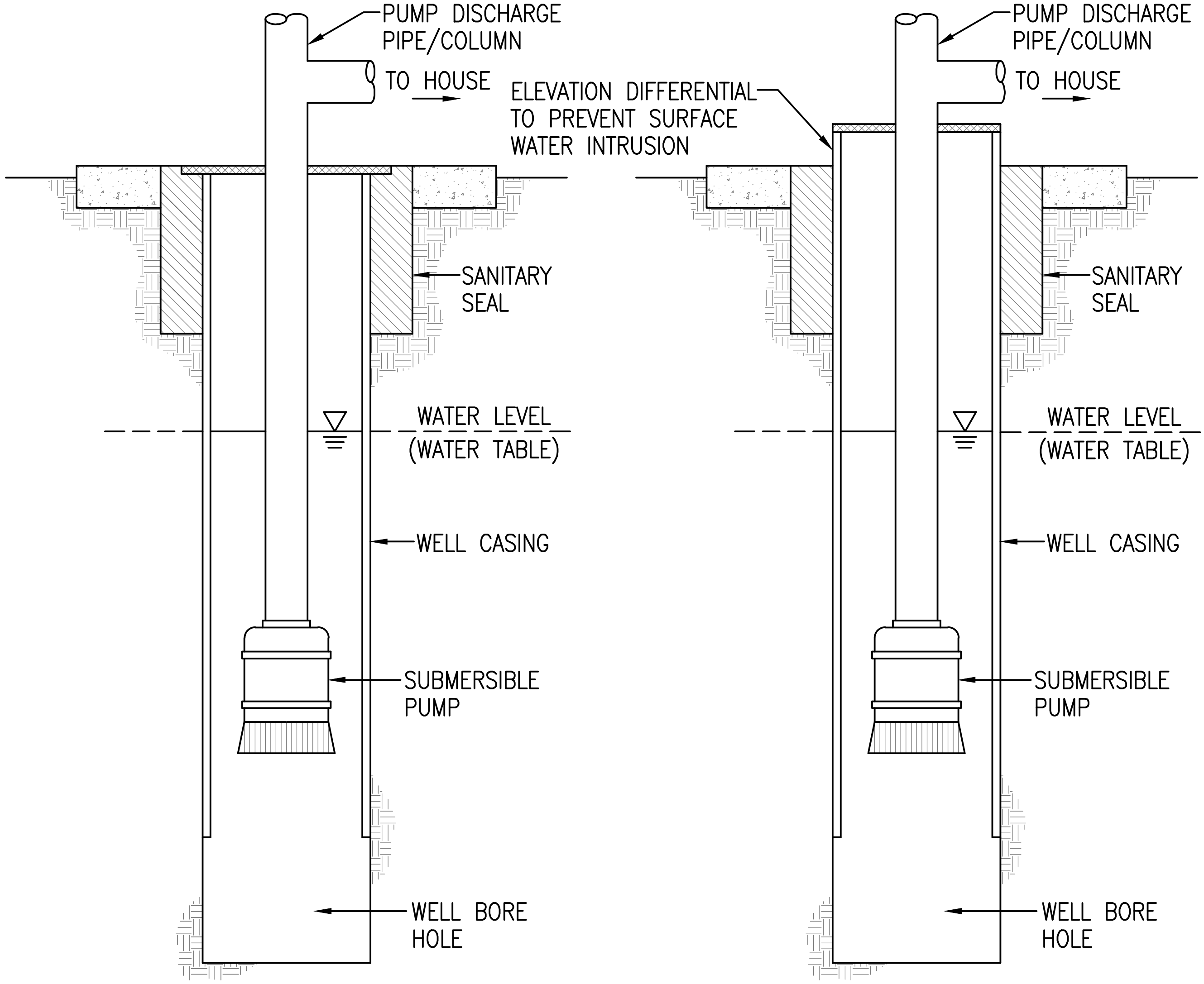
Any licensed contractor and professional under consideration should have the capability to provide recommendations and expected costs associated with a new well. This information can be used for comparison with other alternatives.

B.1.4 Useful Information

The following information will be useful when considering this solution:

1. Existing well drillers log(s) if available;
2. Water quality data related to previous and or existing wells;
3. Well construction information for nearby wells;
4. Locations of wastewater treatment and disposal systems;
5. Water demands (needs); and
6. Available site(s).

FIGURE B.1-1



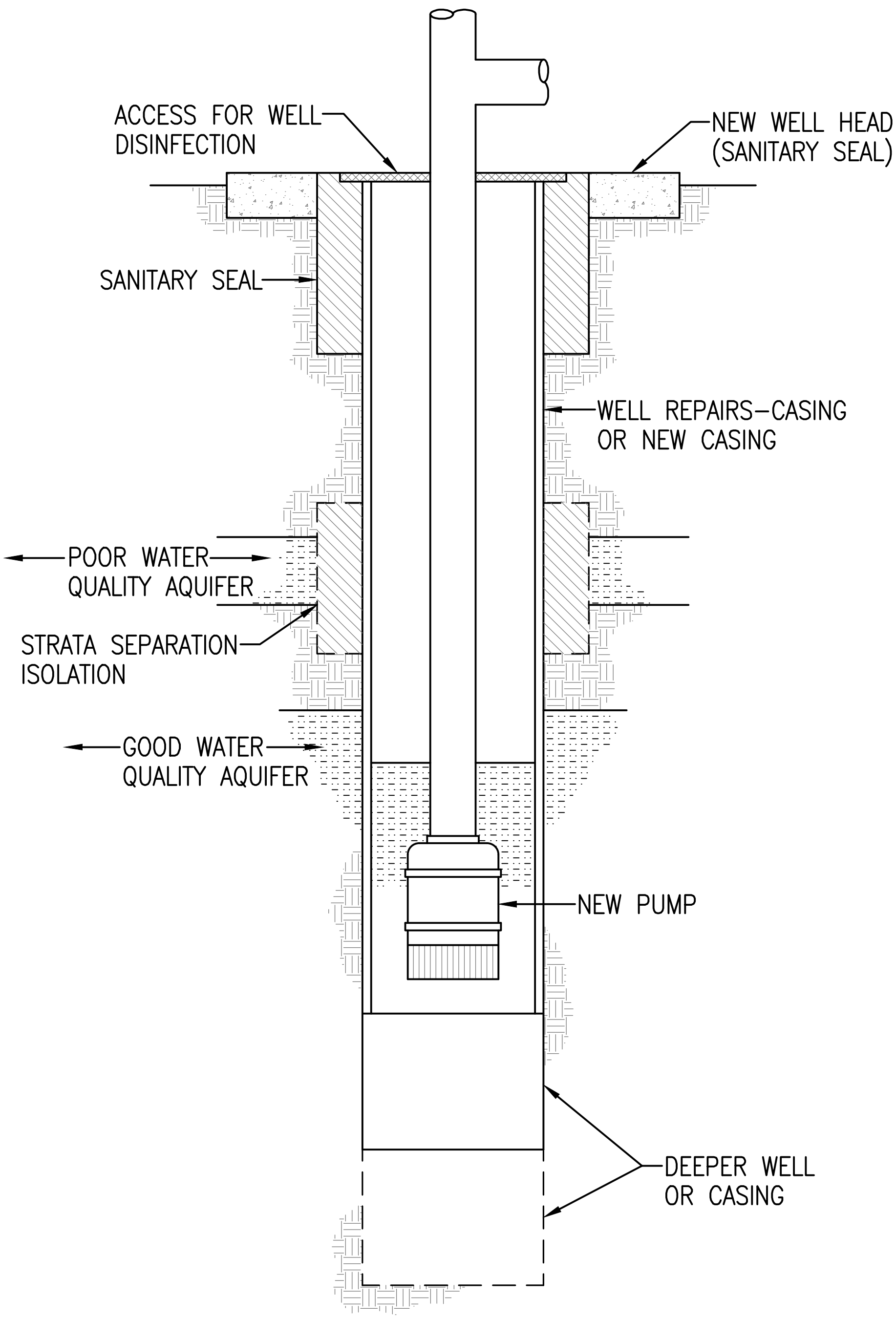
TYPICAL DOMESTIC (HOUSEHOLD) WELL CONFIGURATION

INDIVIDUAL HOUSEHOLD PILOT STUDY

TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\TYPICAL WELL SECTION (6-13-13).Dwg

KELLER/WEGLEY



WELL MODIFICATION TYPES
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\TYPICAL WELL SOLUTION (6-13-13).Dwg

APPENDIX B – SOLUTION SETS

B.2 WATER QUALITY SOLUTIONS

The Water Quality Solution set addresses problems associated with groundwater water quality parameters.

Table 2-1 summarized the types of water quality problems addressed by this Pilot Study. Potential solutions to water quality problems can be placed into three (3) general categories:

1) Existing source options;
2) Treatment options; and
3) New source options.

Existing source options look to address the causative factors of the water quality problem. The party associated with an individual household may be able to make improvement or repairs to the domestic well or its surroundings that result in the improvement of water quality. For example, a new sanitary seal for the well may address the issue of bacteriological contamination.

Treatment options are available for water sources which have well established water quality problems that cannot be addressed by other means.

New source options address a new water supply providing an acceptable drinking water supply. A new water supply can be provided through dedicated access to a bottled water supply or the construction of a new well.

APPENDIX B – SOLUTION SETS

B.2.1 Existing Source Options

An on-site evaluation of existing conditions at and around a well can assist in identifying potential sources of water quality problems. The evaluation includes assessing the condition of the well head and the proximity of contaminating activities, such as leach fields, agricultural practices materials storage and commercial activities.

This solution set for water quality problems present approaches that can result in improvements to water quality for the existing water supply. These types of solutions aim to address the source of the water quality problem. In general, the potential solutions will originate from evaluations of the existing water source, such as from a groundwater well and potential contamination sources, such as from septic tank and related disposal systems.

Examples of these types of improvements include:

1) Well improvements, such as:
    a) A deeper well,
    b) Casing improvements (strata isolation);
    c) Well head improvements; and
2) Wastewater system improvements, such as:
    a) New septic tank and disposal system (including a relocated system); and
    b) Connection to a subdivision or community-based system.

APPENDIX B – SOLUTION SETS

B.2.1.A Well Improvements

Well improvement solutions consist of actions that address water quality problems resulting from deficiencies related to the well. Causes of water quality problems include: well drawing from poor quality aquifer or poor well head conditions, such as no surface sanitary seal. Specific details and considerations regarding well improvements are discussed in Section B.1 – Well Improvements.

B.2.1.B Wastewater System Improvements

Wastewater system solutions consist of improvements that address on-site wastewater system deficiencies that may be contributing to water quality problems in the drinking water source. Poor operational procedures and inadequate separation represent typical problems that could impact the drinking water source. Specific details and considerations regarding wastewater system improvements are discussed in Section 3.6 – Individual Wastewater System Improvements.

B.2.1.C Supplemental Considerations

Well improvements and wastewater system improvements represent the most common solutions. Other solutions exist, however, these solutions will be less common. These types of solutions may be evident following the inventory of potential contaminating sources. For example, the cessation of washing out of spray rigs used for agricultural practices adjacent to a well may reduce the presence of pesticides in a groundwater well.

APPENDIX B – SOLUTION SETS

B.2.2 Treatment Options

Treatment options represent solutions to water quality problems that cannot be corrected by changes/improvements at the water source. Examples of this type of water quality situation include:

- Nitrates;
- Arsenic; and
- DBCP (1,2-Dibromo-3-chloropropane).

Water treatment processes that remove the contaminant enable the individual household to continue to be served utilizing its existing well. For the individual household, two (2) types of water treatment units are available: point of use (POU) and point of entry (POE).

Treatment Technologies

There exists several technologies for POU and POE units. The two most prominent types of devices are ion exchange (IX) and reverse osmosis (RO).

IX units utilize a resin media that is specifically selected to remove the targeted contaminant. After a certain amount of water has been treated, the resin loses its capacity to remove the contaminant. The spent resin can be replaced with a new cartridge or the resin can be recharged using a suitable cleaning solution, depending on the IX unit design. A typical IX POU installation is shown on Figure B.2-1

APPENDIX B – SOLUTION SETS

RO units utilize membrane cartridges that are operated under high pressure to filter out the constituents in the water. Once the membranes become clogged, the RO unit must be cleaned. RO units typically utilize a salt-based (brine) cleaning solution. A typical RO POU installation is shown on Figure B.2-2.

It should be noted that all water treatment devices must be certified and approved by the California Department of Health Services before they can be marketed for use in California.

B.2.2.A Considerations

A POU unit treats water for consumptive use only. A POU unit is located at a designated use location such as a kitchen sink. The unit is attached to the plumbing at the sink, usually underneath. The POU unit typically utilizes a separate, dedicated faucet to deliver treated water.

Advantages:

- Smaller unit is normally associated with lower costs; and
- Smaller quantity of residuals is generated for disposal.

Disadvantages:

- Provides water for single location (sink) only;
- Unit capacity sized for consumption use (typically small water volume); and
- Multiple units would be required for multiple locations.

A POE unit is installed on the water supply line to the house and treats all of the water used in the household. Sinks, showers, toilets, water heater, dishwasher and

APPENDIX B – SOLUTION SETS

clothes washer would all use water that has been treated by the POE unit. A POE unit may be referred to as a "whole-house" water system.

Advantages:	Eliminates concerns regarding exposure to contaminants through exposure, such as while taking a shower.
Disadvantages:	Larger unit is normally associated with higher costs; and Larger amount of residuals are generated for disposal.

B.2.2.B Costs

Costs for specific POU and POE units can be kept relatively competitive, due to competition created in the consumer marketplace. This situation will provide the individual household the opportunity to minimize cost. In general, POU and POE device use will present the cost considerations outlined in Table B.2-1.

TABLE B.2-1
SOLUTION COSTS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
Capital cost (Equipment, etc.)	Low – Moderate	Cost dependent on equipment size; competitive marketplace
Annual cost (material replacement, pumping, etc.)	Low – Moderate	Cost dependent on replacement frequency. Increased pumping may occur due to recovery rates. Some units may require additional electrical power such as for UV disinfection systems.

APPENDIX B – SOLUTION SETS

B.2.2.C Supplemental Considerations

Water Pressure. POU and POE units typically have minimum operating pressures for proper operation. An operating pressure of 20 to 40 psi should be anticipated. Upgrades to the existing individual household water system may be necessary to meet POU and POE device pressure requirements.

Water Storage. In general, POU and POE units utilize additional tanks for water storage to deliver water during unit operation and to reduce the size of the installed device.

Water Recovery. Water recovery refers to the percentage of water produced when compared to the total amount of water used in the production and backwash processes. Water recovery rates range widely between 20 percent to 95 percent. Actual water recovery rate information will need to be obtained from individual equipment manufacturers. The actual water recovery rate is an important consideration since it demonstrates the actual amount of water produced for use for the total available and gives indication of the disposal requirements for the generated backwash.

Waste Stream/Residuals. POU and POE units will generate a waste stream from the regeneration or backwash cycle which is started when the units' treatment capacity is used up. IX processes typically utilize a regeneration process with a salt water (brine) solution that may prove detrimental to on-site wastewater systems and receiving groundwater quality. Some IX processes utilize exchangeable cartridges that can be

APPENDIX B – SOLUTION SETS

thrown away or exchanged, if residual concentrations meet standard disposal limits. Otherwise, special disposal handling or recycling is required.

RO processes present similar backwash water management considerations. It should be noted that backwash water from RO processes will contain higher concentrations of constituents, including the target constituent.

Cartridge Life: The replacement of IX cartridges and RO membranes will vary depending on the concentration of the target contaminant and other non-target materials. In general, replacement is driven by the number of gallons of water treated through the cartridge. The cartridge life will need to be estimated once the installation considerations have been established.

Limitations: All water treatment devices must be certified and approved by the California Department of Public Health before they can be marketed for use in California. Water treatment technologies are continuously evolving and the certification list changes regularly. CDPH maintains lists of certified treatment devices at:

www.cdph.ca.gov/certlic/device/Pages/watertreatmentdevices.aspx

CDPH maintains lists for treatment devices that address the following contaminants:

- Arsenic;
- Cysts;
- Fluoride;
- Hexavalent Chromium;
- Lead;
- Microbiological Treatment;

APPENDIX B – SOLUTION SETS

- MTBE;
- Nitrates;
- Perchlorate;
- Radium 226/Radium 228; and
- Volatile Organic Compounds.

Table B.2-2 pairs these parameters to the solution sets prepared for this Pilot Study.

APPENDIX B – SOLUTION SETS

TABLE B.2-2

TREATMENT DEVICES AND PARAMETERS

INDIVIDUAL HOUSEHOLD PILOT STUDY

Solution Set Target	Treatment	Target Constituents(s)
Nutrients	Reverse Osmosis; Ion Exchange	Nitrates
Bacteriological	Reverse Osmosis; Filter Cartridge UV unit	Cysts Microbiological Treatment
Inorganics	Reverse Osmosis; Ion Exchange	Arsenic Fluoride Hexavalent Chromium Lead Radium 226/Radium 228
Organics	Reverse Osmosis	MTBE Perchlorate Volatile Organic Compounds
General water quality	Reverse Osmosis; Ion Exchange; Granulated Activated Carbon (charcoal) Filter Cartridge	Taste Hardness Chlorine residuals

Note: CDPH does not certify devices that address aesthetic conditions such as taste, odor and color.

APPENDIX B – SOLUTION SETS

B.2.3 New Source Options

This group of solutions is structured toward offering the party associated with the individual household a source of domestic water supply as an alternative to upgrading the physical well source or treating existing supplies. Two (2) options exist within this set of solutions. The first is a nonstructural solution, such as bottled water and the second, a structural solution, such as a new well.

Non-Structural Solutions

Non-structural solutions offer options for the party associated with the individual household that do not result in tangible, fixed improvements that address water quality problems. These solutions are coupled, however, with ongoing costs. These solutions consist of various bottled water arrangements, including bottled water delivery or centralized bottled water distribution. Non-structural solutions in this case, provide water for consumptive use only.

Centralized bottled water distribution is an option to delivery of bottled water to the individual household. With this solution, bottled water is obtained at a centralized location. The party associated with the individual household would be required to travel to the location of distribution to obtain the bottled water.

Bottled water delivery provides an individual household with a supply of water for consumption purposes. The water is delivered to the household. Typically, water

APPENDIX B – SOLUTION SETS

delivery is scheduled by the household and the billing (cost) is associated with the amount of water delivered.

B.2.3.A Considerations

A summary of the consideration of advantages and disadvantages regarding non-structural solutions can be found in Table B.2-3.

B.2.3.B Costs

Table B.2-4 summarizes cost information related to the non-structural solutions.

B.2.3.C Supplemental Considerations

Use of centralized distribution centers could present additional obstacles, such as inability of some individuals to reach a distribution center possibly due to lack of transportation or physical impairment.

Structural Solutions

Structural solutions consist of options that permanently address water quality problems by eliminating the use of poor water quality sources. These options include a new individual well, a new well serving multiple individual households and consolidation into or extension of service from a community water system.

In general, structural solutions are based upon infrastructure developed to address other water quality problems. Specific features associated with specific structural solutions are as follows:

1) New individual well: B.1 – Well Improvements (B.1.4)

APPENDIX B – SOLUTION SETS

2) New multi-households well: B.3 – Community-Based Water Source Solutions (B.3.3)

3) Consolidation/Interties: B.3 – Community-Based Water Source Solutions (B.3A)

Relative costs and supplemental considerations can be found with each solution set.

TABLE B.2-3

NON-STRUCTURAL SOLUTION CONSIDERATIONS

INDIVIDUAL HOUSEHOLD PILOT STUDY

SOLUTION	ADVANTAGES	DISADVANTAGES
Bottled water distribution	Relatively low cost implementation Can be implemented in short time frame	Addresses water for consumption only Does not address VOC's that may be released in showers Represents an ongoing cost (monthly and annually) Could be subject to delivery limitations
Bottled water delivery	Short implementation schedule Water delivered to household No significant up front (capital) cost	Provides water for consumptive use only Constrained to delivery schedule and availability (vendor) Service can be tied to delivery contract

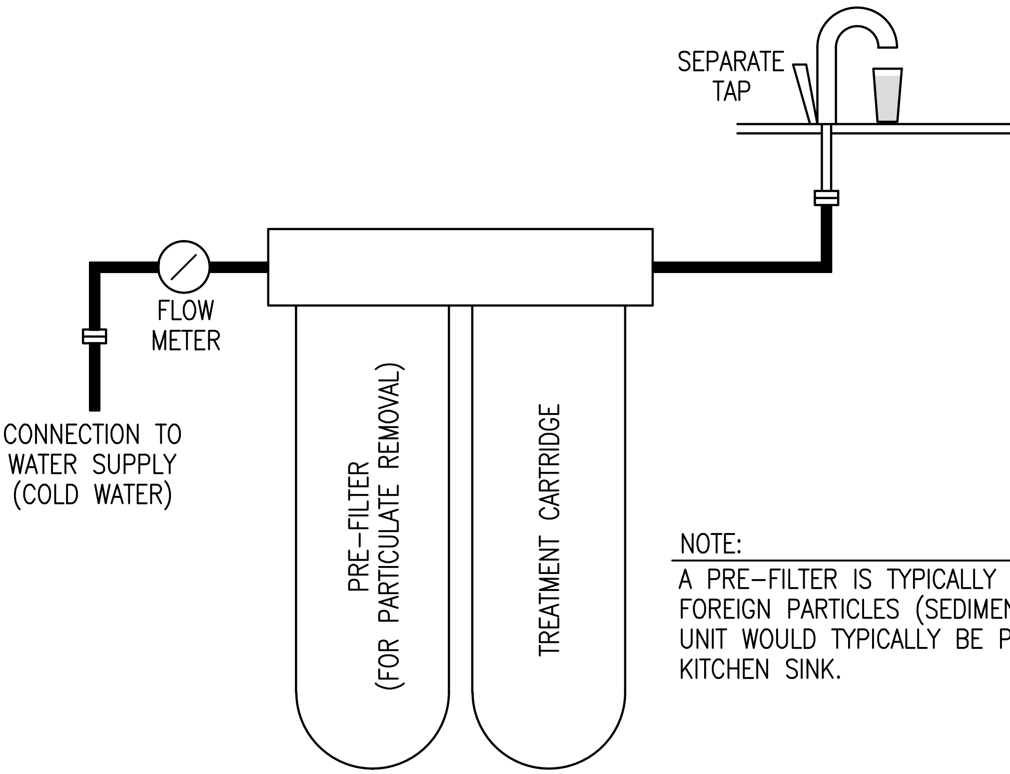
APPENDIX B – SOLUTION SETS

TABLE B.2-4

NON-STRUCTURAL SOLUTION COSTS

INDIVIDUAL HOUSEHOLD PILOT STUDY

SOLUTION	CAPITAL	ANNUAL	NOTES
Bottled water distribution	None	Moderate	
Bottled water delivery	Start-up cost may be required	Annually/monthly cost may be dependent on quantity and delivery distance.	



NOTE:

A PRE–FILTER IS TYPICALLY USED TO REMOVE FOREIGN PARTICLES (SEDIMENTS, ETC. TREATMENT UNIT WOULD TYPICALLY BE PLACED UNDER THE KITCHEN SINK.

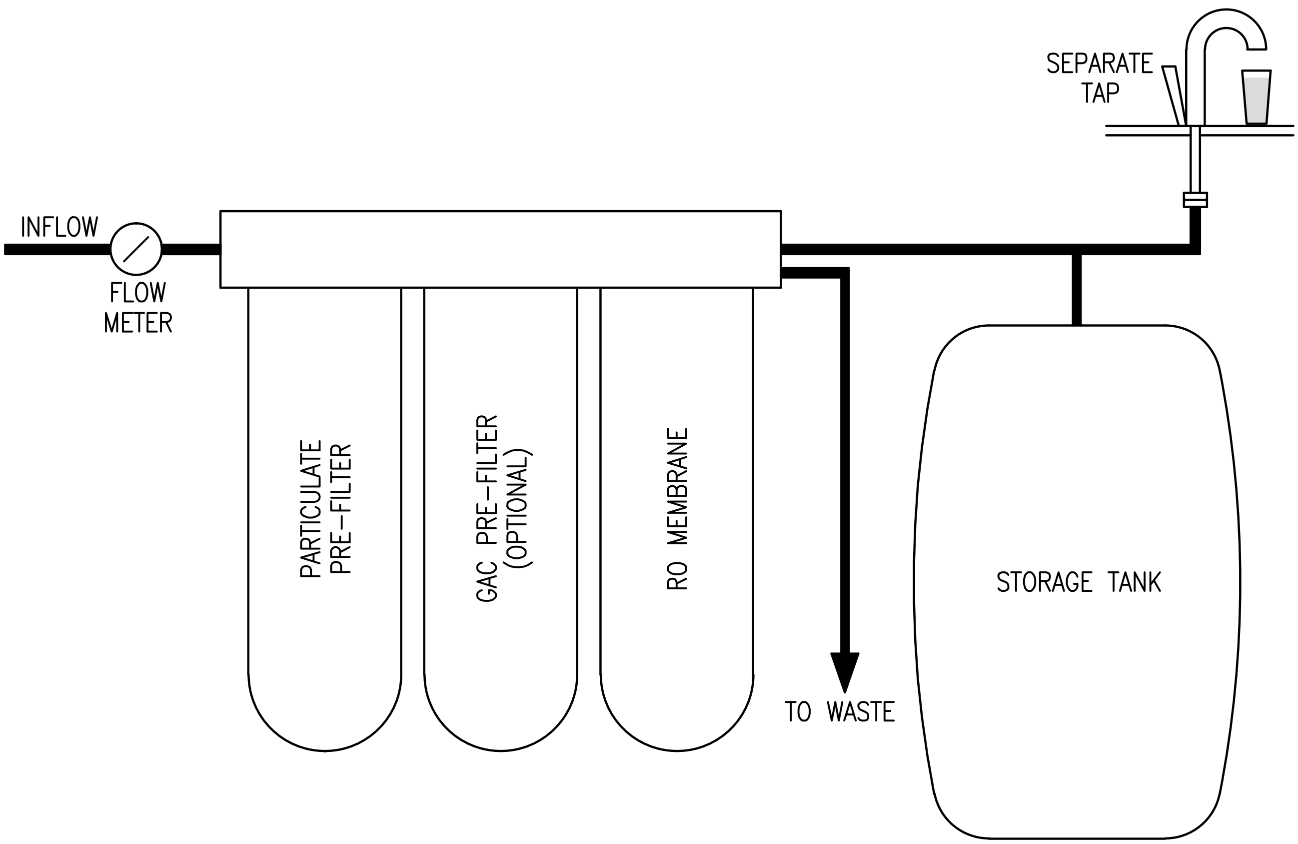
SOURCE: USEPA

TYPICAL POU INSTALLATION

INDIVIDUAL HOUSEHOLD PILOT STUDY

TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\TYP POU INSTALLATION.Dwg



SOURCE: USEPA

TYPICAL POU RO INSTALLATION
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\TYP POU RO INSTALLATION.Dwg

APPENDIX B – SOLUTION SETS

B.3 COMMUNITY BASED WATER SOURCE SOLUTIONS

Community based water source solutions consist of potential actions for individual households that share common problems or clusters of households currently utilizing a common water source, typically a well. Solutions may address both water quality and quantity problems. In general, community-based solutions reflect similar considerations as individual household solutions as presented in Sections B.1 and B.2. Community-based solutions aim to address a similar problem for multiple households as a single action.

Some solutions could recommend the development of a common water source, if a common water source does not already exist.

B.3.1 Water Well Improvements

This solution set pertains to rural subdivisions or household clusters that already utilize a shared (common) water well or have the potential to develop a common water well as the solution to a contamination problem. If already a common source, it is assumed that some degree of shared cost arrangement already exists. Well improvement solutions for community based water sources are the same as those for individual households. Details regarding specific well improvement solutions can be found under Section B.1 – Well Improvements.

APPENDIX B – SOLUTION SETS

B.3.2 Well Discharge Treatment

Wellhead treatment solutions for the generated supply consist of options that treat the water quality problem at the source (well). This set of solutions applies to household clusters or rural subdivisions that do or could use a common (shared) well.

Wellhead treatment options consist of water treatment facilities that are installed at the site of the water well. The treatment unit or process is specifically designed to remove or reduce the level of the target constituent/contaminant in the final discharge. In general, these units operate under the pressure provided by the well or other post discharge pressure source.

Wellhead treatment systems are designed by licensed professionals to ensure that the unit provides the necessary treatment and capacity. In some cases, the equipment manufacturer provides the design services as part of the equipment purchase process. Installation will need to be completed by the manufacturer or licensed contractor to maintain equipment warranties and to insure applicable code compliance.

The primary technologies utilized for wellhead treatment are ion exchange (IX) and reverse osmosis (RO). Both technologies require the use of backwash water (and/or brine solutions) to clean the units after use. Disposal of the spent backwash can present difficulties for onsite treatment systems. Specific details regarding IX and RO processes can be found in Section B.2-Water Quality Solutions.

APPENDIX B – SOLUTION SETS

B.3.2.A Considerations

Advantages: Treatment allows continued use of production well with sufficient yield.

Disadvantages: Residual disposal issues.

High capital and O&M costs.

Operator skills and possibly certificate may be necessary.

B.3.2.B Costs

TABLE B.3-1
SOLUTION COSTS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
Treatment unit	High – Very High	Unit needs to be designed for installation
Pumping unit	Moderate – High	Pumping may not be required
Operation and maintenance	Moderate – Very High	Ongoing maintenance will be required. Part-time operations assistance may be necessary.

APPENDIX B – SOLUTION SETS

B.3.2.C Supplemental Considerations

Proper design of the treatment system will be necessary which may require the use of professional services. Any professional utilized should have the capability to estimate costs and operational considerations. This information can be used for comparison to other alternatives.

Processes for wellhead treatment are rapidly evolving. Technology advances continue to improve design and operational features of wellhead treatment processes. This solution set should be revisited periodically for consideration of new technology.

APPENDIX B – SOLUTION SETS

B.3.3 New Community Water Source

For a cluster of rural households with independent water sources, establishing a new community water source could represent a viable solution to individual water source problems. A new water source can be developed from either groundwater or surface water.

Developing a new groundwater source presents the considerations presented in B.1 – Well Solutions. For a cluster of households, a distribution system will also have to be installed.

Utilizing surface water, if available, may provide an additional option. Surface water, to be utilized as a new source, will require very specific treatment processes that require specific operational skills. In the pilot Study Area, access to surface water and long-term rights to the surface water, represents the most significant obstacle to surface water treatment.

B.3.3.A Considerations

Advantages:	Eliminates reliance on unsuitable water sources.
	Cost sharing between households lowers individual cost.
Disadvantages:	Land requirements.
	Governance structure required.
	Relatively high cost.
	Operations with specific skills required.

APPENDIX B – SOLUTION SETS

B.3.3.B Costs

TABLE B.3-2

SOLUTION COSTS – COMMUNITY WATER SOURCE

INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
Capital cost		
Land	Variable	Land purchase or easement likely required
Equipment	High – Very High	
Distribution system and service connections	High – Very High	Extent of system directly impacts costs
Annual cost		
Operation and maintenance	Low to Moderate	

Note: Cost sharing will affect the evaluation of costs, and is dependent on the number of participants.

B.3.3.C Supplemental Considerations

The development of a community water source will require the collective participation of the aggregated households to successfully accomplish the construction and operation of the facilities. A governance structure will need to be established in order to ensure that costs are equitably distributed amongst the participants and the facility is properly operated and maintained.

APPENDIX B – SOLUTION SETS

B.3.4 Alternative Water Sources

This solution set consists of approaches to water quality or water supply problems through the use of an alternative water supply. The use of existing water supplies is discontinued. An alternative water source can be secured through consolidation, interties or the use of non-structural approaches.

Non-structural solutions for community based water sources are typically represented by solutions based upon provision of bottled water. For community needs, two options exist: use a community distribution center or provide delivery to the individual households. These options were previously discussed in greater detail in Section B.2.3, New Source Options.

Consolidation occurs when a cluster of independent households connects to an existing community water system and the subdivision or cluster of homes is added to the water system's responsibilities. This situation is typically accommodated through an annexation or extraterritorial services agreement process.

With an agreement a cluster of homes connects to a community water system, but maintains its identity apart from that of the water system. The water is often purchased wholesale as a delivery to the area rather than individual households. The entire area becomes responsible for the payment for water delivered.

B.3.4.A Considerations

Advantages: Responsibility for quality of water removed from the individual household.

APPENDIX B – SOLUTION SETS

Disadvantages: Independence/autonomy of individual household is lost.

Additional financial responsibilities become necessary to ensure delivery of water.

B.3.4.B Costs

TABLE B.3-3
SOLUTION COSTS – ALTERNATIVE WATER SOURCES
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
Distribution system, connections and fire flow provisions	Variable	Cost is highly variable depending on the extent of distribution system and cost share requirements
Operation & maintenance	Variable	Cost is dependent on cost share requirements and basis of charges for supplying entity

B.3.4.C Supplemental Considerations

For an individual household, there will be no physical difference between consolidation and an intertie. In each case, the individual household is connecting to a community water distribution pipeline. After connection, the party associated with the individual household pays for the use of the water, typically on a monthly basis. Up-front costs in the form of capacity rights fees and connection costs may also be required.

Approaches that rely on consolidation or an intertie to an existing water distribution system may be eligible for funding through programs offered by the California Department of Public Health (CDPH) or other regulatory agencies. Funding reduces or eliminates the capital costs of project implementation. Parties associated

APPENDIX B – SOLUTION SETS

with individual households would, however, remain responsible for annual operating costs and associated cost of obtaining water supply.

APPENDIX B – SOLUTION SETS

B.4 HOUSEHOLD IMPROVEMENT SOLUTIONS

Household improvement solutions address problems experienced by the individual household with an individual solution approach. These solutions address both water quality and water supply problems. Water quality problems include lead or copper contamination as well as bacteriological contamination that has been isolated to have been generated within the household. Water delivery/supply problems include insufficient flow at the delivery points.

Household improvements can be grouped into two categories: plumbing improvements and water treatment solutions. Plumbing improvements consist of solutions where changes are made to the individual household's plumbing. Water treatment solutions address water quality problems through utilization of treatment devices.

APPENDIX B – SOLUTION SETS

B.4.1 Plumbing Improvements

Plumbing improvements may provide an opportunity to address both water quality and/or water supply problems. Water quality problems may originate from the individual household plumbing or an existing cross connection to a non-domestic well. Water supply problems may be caused by poor-sized plumbing fixtures or undersized plumbing. Plumbing improvements can be summarized as follows:

1) Plumbing/piping replacement – An option where existing plumbing is removed and replaced with new plumbing.
2) Fixture Replacement – Under this option, fixtures, primarily faucets and other delivery devices, are replace to improve the flow of water.
3) Plumbing disinfection – This option specifically addresses bacteriological contamination that is occurring with the household plumbing not from the source well. Detailed investigation(s) into the cause of contamination will be needed to ensure that this solution permanently addresses the problem.
4) Cross Connection Elimination − A cross connection exists when a non-domestic well or contaminated well is connected to a household (or system) served by a domestic well. In the pilot Study Area, this situation is unlikely, as most individual households are served by only one well. Households with large acreages, such as farms, however, may have irrigation wells that may have been connected in the past. A cross connection provides an opportunity for contaminated water to enter the individual household water supply. Under

APPENDIX B – SOLUTION SETS

this scenario, person(s) associated with the individual household takes action to eliminate the cross connection.

Table B.4.-1 summarizes the applicability of the plumbing improvement solutions.

B.4.2 Water Treatment Solutions

Solutions that utilize water treatment units may be feasible for households that have established water quality problems that originate from within the household. For these types of problems, a point-of-use (POU) device represents the most appropriate approach.

A POU device will produce water for the point of application (use), most likely a faucet. The POU device can address many different contaminants. More details can be found in Section B.2 – Individual Water Source Solutions.

A POE device will produce water for the entire household. Its application, however, will be more limited, depending on the household problem. For example, if lead represents the primary contaminant, its most probable source is the plumbing. A POE device targeting lead will not address this situation. More details regarding the capabilities of POE devices can be found in Section B.2. – Individual Water Source Solutions.

APPENDIX B – SOLUTION SETS

B.4.3 Solution Costs and Considerations

Table B.4.2 summarizes the relative cost and general considerations associated with household improvement solutions. Plumbing improvements will typically result in somewhat costly solutions, depending on the extent of plumbing work.

APPENDIX B – SOLUTION SETS

TABLE B.4-1

APPLICABILITY OF PLUMBING IMPROVEMENTS

INDIVIDUAL HOUSEHOLD PILOT STUDY

Solution	Water Quality	Water Supply
Plumbing/piping replacement	X	X
Fixture replacement	-	X
Plumbing disinfection	X	-
Cross connection elimination	X	-

TABLE B.4-2

SOLUTION CONSIDERATIONS AND COSTS – IMPROVEMENTS

INDIVIDUAL HOUSEHOLD PILOT STUDY

Solution	Advantages	Disadvantages	Cost	Notes
Plumbing/piping replacement	A single/one time action that addresses problem Replaces old, potentially undersized plumbing	Difficult to implement especially throughout household; Costly	High to Very High	Can address delivery problems
Fixture replacement	Opportunity to upgrade fixtures	Most new fixtures implement water saving (conservation) designs	Moderate	Only addresses delivery problems
Plumbing disinfection	Straightforward implementation	Potential for repeated application procedures Disposal of residuals	Low to Moderate	Need to address cause of contamination Testing required
Cross connection elimination	Permanently eliminates potential contamination risk	-	Moderate	Multiple wells most commonly associated with large properties
Water treatment	Can address multiple issues	POE effectiveness may be limited	High to Very High	See Section B.2. for supplemental information

APPENDIX B – SOLUTION SETS

B.4.4 Supplemental Considerations

The Uniform Plumbing Code has brought about a standardized approach to household plumbing issues since 1945. Older homes, therefore, are the most likely locations that may experience deficiencies regarding plumbing. Rural households may also have insufficient plumbing due to limited access to professional plumbers and the use of unlicensed contractors.

In general, the potential for household plumbing to represent the primary cause of water delivery problems is small.

APPENDIX B – SOLUTION SETS

B.5 WATER DELIVERY IMPROVEMENT SOLUTIONS

This solution set addresses issues specific to the delivery of water from the primary source, such as a well, to the individual household for use. These solutions address the quantity and delivery of water for an individual household.

These solutions can be categorized as to their approach as follows:

a) At the well;

b) To the household; and

c) In the household.

Delivery improvements associated with a well consist of pump replacement or other improvements to increase the water delivery amount.

Piping to the household may be the most significant restriction that prevents sufficient water from reaching the household. Finally, water conservation measures at or in the household may represent alternatives to increase available water at the household.

B.5.1 Well Improvements

Solutions that address water delivery from a well are specifically associated with the pumping capacity of the well. The primary solution consists of replacing the pump and motor to achieve the objective delivery conditions. Specific considerations regarding pumping improvements can be found in Section B.1 – Well Improvements.

APPENDIX B – SOLUTION SETS

It should be noted that prior to making any changes to the pump and/or motor, the person(s) associated with the individual household needs to consider the well conditions. The party needs to ensure that the well has the capacity to deliver the increased design quantity. A detailed well evaluation may need to be performed to ensure a workable solution. For example, a well that produces 20 gallons per minute will not meet the demands of a 25 gallons per minute pump.

B.5.2 Water Distribution (Delivery) Improvements

Options under this solution alternative consist of addressing pipeline deficiencies for individual households or clusters of households on a common distribution system. Deficiencies may exist as damaged pipe, undersized pipe or inefficient installations, such as unnecessarily long pipeline routes, excessive valve arrangements and pipeline bottlenecks.

In general, the types of problems associated with this solution set are associated with very old households where upgrades may have overlooked the pipeline between the well and household, such as when connecting a new well to an old line. Older rural subdivisions may experience undersized pipelines or inefficient system capabilities as a result of additions (expansions) to the original delivery system pipelines.

B.5.2.A Considerations

Advantages: Opportunity to upgrade pipelines, provide improved alignment

Disadvantages: Cost (depending on extent of improvements)

APPENDIX B – SOLUTION SETS

B.5.2.B Costs

Pipeline cost is the primary cost element for this solution. This solution will also require earthwork and connection fittings. The overall cost associated with this solution will be dependent on the size (diameter) and length of the pipeline from the well to the house. There should be no significant annual (recurring) costs associated with this solution.

B.5.2.C Supplemental Considerations

A sufficient supply of water must be available. Replacing old pipelines may address water quality issues.

B.5.3 Water Demand Considerations

Another potential solution to water delivery problems is to address water demand considerations. Under this solution, the water demand of the individual household is reviewed for water savings that could result in sufficient water supply for the household. Prominent options include:

1) Low flow toilets;
2) Low flow shower heads;
3) Low flow faucets;
4) Tankless water heaters; and

APPENDIX B – SOLUTION SETS

5) Water efficient appliances.

As technology regarding these options improves, the availability of these units increases and the cost typically decreases.

Water conservation practices implemented by the individuals living in the household can also reduce water demand. Any practice or action taken to reduce the use of water represents a conservation effort. Common practices include:

1) Repairing leaking water fixtures;
2) Installing water efficient fixtures and appliances (previously discussed);
3) Modifying landscape irrigation practices;
4) Installing water conserving (drought-tolerant) landscaping; and
5) Grey-water recovery systems and reuse for irrigation demand.

Water that is conserved by these or other practices becomes available for higher priority water demands.

Irrigation represents a significant area where water conservation can assist with reducing water demands. First, scheduling irrigation cycles to not coincide with daily water uses such as bathing and clothes washing can reduce the water demand from the water well. Water savings can also be realized by applying the proper amount of water during irrigation (lawn watering, for example). Finally, utilizing native plants or xeriscaping can significantly reduce the amount of water needed for irrigation.

APPENDIX B – SOLUTION SETS

B.5.3.A Considerations

Advantages: In general, implementation can be completed at a low cost;

Most practices can be readily implemented.

Disadvantages: Most solutions require changes in established activities, which will require acceptance by individuals within the household such as lower flow fixtures and reduced watering per application.

B.5.3.2 Costs

Table B.5-1 summarizes relative cost information for water demand considerations.

TABLE B.5-1
SOLUTION COSTS – WATER DEMANDS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Solution	Cost	Notes
Water conserving fixture	Low	
Water saving appliances	Moderate	
Water conservation practices	Low to Moderate	

APPENDIX B – SOLUTION SETS

Water conservation practices will likely result in lower annual costs due to a reduction in water use and associated power costs. Any increase in consumptive use, however, could offset annual cost savings.

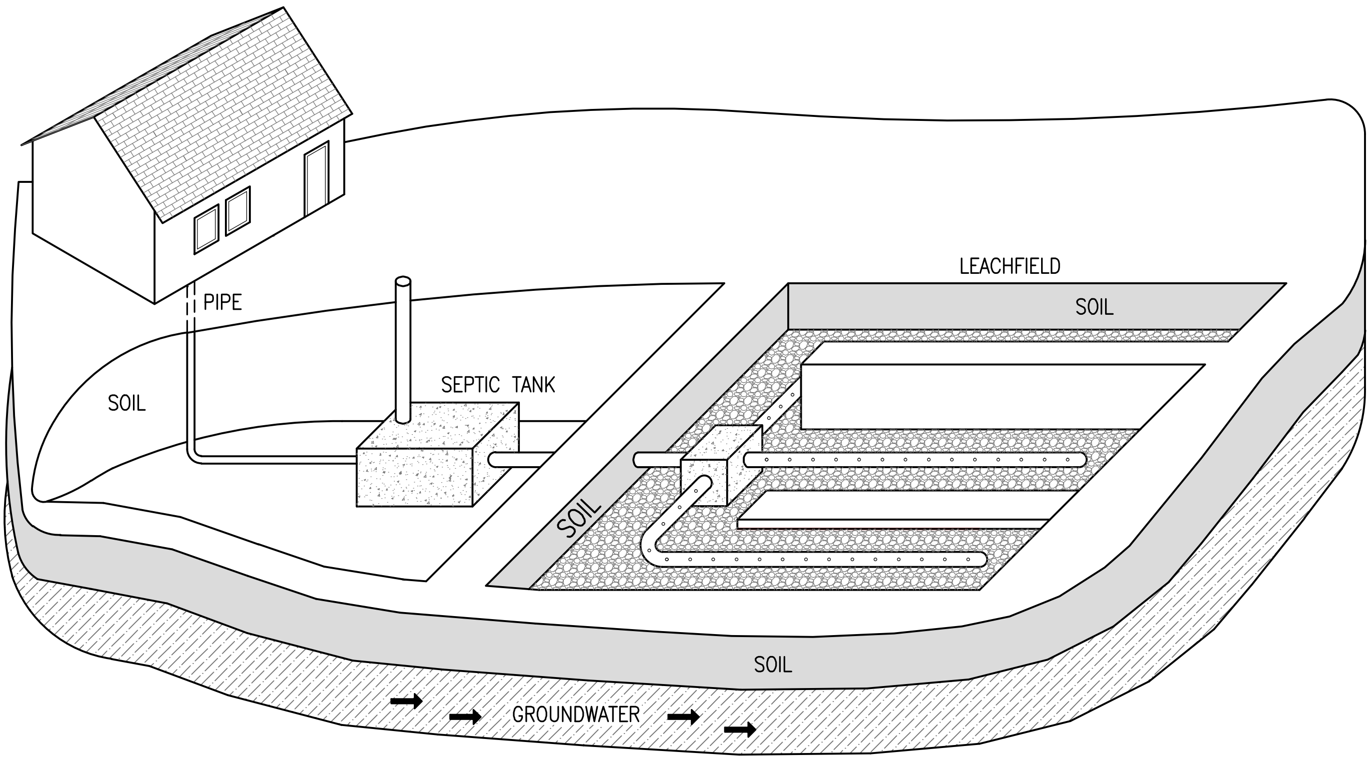
B.5.3.C Supplemental Considerations

In rural areas, the potential exists for more individuals to occupy a household than can be supported by the water (and wastewater) systems of the household. The evaluation of the water demands can establish the existence of this condition.

B.5.4 Community Based Water Delivery Solutions

Community based water delivery solutions consist of potential actions for individual households that share delivery problems with other individual households. Solutions include the formation of a community water system or consolidation into an existing water system. Specific considerations regarding community based solutions can be found in Section B.3-Community Based Water Service Solutions.

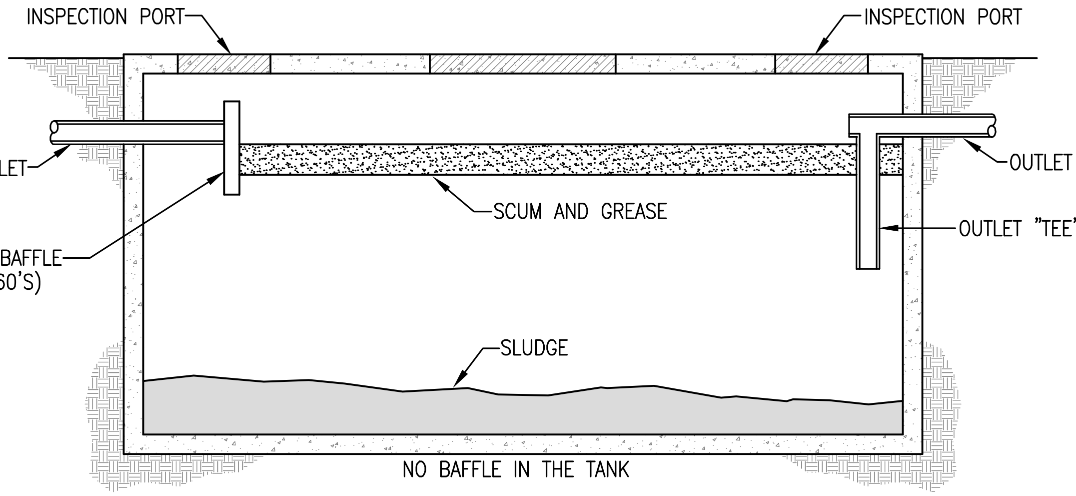
FIGURE B.6.1



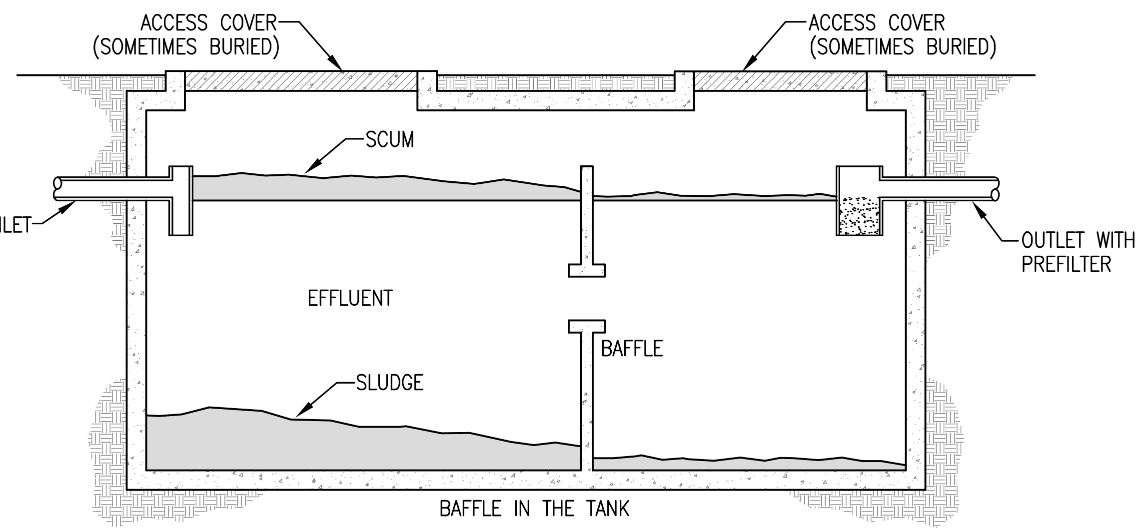
TYPICAL INDIVIDUAL WASTEWATER TREATMENT AND DISPOSAL SYSTEM
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\TYP INDIVIDUAL WASTEWATER (6-17-13).Dwg

KELLER/WEGLEY



**SEPTIC TANK
(OLDER DESIGN)**



**SEPTIC TANK
(CURRENT DESIGN)**

SEPTIC TANK DESIGNS
INDIVIDUAL HOUSEHOLD PILOT STUDY
TULARE LAKE BASIN DISADVANTAGED COMMUNITY WATER/WASTEWATER STUDY

L:\TCDC\SEPTIC TANK DESIGNS (6-14-13).Dwg

B.6 INDIVIDUAL WASTEWATER SYSTEM SOLUTIONS

Preface

On June 19, 2012, the State Water Resources Control Board (State Board) adopted the Water Quality Control Policy for Siting, Design, Operation and Maintenance of Onsite Wastewater Treatment Systems (Policy). The Policy became effective May 13, 2013. The Policy establishes statewide regulations associated with septic systems and associated required performance standards. The Policy will affect considerations associated with the solution set for individual household wastewater treatment and disposal systems.

One element within the Policy consists of a local agency management program. Under this element, a local agency becomes responsible for developing and implementing septic system implementation and oversight policies that meets the requirements of the Policy.

B.6 Individual Wastewater Systems Improvements

In general, an individual wastewater treatment and disposal system consists of two components: a septic tank and a disposal system. This disposal system is typically a leach field. A septic tank treats wastewater generated with an individual household by its toilets, sinks, showers, tubs and water-using appliances. From the septic tank, treated wastewater flows to a disposal system where it percolates through the soil for final treatment and disposal. A leach field, vertical seepage pit or evapotranspiration mound requires the proper soil type and properly configured disposal line to ensure proper application rates.

The components of an individual wastewater treatment and disposal system are shown on Figure B.6-1.

Treatment

Typical septic tank configurations are shown in Figure B.6-2. Septic tanks can be constructed out of concrete or plastic. Septic tanks come in many shapes including rectangular-box, cylindrical or spherical. Septic tanks will have an inlet connection, outlet connection and an access cover. Baffles to create multiple chambers and to prevent short circuiting are typically present.

Disposal

Common components to a leach field are shown on Figure B.6-3. A properly functioning leach field enables treated wastewater to percolate through the soil and away from the leach field. Multiple leach lines often direct flow throughout the leach field. A distribution box commonly is used to direct flow equally or to allow for rotation between disposal areas. In general, perforated leach lines are placed within a trench filled with graded gravels with asphalt coated felt paper to retard the invasion of the fine soil particles and to optimize percolation. Some installations utilize shields or domed chambers to protect the leach lines from roots and other invasions.

This solution set addresses deficiencies in an individual wastewater treatment and disposal system. Solutions range from repairs to enhancements or modifications to new installations. The solutions discussed in this section cover activities typically completed on a one-time, or infrequent basis. Routine maintenance activities are discussed in Section B.7 – Maintenance Activities.

In general, solutions identified for individual wastewater systems will require the assistance of qualified professionals in part due to permit requirements.

B.6.1 Repairs to Existing Components

Over time, an individual wastewater system may become damaged or impaired to such a degree that its treatment and/or disposal capacity becomes limited or adversely affected. Table B.6-1 summarizes typical damages and impacts to a septic system and potential causes. If repairs become too extensive, the replacement of the existing system becomes warranted (Section B.6.3).

TABLE B.6-1
TYPICAL DAMAGE TO SEPTIC SYSTEMS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Component	Damage	Cause(s)	Impact(s)	Repairs
Septic tank	Cracks/holes	Age Vehicular Traffic Vegetation (roots) Excavation work	Infiltration (additional water) in tank	Crack repair; joint sealants
Leach lines	Broken pipe	Vehicular traffic Vegetation (roots) Excavation work	Inadequate disposal of wastewater flows	Leach line replacement
Septic tank	Poor pumping (if pump is used)	Age Poor operating conditions	Inadequate delivery of wastewater flows	Repair and/or replace pump
Leach field	Compacted soils	Vehicular traffic Age	Poor operation of leach field	Break up soils (can damage leach lines)

Repairs to Septic Tanks

In general, concrete and plastic formulations (polyethylene) are the most common materials used for septic tanks. A septic tank is buried below ground which provides the tank a certain degree of protection. Damage to a septic tank, however, can result from the following:

- Vehicular traffic. Heavy vehicles can damage tanks when they drive over tanks. Vehicles can also damage risers or access ports, leading to infiltration to the septic tank.
- Age. The annual physical toll can result in damage in a septic tanks, especially concrete tanks. Concrete tanks are susceptible to corrosion over long periods of time. Tank seals can also wear out from routine maintenance activities.
- Depending on subsurface soil conditions, damage to the septic tank can occur any time the septic tank is empty, such as after pumping or during installation. Soil and/or groundwater pressure exerted on the tank can cause damage to the walls or damage to the inlet and outlet connections.

In most cases, significant damage to a septic tank will warrant its replacement. Minor damage can be addressed through crack repair materials and sealants. Connection repairs can be completed through normal plumbing repair practices.

Repairs to Disposal System

Procedures noted herein are for a disposal system consisting of leach lines and a drain field (leach field). In general, treated wastewater flows by gravity from the septic tank to the leach field. In some systems, a pump may be required to deliver treated flow to the drain field. Leach lines consist of perforated plastic pipe located within a gravel rock trench. A network of leach lines comprises the leach field. Indicators of damaged leach lines or leach field conditions include dry areas, uneven ground cover growth and standing water in the leach field. Damage to the leach lines and leach field can result from the following:

- Vehicular traffic. Heavy vehicles can damage leach lines and excessively compact drain field soils. Damaged leach lines lead to uneven distribution of wastewater flows.
- Vegetation. Trees and shrubs growing too close to the drain field can produce roots that enter into and clog/plug leach lines.

Physical damage to the leach lines will require replacement. Roots may be able to be removed by maintenance practices, however, tree and shrub removal will likely be necessary to prevent future damage. Significant clogging may require leach line replacement as well.

Worn or damaged pumps (if used) will show signs of inconsistent operation and wastewater delivery. A septic tank back-up is the most common sign of pump problems. The condition of the pump will determine whether it is more cost effective to repair or replace the pump.

B.6.1.A Repair Considerations

Advantages:	Repairs may be at a lower cost than outright replacement of system.
	Extends service life of existing system.
Disadvantages:	May not address causative factors of septic system damage.
	Some repairs may require extended out of service time to complete.

B.6.1.B Costs

TABLE B.6-2
SOLUTION COSTS – REPAIRS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes/Considerations
Crack repair-joint sealant	Low – Moderate	Cost dependent on quantity; if cost too high, replacement may be warranted
Concrete repair	Low – Moderate	Extensive damage may require replacement
Plumbing repairs (inlet/outlet connections)	Low – Moderate	
Leach line replacement	Moderate – High	
Cover soil modification	Moderate – High	
Vegetation removal - groundcover repair	Moderate – High	
Pump repair/replacement	Moderate – Very High	

B.6.2 Enhancements/Modifications to Existing Systems

This solution set consists of approaches to improve the capabilities of existing onsite wastewater systems through upgrades, modifications, or expansions.

Modifications

Evaluation of the existing onsite wastewater system may establish that modifications are warranted to improve treatment and/or disposal. Modifications provide the homeowner opportunity to extend the operational life of an existing system.

B.6.2.A Treatment Modifications

These solutions describe improvements to the treatment portion of the system. Examples include baffle installation, inlet-outlet reconfiguration, outlet filters and aeration. Older septic tanks may consist of a single chamber. The installation of a baffle wall to create two chambers can improve the treatment capabilities of an existing system. Baffles can prevent scum and other floatable material from reaching (and impacting) the disposal system. Baffles also reduce short-circuiting to ensure the wastewater is adequately treated.

Inlet and outlet “tees” can also be used to improve hydraulic and treatment conditions of a septic tank. Outlet filters can also be installed to provide further removal of solids prior to disposal. The use of filters, however, will require additional operation and maintenance (O&M) considerations. Another modification that can improve O&M efforts is the installation of access cover risers. A riser enables the person(s) associated with an individual household to readily have the septic tank pumped. A buried access cover provides the opportunity to "forget" the pumping requirement for the septic tank.

B.6.2.B Disposal Modifications

Several modifications exist to address disposal limitations. Grading modifications can prevent unwanted storm water or irrigation water from entering the soils area over a leach field. Oversaturated leach fields prevent the proper disposal of treated wastewater. Improvements to the soil conditions can also be accomplished. Existing solids may need to be augmented to provide suitable condition for leach field vegetation (grass) and percolation, in lieu of standing water.

If space allows, incorporating a second leach field can address problems associated with poor disposal. A second drain field allows the resident to alternate leach field use. Typically, alternating occurs every six months, which allows one leach field to recover while using the other.

Expanding the existing leach field also represents a modification to improve the disposal capacity. Under this solution, the leach field is expanded by extending or adding leach lines and disposal field area. The entire leach field is available for disposal, in lieu of alternating leach field areas. Sufficient area and suitable soils are required for this solution.

TABLE B.6-3
SOLUTION SUMMARY – MODIFICATIONS CONSIDERATIONS

Modification	Advantages	Disadvantages	Costs	Other Information
Baffle installation	Lower cost than replacement of system; Straightforward improvement; Treatment Improvement	Does not address hydraulic capacity; May not extend service life of system	Low – High	Useful for older unbaffled tanks; Full access to tank will be required Need for baffles will likely be observed in leach field (clogging, etc.)
Inlet/outlet modification	Treatment improvement	May not extend service life of system	Moderate	Requires access to tank ends; Not common due to standardized septic tank designs
Outlet filters	Straightforward improvement; Treatment improvement	May not extend service life of system	Moderate	Useful for older tanks; Modifications to accommodate filler may be required Filter cleaning on regular basis; (O&M) Work may be completed by homeowner
Access risers	Improves access and visibility	Risers susceptible to damage	Low – Moderate	

Modification	Considerations	Advantages	Disadvantages	Costs	Other
Disposal:					
1) Grading Modifications		Above-ground modifications, no modifications to system		Low – Moderate	Improvement may address offsite generated problems
1) Soil Improvements	Soils evaluation needed			Moderate – High	
2) Additional leach field	Additional land required	Provides redundancy; enables household to “rest” one leach field	Additional space requirements; High cost	Very High	Feasible for large lots only

B.6.3 New Treatment and/or Disposal Systems

Based upon the evaluation of the existing onsite treatment and disposal system, a new wastewater system may be warranted. This solution set discusses options and considerations associated with a new onsite wastewater treatment system.

New Treatment System

This solution consists of installing a new treatment system for the individual household. If feasible, the new treatment system can be installed after the removal of the existing system; otherwise a new, suitable location will be necessary.

A new treatment system allows the individual household opportunity to improve treatment capabilities and capacity. A new treatment system also represents an opportunity to incorporate advances in onsite treatment technologies and features. New regulations and requirements may render a new system infeasible at the existing location.

Primary considerations for a new treatment system include:

a. Locations of existing water wells;

b. Size of household (wastewater flow quantity);

c. Location of existing (or new) leach field area.

Specific considerations for the new treatment system will be identified during evaluation activities which are typically accomplished by a qualified professional and/or contractor.

New Disposal System

The evaluation of the existing disposal system (leach lines and leach field) may establish the need for the replacement of the existing system with a new disposal system. Damaged leach lines and poor surface and subsurface conditions represent typical conditions warranting a new disposal system. This solution consists of installing a new disposal system. Depending on the site conditions, the new system may be installed at the existing site, but this is seldom the case. Normally, a new location will need to be identified.

The new disposal system may utilize the existing leach field location if the primary purpose of the new system is to replace damaged leach lines. Repairs to the infiltration trenches may be necessary.

A new disposal system provides an opportunity to utilize new approaches in disposal. Primary considerations for a new leach field include:

a. Soil characteristics;

b. Location of existing wells;

c. Size of system (disposal quantities); and

d. Location of existing treatment system.

APPENDIX B – SOLUTION SETS

Specific considerations and details associated with a new disposal system will need to be identified during evaluation activities, typically accomplished by a qualified professional and/or contractor.

Considerations

Advantages: Entirely new components.

Can address all adverse conditions.

Disadvantages: Installation options may be limited. A new site may be required.

High cost.

B.6.3.B Cost

TABLE B-6.4
SOLUTION COSTS – NEW SYSTEMS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
New treatment system	Very High	Must be designed by a professional
New disposal system	Very High	Must be designed by a professional. Unlikely an option for small parcels

B.6.3.C Supplemental Considerations

A new treatment system and new disposal system can be paired together to provide the individual household an entirely new onsite wastewater system.

New systems are associated with a very high cost to the person(s) associated with an individual household. It is likely that these solutions will not be feasible unless a means to fund the solution is available to the individual household or the house is uninhabitable due to the lack of sewerage capability.

For small rural residential lots, a new system may only be feasible if the new system can be installed in the location of the existing system. This option often results in the most extreme cost requirement.

B.6.4 Community Based Treatment and Disposal Systems

If multiple individual households in reasonable geographic proximity experience similar problems with their wastewater systems, a shared system may represent a potential solution for each household.

Discussion and specifics of Community based Wastewater Treatment and Disposal solutions can be found in Section B.8.

APPENDIX B – SOLUTION SETS

B.7 INDIVIDUAL WASTEWATER SYSTEM MAINTENANCE ACTIVITIES

As a part of the evaluation of an individual wastewater system, the person(s) associated with an individual household may establish that the existing system is properly designed but that maintenance activities need to be addressed. This section discusses solutions that address maintenance activities associated with individual wastewater systems.

B.7.1 Implement/Follow Proper Individual System Use Limitations

These solutions describe efforts by the individual household to operate its wastewater treatment system within its proper design and operational limitations. The individual may not understand the limitations associated with an on-site wastewater treatment and disposal system. Improper disposal of drainage flows, garbage material and chemicals can adversely affect an on-site system's performance, subsequently leading to problems.

<u>Reducing excess flows to the system</u>

An aspect of septic systems operation is the principle of detention time. An individual system is sized to provide a specific "holding time" (detention time) based upon an estimated amount of wastewater. Over time, an individual household may unknowingly increase the amount of wastewater directed to the septic system. Sources of additional flows include:

APPENDIX B – SOLUTION SETS

- Increased household size (number of residents);
- Additional fixtures added as a result of remodeling;
- Increased frequency of processing clothes for laundry;
- Hot tub discharge; and
- Leaking plumbing fixtures.

Solutions for reducing excess flows consist of:

- Installation of water conserving fixtures;
- Installation of water conserving appliances;
- Repairing leaking fixtures and appliances;
- Spacing out laundry activities such as multiple laundry days; and
- Draining hot tubs to locations other than the septic system.

Disposal of inert material and chemicals

In many households, the kitchen sink represents the primary means for disposing of coffee grounds and household cleaners. These materials can adversely affect an individual household's onsite treatment system (septic tank).

Inert materials consist of materials that cannot be treated by the septic system. Coffee grounds and egg shells are two types of inert materials. Dumping of cooking grease down the drain also introduces materials into the septic system that cannot be

APPENDIX B – SOLUTION SETS

adequately treated by the on-site wastewater treatment system and actually hinder the proper treatment of other materials.

Inert materials interfere with a septic system operation by reducing the available storage volume used for treatment, subsequently resulting in reduced treatment performance. Septic tank pumping (cleaning) frequencies typically increases as well.

Many chemicals can detrimentally effect the treatment performance of on-site treatment systems. Paints, solvents and household pesticides represent examples of chemicals that should not be dumped into drains for disposal in the septic system. Chemicals can adversely affect the microorganisms in the septic system which result in wastewater treatment impacts.

In general, solutions that address the improper disposal of materials to a septic tank consist of changes to disposal habits. If multiple households or a rural subdivision share the same disposal problem, community based disposal services may provide an additional solution.

Septic tank inserts for grease (grease traps) are available, however, maintenance and disposal procedures related to the accumulated grease must be conducted.

B.7.1.A Costs:

Water conserving fixtures are considered relatively low cost solutions, however, water saving appliances result in significant expenditures. Some cost savings can be realized through utility replacement programs or other special funding, if available.

APPENDIX B – SOLUTION SETS

In general, implementation costs for water conservation measures and changes in disposal practices will result in cost savings. Less septic tank pumping and maintenance activities will be required.

B.7.1.B Supplemental Considerations

In rural areas, the potential exists for more individuals to occupy a household than can be supported by the then existing wastewater system. Water conservation efforts may extend the capacity of the wastewater system, however, additional capacity may need to be considered to ensure proper operation.

Many water conservation efforts and disposal practices result in changes in water use habits. Water use and disposal habits can be difficult to change.

A properly designed greywater system can relieve a portion of the flow to the septic system. Greywater consists of flows from sinks and showers and other water use locations that do not contribute human waste. In lieu of discharge to the septic system, greywater can be used for landscape irrigation.

Annual costs may be incurred if regularly scheduled tank contents collection and disposal is implemented.

B.7.2 Implement/Follow Proper Maintenance Practices

On-site wastewater treatment and disposal systems require regular maintenance to ensure proper operation and long term sustainability. Regular maintenance activities include:

APPENDIX B – SOLUTION SETS

1) Septic tank pumping;
2) Leach line flushing; and
3) Leach field maintenance and care.

Poor attention to maintenance activities can result in reduced system performance and adverse impacts. This solution set emphasizes the importance of following the specified maintenance practices for the on-site system.

Over time, septic tanks will accumulate solids. If not removed, the solids build-up will adversely affect the treatment and disposal efficiency. A common frequency for pumping is between 3 and 5 years. The the frequency is dependent on many factors, including the capacity of the tank, usage and other maintenance considerations.

Depending on the degree of treatment provided by the septic tank, solids can accumulate in the leach lines related to the disposal system. Flushing the leach lines distributes these accumulated solids. Flushing is accomplished by directing a high rate of flow through the leach lines. In general, a leach field must have the capability for flushing to accomplish this effectively. Access ports are the usual appurtenance.

The leach field needs to be properly maintained to ensure adequate disposal condition. The leach field should utilize vegetation as groundcover. Mowing is required to prevent lush conditions that may hinder disposal. In addition, grass clippings need to be removed, to prevent matting of the grass. The leach field area needs to be clear of shrubs and trees, where roots may grow and clog the leach lines.

APPENDIX B – SOLUTION SETS

Leach lines need to be protected from heavy vehicles, otherwise damage may result. This may represent a significant concern for rural areas where vehicular restrictions to an individual household's property are not extensive.

B.7.2.A. Costs

Costs associated with this solution set represent routine costs incurred on a regular basis. Some costs, such as tank pumping will occur less frequently. Leach field maintenance such as mowing will need to be more regular, depending on the season.

Annual costs for this solution set are estimated to exist in the Low to Moderate range.

B.7.2.B Other Considerations

New homeowners may not be familiar with the maintenance requirements of an on-site wastewater treatment system. Public education offers a potential solution to improve awareness of the importance of maintenance activities.

Several companies offer microbial additives to improve treatment and for maintenance benefits. There is much debate regarding the benefit of additives. Additives do not eliminate the need for regular tank pumping.

B.7.3 Increase Maintenance Practice Frequency

Conditions may exist at the individual household level that warrant considering increasing maintenance practice frequencies. An existing septic tank may be undersized for the current conditions at the household. As a result, septic tank pumping on no more than an annual basis may be necessary to maintain proper operational conditions.

The features and considerations associated with these solutions are the same as the solutions in Section B.7.2. The frequency of use increases. With an increase of use, however, comes an associated increase in cost.

The primary consideration for this solution set pertains to the conditions warranting the additional maintenance such as, being more frequent. Excessive maintenance typically indicates that the proper operating conditions are being exceeded. Upgrading the on-site wastewater treatment system may be warranted.

B.7.4 Community Based Maintenance Activities

This solution set addresses approaches where maintenance activities associated with on-site wastewater treatment systems are shared amongst multiple individual households. Typical maintenance activities are summarized in Section B.7.2. The activities that represent candidates for community based approaches include:

- Septic tank pumping; and
- Leach field maintenance.

Under this solution, a group of households, or a rural subdivision, contracts with a septic system maintenance provider to conduct the maintenance, such as tank pumping for all households within the group.

APPENDIX B – SOLUTION SETS

Scheduled contract maintenance of several on-site systems provides the individual households opportunity to negotiate lower costs with a common maintenance provider.

B.7.4.A Supplemental Considerations

A maintenance service provider may require a service contract which results in contracted participation requirements. A service contract may require additional governance considerations for the participants.

APPENDIX B – SOLUTION SETS

B.8 COMMUNITY BASED WASTEWATER TREATMENT AND DISPOSAL SOLUTIONS

Community based wastewater system solutions consist of solutions for individual households that share common problems or household clusters utilizing a common wastewater treatment and disposal system, such as a common septic system. These solutions are presented to address potential wastewater treatment disposal and water quality problems. In general, community based solutions reflect similar considerations as individual household solutions presented in Sections B.6 and B.7. Community based solutions aim to address problems for multiple households.

B.8.1 Wastewater System Improvements

This solution set pertains to rural subdivisions or household clusters that already use a common wastewater treatment and disposal system. Solutions for community-based wastewater systems are the same as for individual households. Improvement solutions may need to address wastewater treatment, wastewater disposal, or both. Details regarding wastewater system improvement solutions can be found in Section B.6 – Individual Wastewater System Improvements. Under this solution set, it is assumed that a cost sharing agreement exists amongst the multiple households to collect funds for the existing system.

APPENDIX B – SOLUTION SETS

B.8.2 New Community Based Wastewater System

This solution set addresses common or shared wastewater treatment or disposal problems for multiple individual households or rural subdivisions. The solutions describe new wastewater treatment and/or disposal systems that address a problem on a community-wide basis. One primary consideration for this solution set is the creation of the necessary governance structure to facilitate cost sharing between the connected households. Two primary options exist for small wastewater treatment and disposal systems: septic systems and package wastewater treatment plants.

B.8.2.A Considerations

Community septic systems have similar design and operational considerations as septic systems for individual households. The primary difference exists in the treatment and disposal capacity, since the system must accommodate multiple households. Although very little equipment is typically associated with a septic system, the septic tank needs to be pumped out on a periodic basis, typically every one to three years.

A community septic system presents several advantages. First, septic systems require a low amount of operational attention. Septic system can be considered passive, having few, if any, equipment considerations. Specialized training is not necessary to operate a septic system.

APPENDIX B – SOLUTION SETS

Disadvantages exist for a septic system. A community-based septic system will need a separate site (property) for the tank and leach field (disposal area). A suitable area must be available for proper treated wastewater disposal.

Package wastewater treatment plants typically provide more advanced treatment than septic systems. The disposal system, however, must meet the same conditions as those for a septic system. Disposal systems can vary from leach fields to disposal ponds. Reclamation of the wastewater can also be considered.

The primary advantage to utilizing a package plant is the higher degree of treatment, which increases disposal alternatives, including reclamation. Package plants also rely less on storage volumes which typically translates into smaller treatment units.

Package plants for a community system present several disadvantages to the party(s) associated with an individual household. First, package plants will require specifically trained personnel for operation and maintenance. As the level of treatment increases, to accommodate disposal, the level of expertise increases. Package plants require daily attention. Package plants and associate disposal system will need a separate site (property). Finally, package plants utilize treatment processes that use ancillary equipment (pumps and motors) that will present increased operation and maintenance costs.

APPENDIX B – SOLUTION SETS

B.8.2.B Costs

TABLE B.8-1
SOLUTION COST CONSIDERATIONS
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Notes
Septic System		
Facilities	Moderate – Very High	Complexity of system affects cost
Operations	Low – Moderate	Few equipment considerations Simple operation
Package Plant		
Facilities	High – Very High	More complex equipment
Operations	High – Very High	Will require trained operator

Both options will require considerations associated with land costs and/or easements. New facilities will require a separate site for treatment and disposal. Availability of the necessary land will affect the cost associated with the land.

B.8.2.C Supplemental Considerations

In many cases, septic systems can be configured and installed by a properly licensed contractor. In rural areas, contractors specializing in construction of septic systems typically exist due to the demand for such systems.

In general, licensed professionals specify the requirements for a package plant. Many variations of package plants exist which require detailed evaluation to ensure the

APPENDIX B – SOLUTION SETS

proper type of package plant. A separate contractor is utilized to install the treatment system.

B.8.3 Alternatives to Community Based Approaches

This solution set presents an alternative for wastewater treatment and disposal systems for rural subdivisions or individual household clusters. The use of existing systems is discontinued. Wastewater treatment and disposal is completed through consolidation or an intertie with other wastewater systems.

Consolidation refers to the situation where a rural subdivision connects to a larger community wastewater system and the subdivision or cluster of homes is added to the wastewater system's responsibilities. This situation is typically accommodated through an annexation or extra territorial service agreement process. Consolidation can also occur through the combination of multiple small community based systems to create a larger system.

With an intertie, an area connects to a community wastewater system, but maintains its identity apart from the wastewater system. The capacity in the wastewater system is purchased at-large for the subdivision, rather than by individual household. The group becomes responsible for the payment for the capacity and operation and maintenance costs related to the wastewater system.

APPENDIX B – SOLUTION SETS

B.8.3.A Considerations

Advantages: Responsibility of wastewater treatment and disposal is removed from the individual household.

Disadvantages: Independence/autonomy of individual household is lost or compromised. Additional responsibilities become necessary to ensure access to wastewater treatment and disposal, such as monthly costs.

B.8.3.B Costs

TABLE B.8-2
SOLUTION COSTS – COMMUNITY BASED ALTERNATIVES
INDIVIDUAL HOUSEHOLD PILOT STUDY

Item	Cost	Note
Collection system, connections and treatment system (if necessary).	Variable	Cost is highly variable depending on the extent of collection system and cost share requirements
Operation & maintenance	Variable	Cost is dependent on cost share requirements

APPENDIX C – CASE STUDIES

APPENDIX C – CASE STUDIES

C.1 GENERAL

Although this Pilot Study Report has been prepared to assist the individual household, its solutions can be utilized in a community setting where a community water system does not exist.

The attached case study, as prepared by Community Water Center (Visalia, CA), summarizes efforts undertaken to install treatment devices in individual households in Monson, California.

A similar project was completed in March, 2005 for the community of Grimes, California. NSF International completed the project through a U.S. Environmental Protection Agency grant. The final report, “Feasibility of an Economically Sustainable Point-of-Use/Point of Entry Decentralized Public Water System,” is available in the public domain. The Executive Summary has been included in this Appendix for reference purposes.

It should be noted, however, that although the individual households described in the case studies addressed the identified problem through the installation of a water treatment device, the decisions leading up to the selection and use of the device and subsequent installation of the selected device were completed by outside groups (third parties). An individual household that does not exist in a community setting will likely be required to make decisions and subsequently take action regarding potential treatment devices.

Case Study: Monson – POU Filters for a Community on Private Wells with Nitrates

Figure 1: Monson resident with his POU filter system.

Problem

Monson is a small, unincorporated community comprised of primarily Latino farmworkers and retired residents in approximately 40 households, many of whom live below the poverty line. Surrounded by orchards and farm land, Monson has some of the highest levels of nitrate contamination in Tulare County, up to three times the federal legal limit. The main sources of nitrates come from fertilizers and animal waste from dairies. High levels of nitrates can cause health problems like Blue Baby Syndrome, diarrhea and vomiting, birth defects, pregnancy complications, and cancer. With the lack of a water system infrastructure, Monson families must rely on unregulated private wells for their source of water and can spend up to 10% of their monthly income on bottled water, more than double the affordability rate of purchasing water by the Environmental Protection Agency. In 2008, the community applied for state funding to explore their options for long-term, sustainable solutions to have clean water, but were met with years of funding obstacles and bureaucratic delays.

Solution

While Monson community members have continued to advocate and worked to address these obstacles to achieve long-term funding, they also realized that they needed an interim source of safe water in the mean-time. In 2012, the community of Monson partnered up with local Rotary clubs and Community Water Center (CWC) in order to explore cost-effective options for interim solutions that met their needs and decided to implement Point-of-Use (POU) water filters in their kitchens. These POU filters are certified by NSF and the California Department of Public Health to remove nitrates with reverse osmosis technology, are locally available in hardware stores and are more cost-effective and convenient than buying bottled water.

Partners

This community-driven project was a collaborative process that involved the support of many different partners. Monson families, Rotary, and CWC worked together to develop a plan for implementation. The costs of the POU filter systems, replacement filters, and installation labor costs were sponsored by Rotary and the costs of initial and follow-up water quality testing were donated in-kind by California Water Service Company. Together, CWC and Rotary facilitated community meetings, assessed the plumbing needs of each home, coordinated and installed filters in homes, collected water samples, conducted educational workshops on proper operations and maintenance (O&M), and provided assistance with ongoing O&M and troubleshooting support. CWC's time was covered through generous support of the California Endowment, Blue Planet Network (through a grant from Yahoo! Employees Foundation), and Wells Fargo.

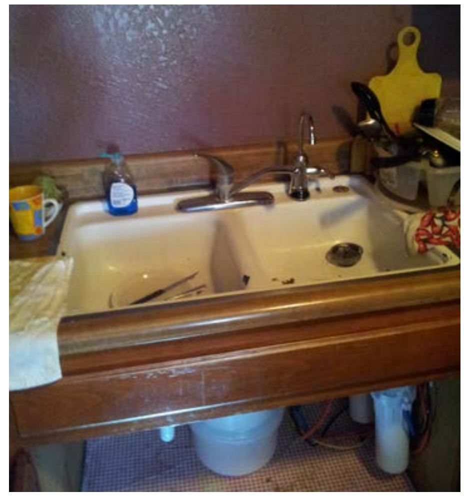


Figure 2: Installation of POU filter in a Monson home.

Project costs

Project item description	**Total project cost**	**In-kind donation**	**Funding source**
Filter systems and installation labor for 29 households	$12,000	$12,000	Rotary
Operations and maintenance support and replacement filters	$1,500	$1,500	Rotary
Water quality testing	$2,500	$2,500	California Water Company
CWC staff time	$59,966	$0	Grant Funding via CWC[1]
Monson total project costs	**$75,966**	**$16,000**	

Table 1: *Project costs for Monson.*

This project implemented the POU filter system GE GXRM10RBL, which can be found at Home Depot. The maintenance costs include replacement parts and ongoing water quality

[1] This grant funding was generously supported by The California Endowment, Blue Planet Network (through a grant from Yahoo! Employees Foundation), and Wells Fargo.

testing. The annual operating cost is $110 - $164, depending on when the membrane needs to be changed. The following list is a breakdown of the ongoing maintenance costs involved[2]:

- POU filter system: $147
- Membrane replacement (change every 2-3 years): $54
- Filter set replacement (change twice a year): $45
- Nitrate lab testing (quarterly): $20

Figure 3: Filter system and replacement components.
The filter system is depicted on the left, the replacement membrane in the middle, and the replacement filter set on the right. Photo credit: Home Depot website.

Sustainability model
Capacity building is key to the sustainability of this filter project. CWC has been educating community residents about the health impacts of nitrate contamination so that they can 1) understand what nitrate contamination is and how to prevent exposure, 2) how to properly operate and maintain the POU filter, a short-term solution, and 3) participate in advocacy and decision-making processes throughout the development of long-term solutions.

After the installation of the filters in 2013, Monson also finally received state funding to explore long-term solution options. This means that the filters will be a band-aid solution for three years until the long-term solution is in place. In order for the project to be successful for this period of time, CWC has conducted a training workshop about proper O&M that 15 community residents participated and also has been doing check-ins and providing troubleshooting support and water quality testing to families with Rotary every month. Rotary will donate replacement filters and membranes for the first year, and for future years, families have agreed to pay for the maintenance costs. It's very important that families learn how to properly change filters during this year; so this is why Rotary and CWC are committed to help families with as many hands-on tutorials and troubleshooting help as needed.

Ultimately, all partners want the filters to be an interim solution, so not only is it important to know where to purchase replacement filter cartridges and how to correctly replace them on-time, it is also important that the community of Monson keeps advocating to achieve a sustainable, long-term drinking water solution.

[2] Prices from Home Depot website. Actual prices may vary in stores.

EPA Grant: X82952310
March 2005

Feasibility of an Economically Sustainable Point-of-Use/Point-of-Entry Decentralized Public Water System

Final Report

Prepared By

NSF International

Authors:

Gordon Bellen, NSF International, Ann Arbor, Michigan; Joseph Cotruvo, Cotruvo & Associates, Washington, D.C.; Patrick Mann, West Virginia University, Morgantown, West Virginia; Perialwar Regunathan, Regunathan & Associates Inc., Wheaton, Illinois

EPA Grant # X-82952301

Evyonne Harris, Project Officer for Assistance Agreement
Office of Groundwater and Drinking Water (OGWDW)
U.S. Environmental Protection Agency
Washington DC 20460

Acknowledgements

The residents of the community of Grimes, CA were a tremendous help to this project. Their willingness to accept project members into their homes, and their friendliness was greatly appreciated. The three town board members were extremely helpful, volunteering time, resources, and assistance to the project at any given time. Thanks to Fred Durst, Gus Moore, and Art Olivares. The California Department of Health Services was also very helpful, particularly Dan Cikuth, Gunther Sturm, and Gary Yamamoto. The California Rural Water Association (CRWA) was also helpful with special thanks to Catherine Smith and Roger Bennett. The staff of Blue Fountain Water (Randy Orella and Christine Thompson) were helpful throughout the project, but particularly during installations. Finally, this project would not have been possible without the support of Kinetico, specifically Mark Brotman and Keith Brown. When Kinetico originally agreed to provide equipment and time, the specification was for a much smaller community.

This publication was developed under Cooperative Agreement EPA Grant No: X-82952301 awarded by the U.S. Environmental Protection Agency (EPA). EPA offered comments and suggestions to improve the scientific analysis and technical accuracy of this document. However, the views expressed here are those of the authors and EPA does not endorse any products or commercial services mention in this publication.

Foreword

Small community water treatment has posed an enormous problem for the drinking water regulatory community, drinking water professionals, and the people living in these communities. The Safe Drinking Water Act (SDWA) and subsequent regulations require that all water in the distribution system and at every tap connected to the distribution system comply. This essentially mandates central treatment prior to entering the distribution system. For very small communities, this may be a cost that poses an undue burden. Often it could be a cost that has negative public health implications. For a very low-income family, the money spent on water treatment may not be available for other essentials. Rather than spend that money; a community may apply for a variance or exemption. Exemptions and variances are intended to be temporary solutions to regulatory compliance. They may, however, extend indefinitely leaving a community with no water that meets the regulation. Point-of-use (POU) treatment provides an alternative by treating a portion of water for less cost. The new arsenic regulation mostly affects small communities. This may be the time when this alternative treatment technology may be the best choice. This report details the feasibility and results of implementing a centrally managed POU strategy in the small community of Grimes, California.

Abstract

This project had the goal of identifying the important issues for successfully implementing a centrally managed point-of-use (POU) treatment system in a small community for the purpose of complying with the new EPA national drinking water regulation that will reduce the standard for arsenic in drinking water from 50 μg/L to 10 μg/L. Several small communities were identified in a number of states. Ultimately, the city of Grimes, California was selected because of its demographics, water quality, and the support of the California Department of Health Services (DHS). Treatment equipment was selected from a variety of options. Kinetico, Incorporated, the selected commercial manufacturer, provided the project with an activated alumina treatment system. Kinetico was selected as the vendor for the project based on its ability to donate equipment and time and the availability of a qualified dealer in the area for support. The equipment was installed in every home that agreed to participate. As the project progressed, more people in the community volunteered to have equipment installed. At the end of the project there were 122 treatment units in place including businesses and residences. Only three residents were not participating. Sampling of treated water was conducted quarterly for one year. The units were very effective, reducing arsenic at 25 μg/L to less than 2 μg/L. There were no problems with microbial growth. The units were left with the community for them to maintain. This approach was less than one half of the projected cost of central treatment for Grimes.

Feasibility of an Economically Sustainable Point-of-Use/Point-of-Entry Decentralized Public Water System

Executive Summary

The Safe Drinking Water Act (SDWA) imposes significant demands on small water systems to achieve compliance, but it also provides opportunities to devise unconventional compliance approaches that are geared to the specific problems and capabilities of small and very small communities. Numerous decentralized Point-of-Use (POU) treatment technologies have been shown by challenge testing and experience to possess the capability to reliably reduce contaminants in drinking water to below maximum contaminant levels (MCLs).

This project evaluated the approaches and methodologies for a day-to-day management, operating, and compliance system that would be within the financial reach of many very small communities. The objective was to demonstrate to the satisfaction of all stakeholders, particularly state and local decision makers, that there is a feasible procedure available to economically meet SDWA standards in very small communities. The goal is that the documented results will encourage those decision makers to apply these methods within their jurisdictions. Thus, many very small public water supplies will finally have the necessary knowledge and opportunity to provide safe drinking water to their residents. This project is intended to identify the conditions necessary for successful implementation of a centrally managed POU system strategy for compliance with the SDWA.

A project management group (PMG) was formed to help guide this project. The PMG included representatives from the US Environmental Protection Agency (EPA), Association of State Drinking Water Administrators (ASDWA), American Water Works Association (AWWA), National Rural Water Association (NRWA), and the Water Quality Association (WQA). The PMG helped develop criteria for community and equipment selection, and review and comment on project outcomes.

Criteria for the community selection included size (25-100 connections), compliance (otherwise in compliance with the SDWA), arsenic concentration (20-50 μg/L), water quality compatible with selected technologies, support from appropriate regulatory agencies, community willingness to participate, and a community with a variety of different installations; i.e. residences and businesses. The community selected was Grimes, CA. It is a small residential and farming community about 45 miles northwest of Sacramento. The arsenic concentration in Grimes was 25 μg/L; evenly split between arsenic (III) and arsenic (V). The

water was chlorinated, so for treatment purposes the arsenic was all in the +5 valence state. The community was mostly residential but did have two restaurants, a store, library, school and church. The homes varied from cabins and trailers to more typical family homes. Three volunteer town board members managed the community water supply.

Criteria for treatment equipment selection included performance, cost, and ease of use. The PMG preferred a media based product to reverse osmosis (RO). Other considerations were the inclusion of an automatic shut off device or alarm to signal when the media cartridges needed replacement, availability of a local service representative, certification against appropriate NSF International (NSF) and American National Standards Institute (ANSI) standards, a warranty, whether the manufacturer would donate the treatment units, commercial availability of the product, and ease of installation and maintenance. Several manufacturers offered equipment free of charge. A Kinetico, Incorporated activated alumina (AA) device was selected. It was composed of two AA cartridges in series followed by a granular activated carbon (GAC) cartridge. It was designed to be installed under the sink with a separate drinking water tap. It had an automatic shut off device set to activate after 500 gallons. There was a local distributor available for service during the project and after project completion. Kinetico donated the equipment for the project and a complete set of replacement cartridges for change out at project completion.

Certification of the Kinetico product for arsenic reduction under NSF/ANSI Standard 53, *Drinking water treatment units – Health effects*, was not possible because the test protocol was still in draft status at the time of the project. The product was tested against the draft test protocol for arsenic (V) reduction. It passed for a 500-gallon treatment capacity, and it also met the other requirements of the standard, such as materials safety and structural integrity. The AA media itself was certified to NSF/ANSI Standard 61 – *Drinking water system components – Health effects*. Pilot testing of the product was also conducted in Grimes prior to installation to confirm performance with Grimes drinking water and to verify that units were still producing water with non-detectable (<2 μg/L) levels of arsenic at shut off (500 gallons). The California Department of Health Services (DHS) requested that the units meet the <2 μg/L criteria instead of the MCL to provide a safety factor. Two units were run to exhaustion with their shut off devices disabled. The units were producing water containing <2 μg/L of arsenic beyond 500 gallons. The treated water did not reach 10 μg/L until approximately 800 gallons.

The spent cartridges from the pilot test, loaded with more arsenic than they would under normal operation, were tested for disposal safety according to the California Waste Extraction Test (WET) and EPA Toxicity Characteristics Leaching Procedure (TCLP) test. They passed both tests; indicating that disposal in the household trash would be acceptable.

A town meeting was held in Grimes to explain the project and encourage participation. The response was generally positive although a few individuals thought the regulation was unnecessary. As the project progressed more people participated. At the end of the project, only six residences did not have units installed, two of which already had their own RO systems. The fact that the units included GAC treatment to remove chlorine, tastes, and odors was a contributing factor to acceptance. Homeowners were asked if they would be willing to pay more for water service that included the POU devices. At the time of the project, residents paid $5 per month for water in Grimes. The average response was that they would be willing to pay $8 per month for POU treatment and $12 per month for central treatment.

Installation provided some challenges. Installations began in July, which coincided with the beginning of the harvest period. It was difficult to schedule them with residents who worked in agriculture. Also, several residents spoke very little English. The physical configuration of plumbing in some of the homes was unusual. Installation of the system in a typical modern home should take 15 to 30 minutes. Installation times in Grimes ranged from 15 minutes to 3 hours, including business installations. Note that the time the plumbers spent tracking down unusual parts and fittings was not included in the installation times, but was included in the calculation of the cost of installation.

The performance of every unit was verified at installation. All units were producing water with <2 μg/L of arsenic. Sampling continued on a quarterly basis. Most units continued to produce water with <2 μg/L of arsenic throughout the project. Very few units needed to be replaced during the 12 months of operation. A few units produced water with greater than 2 μg/L but less than 10 ppb before the shut off device activated. When arsenic was detected in the treated water at >2 μg/L, the filter cartridges were replaced immediately. The carbon filters used in this project were standard production units, but the AA cartridges were not. Kinetico discovered late in the project that the contractor filling the AA cartridges was not filling all of them to capacity. This may explain the few positive arsenic samples. Cartridges not completely filled could experience channeling through the media.

Treated water samples were also collected for heterotrophic plate count (HPC) and fecal coliform analysis. There were no positive fecal coliform samples. The geometric mean of the HPC counts from each quarterly sampling event were 134 colony-forming units per milliliter (cfu/ml), 169 cfu/ml, 255 cfu/ml, and 33 cfu/ml.

The units whose automatic shut off devices activated during the project were all in high use situations, such as the school drinking fountains, businesses, or large families.

Water meters were installed on some units as an additional indicator of use. The mean use per person per day was 0.49 gallons. Mean household usage per day was 1.26 gallons.

The sole complaint of homeowners was the low flow rate of the treated water (less than 0.5 gallons per minute). Homeowners did not object to people entering their homes for installation, sampling, and maintenance.

Costs were tracked for installation, operation and maintenance. Kinetico also provided estimated costs for installing central treatment equipment. These data were used to predict monthly homeowner costs for POU treatment and central treatment, both using AA. Costs were calculated using a projected seven-year life and a seven percent cost recovery rate. Central treatment would be $24.31. POU treatment with all cartridges changed every six months, and no sampling for equipment performance monitoring would be $18 per month. If the filter cartridges were changed annually, and every unit was sampled once per year, the monthly cost would be $14.67. Annual filter cartridge change-out with sampling from only one half of the units would drop the cost to $13.75 per month. If the units were allowed to operate until shut off device activation, with one half of the units sampled per year, the cost would be $11.46. This figure assumes that the average time to shut off is 2 years. For a community with more standard installations, monthly costs could be reduced by $3.75. Grimes costs were probably higher than average for installation, but administration costs were lower because so much of the work was volunteered in this community.