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WATER SYSTEM FEASIBILITY STUDY FOR

BIG FLOYD LAKE
DETROIT TOWNSHIP
BECKER COUNTY, MINNESOTA

DECEMBER 1997

Prepared By

Widseth Smith Nolting & Assoc., Inc.
Project No. 470A473

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JANUARY 1998

<u>DETROIT TOWNSHIP</u>

Chair:	John Tigges
Clerk:	Ray Windschitl
Supervisor:	Eugene Pavelko
	Curtis Weldon

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I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Timothy E. Bayerl	Jan. 5, 1998	17651
Timothy E. Bayerl, P.E.	Date	Reg. No.

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2. ESTIMATED WATER USE

Based on information presented in the Wastewater Facility Plan, the design flow will be based on 285 homes each having a projected flow rate of 200 gallons per day (gpd) per home. Therefore the average daily flow (AD) will be 57,000 gpd. Converting this flow rate to gallons per minute (gpm) equals 40 gpm for AD. In water system design, peaking factors are often used to estimate other important flow rate values. For this study peaking factors for Max Day (MD) = 3.0 and Peak Hour (PH) = 6.75 were used. The following table is a summary of these flow rates.

Design Flows

AD	40 gpm
MD	120 gpm
PH	270 gpm

Another important flow rate is the needed fire flow. Based on our experience with other similar cases, we estimate needed fire flow for this type of residential area to be a minimum of 750 gpm for 2 hours.

3. WATER SUPPLY

For water systems such as the system proposed for Big Floyd Lake, groundwater sources are typically used for water supply. This section of the report is intended to supply some background information and discuss proposed water supply system (i.e. groundwater wells)

GEOLOGY

The Floyd Lake area is located on surficial sand deposits formed by outwash flow from melting glaciers. Although the surficial sand deposits consist of mainly fine to medium-grained sand, gravel layers and thin silt layers are commonly found in the outwash. The hummocky terrain of the surficial deposits was caused by blocks of ice within and beneath the outwash, which later melted leaving depressions and hillocks.

Beneath the surficial outwash are till deposits. Till is a glacial sediment consisting of predominantly clay with varying amounts of silt, sand, gravel, and cobbles, deposited in an unsorted mix directly by wasting ice. The till is found at a depth of 50 to 70 feet beneath the surface in the area just south of Floyd Lake and extends to depths of 150 feet to greater than 170 feet. Beneath the till is a sand outwash layer of 25 to 40 feet in thickness.

Little information is available below that depth, but it is believed that additional till and outwash layers extend to bedrock at a depth of 400 to 450 feet. Bedrock consists of crystalline metamorphic rocks.

HYDROGEOLOGY

Groundwater is found as a water-table aquifer within the surficial sand deposits at depths of 5 to 30 feet below the surface. Pumpable quantities of groundwater occur within the surficial outwash and the outwash layers in and beneath the till. In general, the till is not an adequate source of groundwater because it has high clay content, and thus forms a confining layer to the buried outwash.

Groundwater flow in the surficial watertable is influenced by topography and flows toward area lakes and streams, but regionally the groundwater flow is to the south at Floyd Lake. In the buried outwash aquifers beneath the till, groundwater flow is likely to the west toward the Red River Valley.

Most of the wells in the area of Floyd Lake are either shallow sandpoint wells less than 20 feet deep or drilled wells to around 60 feet deep within the surficial outwash deposits. The surficial sands are often fine-grained; thus, the aquifer has limited production capability and the wells in the area are generally not able to produce more than 50 gpm.

Farther south and southwest of the Floyd Lake area, the wells are often drilled to depths of over 150 feet deep and screened in confined outwash layers. The buried outwash layers are often highly productive, with wells producing 100 gpm to over 1,000 gpm. The City of Detroit Lakes' wells are in a buried outwash aquifer and are capable of producing greater than 1,300 gpm according to the United States Geological Survey Hydrologic Atlas for the Otter Tail River watershed.

Groundwater quality from the surficial and buried aquifers is good, with relatively low amounts of hardness and total dissolved solids. Water from the buried outwash aquifers, however, generally has higher concentrations of iron and manganese with levels commonly around 1 ppm and 0.1 ppm, respectively. This compares with 0.3 ppm iron and 0.05 manganese for the surficial aquifer. Alternatively, the surficial aquifer would likely have higher concentrations of nitrates and, potentially, pesticides or other contaminants. This is because the surficial aquifer has no confining clay layer that can prevent infiltration of contaminants.

WATER SUPPLY OPTIONS

Detroit Township has two options for a groundwater supply source: they can use either the surficial aquifer; or drill deeper wells to one of the buried outwash aquifers that likely exist below a depth of 170 feet.

Wells in the surficial aquifer will cost less to drill, but it may be difficult to obtain wells with capacities greater than 100 gpm because of the fine-grained nature of the sand deposits. Two wells may be needed to obtain the design capacity, which may be a benefit, as the system would then have a backup well if one well went down. Another drawback is the surficial aquifer may have some nitrate contamination from agricultural practices and septic systems. Even if contamination is not currently present, the surficial aquifer is more susceptible to contamination from surface sources.

Wells in the buried outwash have the advantage of being well protected from surface contamination sources. The negatives are they will cost somewhat more and the water will likely be higher in iron and manganese that may cause staining and scale problems in the water system. (Iron and manganese in the surficial aquifer could cause the same problems). One well would likely be able to produce the design capacity; however, a second well would provide more reliability.

TEST DRILLING

For either water supply option, it is recommended that test drilling be completed to determine the depth and production capability of the target aquifer. A temporary test well should be installed to complete a pumping test of the aquifer at which time water samples can be obtained for laboratory analysis of groundwater quality.

WELLHEAD PROTECTION

The Minnesota Dept. of Health has recently finalized wellhead protection regulations which will be implemented for any new community water supply wells. These regulations require submittal of preliminary delineations to the MDH as part of the construction plans for the new well. MDH will approve the preliminary delineation as part of the plan approval process.

The water supplier will then be required to prepare a wellhead protection plan that includes a full (more rigorous) delineation of the wellhead protection area. Both the preliminary and full delineation's determine the area from which groundwater will move to the well(s) over a ten-year time period. They incorporate the projected pumping quantity per year, well design attributes, and characteristics of the aquifer.

The wellhead protection plan will be a plan to prevent contamination of the well. Determining what control actions to implement will be up to the local unit of government. These actions could be as simple taking an inventory of potential contaminant sources, such as industries, potential migration pathways, and unused wells. This, combined with training and education of residents and businesses in the area, could be a cost-effective control measure. Although they are most costly and difficult to implement, programs such as regulatory or zoning controls could also be used, as could be a groundwater monitoring program.

4. ALTERNATIVE SYSTEM COMPONENTS CONSIDERED

In this report various alternatives were evaluated for the water system. For the purpose of this report the water system is divided into the following four components; supply, treatment, storage and distribution. Combinations of these water system components were used to form three alternatives and are discussed in the next section of the report.

WATER SUPPLY

Two 120 gpm wells for alternatives with a storage reservoir. Well pumps for options without a storage reservoir need to be able to produce a minimum of 270 gpm total.

While the hydrogeologic information presented states that is possible to complete wells into the shallow aquifer, the deep aquifer is recommended for this project. The potential problems discussed earlier would make the water supply less reliable for this system.

WATER TREATMENT

Water treatment in some form is usually necessary in a municipal water system. For this report two scenarios were evaluated for treatment, first was a chemical feed system and the other was an iron and/or manganese filtration plant.

Chemical Feed System

A chemical feed system consists of equipment near the wellhead that inject various water treatment chemicals into the water. Fluoride is a Health Department requirement and chlorine is strongly recommended. Phosphate would likely be added if significant quantities of iron are found in the water. Phosphate sequesters iron into a soluble form and prevents many iron related problems. While this system is simple and thus less costly, it has limitations as to the range of water treatment effectiveness.

Filtration Plant

Iron and manganese commonly found in ground water sources in this region. A treatment process that significantly improves the esthetic qualities of water is filtration. This type of plant would remove the iron and manganese as well as some other constituents from the water. This type of plant is a sophisticated system that can be more costly to build and maintain, but produces much higher quality water.

STORAGE

The storage options evaluated are primarily differentiated by size. For this type of system and elevated storage tower will probably not be cost effective. The ground storage alternatives use different steel/concrete tanks, pump equipment and hydropneumatic tanks.

If a water filtration plant is added, then some ground storage is needed to extend treatment plant run times while still allowing for a smaller flow rate through the plant. If fire flow storage is desired a large ground storage reservoir with fire pumps is needed.

WATER DISTRIBUTION

The two water distribution system alternatives are contrasting in their design concepts and have significant cost differences. One alternative is to construct a "rural" type system and the other would be a "municipal" type system. For the purposes of this report a rural type water distribution system would consist of buried pipes sized to convey only normal domestic use water. A municipal type water distribution system would have larger pipes to convey domestic use water plus fire flows. Since fire flows are significantly higher than domestic flows the pipes and fittings would all be larger and more costly. Pipe sizes are shown on the attached exhibits (4-1 and 4-2).

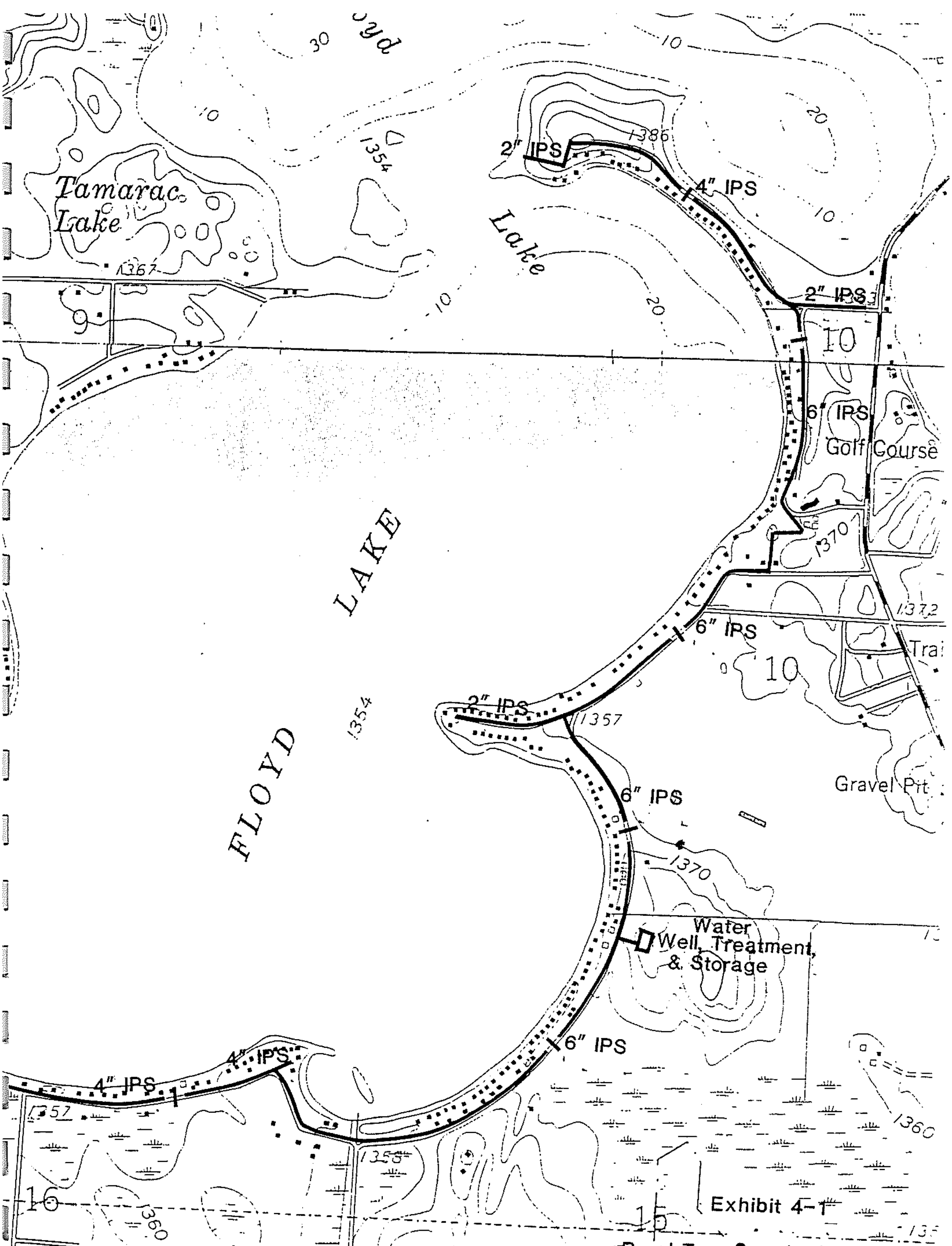

Exhibit 4-1

Rural Type Distribution System

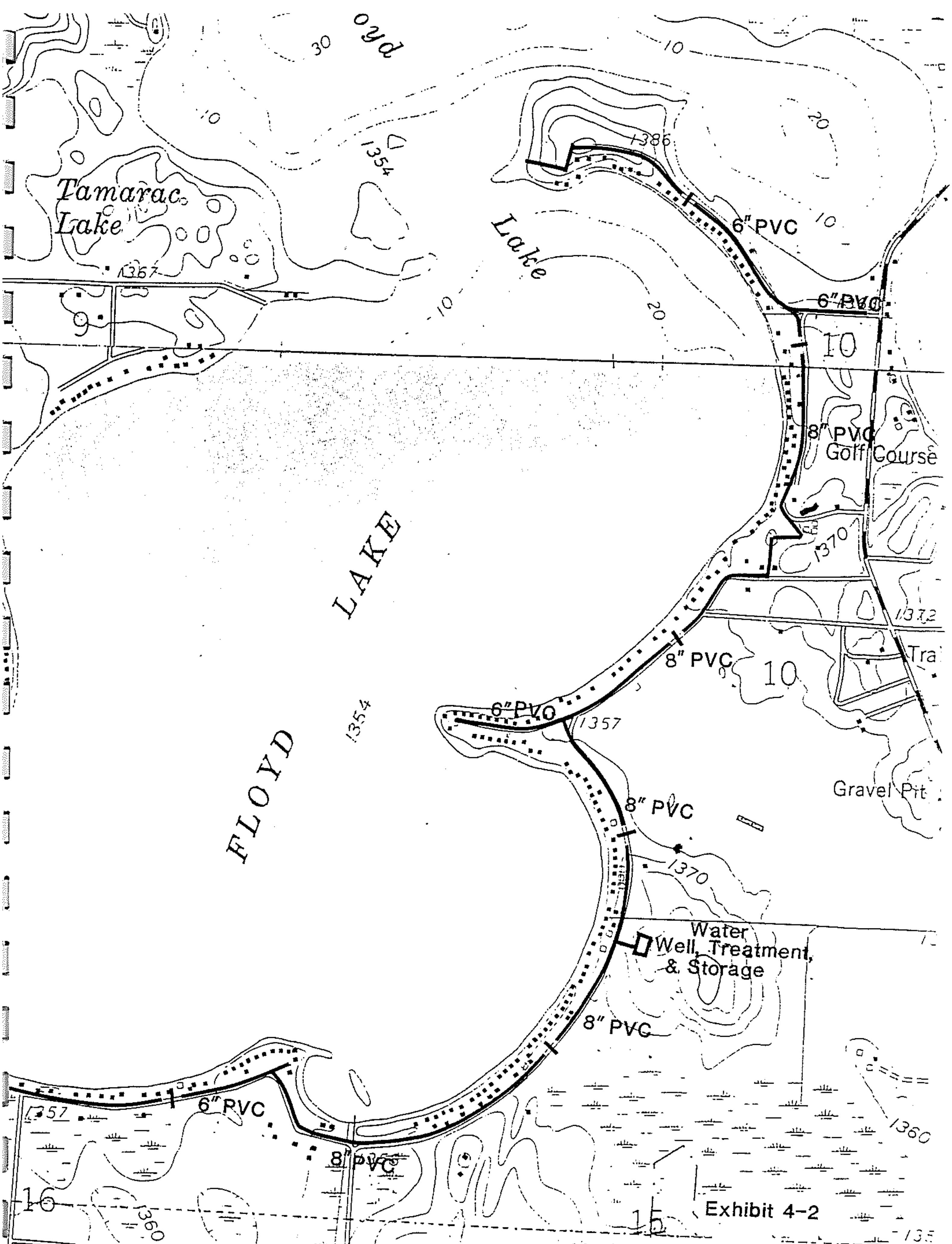

Exhibit 4-2

Municipal Type Distribution System

5. ALTERNATIVE ANALYSIS

In the following alternative analysis components described above were combined to make three alternatives. The following tablet is a summary of the three alternatives.

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
SUPPLY	Wells into the deeper aquifer	Wells into the deeper aquifer	Wells into the deeper aquifer
TREATMENT	Chemical feed system	Filtration plant	Filtration plant
STORAGE	Pump/control equipment and hydropneumatic tanks	Pump/control equipment and ground storage	Pump/control equipment and ground storage
DISTRIBUTION	"Rural" type distribution piping	"Rural" type distribution piping	"Municipal" type distribution piping

Cost estimates for each of the alternatives are included at the end of this section. The following discussion describes the advantages and problems with each alternative.

ALT-1, RURAL TYPE DISTRIBUTION WITH CHEMICAL FEED WATER TREATMENT

Supply ------------------- Wells into the deeper aquifer
Treatment --------------- Chemical feed system
Storage ------------------ Pump/control equipment and hydropneumatic tanks
Distribution ------------- "Rural" type distribution piping

This alternative is the least cost alternative. Estimated costs for this alternative are $756,800. With just the chemical feed equipment type of water treatment, the expense of a filtration plant is avoided. The rural style distribution system also is a less costly distribution system.

An advantage of this alternative is that the deep aquifer wells would provide a reliable water supply with some protection from some types of water contamination (such as nitrates). However, residents now acknowledge that the water quality from individual wells is not high. Water from the deep aquifer is likely to have high iron. This alternative would not take advantage of one of the major advantages of central water supply; cost effective water treatment.

ALT-2, RURAL TYPE DISTRIBUTION WITH FILTRATION PLANT

Supply ------------------- Wells into the deeper aquifer
Treatment --------------- Filtration plant
Storage ------------------ Pump/control equipment and ground storage
Distribution ------------- "Rural" type distribution piping

This alternative builds on Alternative 1 by adding a water filtration plant and ground storage. The filtration plant would provide water that is higher in quality from a central source. In order to keep the flow rate of the filtration plant down (flow rate effects costs), a ground storage reservoir would be added to this alternative.

The principal advantage of this alternative would be the improved water quality. Estimated costs for this alternative are $1,395,800, which is $639,000 more than Alternative 1.

ALT-3, MUNICIPAL TYPE DISTRIBUTION WITH FILTRATION PLANT

Supply ------------------- Wells into the deeper aquifer
Treatment --------------- Filtration plant
Storage ------------------ Pump/control equipment and ground storage
Distribution ------------- "Municipal" type distribution piping

Again this alternative builds on the previous alternatives. In addition to water treatment, a municipal style water distribution system is added to allow for fire flows to be delivered throughout the system. Because of the fire flows, a larger ground storage reservoir is included.

Water distribution mains and storage are sized to provide 750 gpm for 2 hours for fire protection. While fire flow is certainly an advantage, this alternative is estimated to cost $1,737,000. The cost increase over Alternative 2 would be $341,200.

ALTERNATIVE 1

Rural Type Distribution with Chemical Feed Water Treatment

Supply	**Wells into the deeper aquifer**	
	2- 150 gpm wells into deeper aquifer	$100,000
	Test Drilling	$12,000
		$112,000
Treatment	**Chemical feed system**	
	Flouride, Chlorine & Phospate feed equip.	$30,000
		$30,000
Storage	**Pump/control equipment and hydropneumatic tanks**	
	Pump controls	$40,000
	Hydropneumatic tanks	$20,000
	Pump house	$50,000
		$110,000

Distribution **"Rural" type distribution piping**

Item Description	Unit	Quantity	Unit Price	Cost
Mobilization	L.S.	1	$10,000.00	$10,000
6" IPS PVC Watermain	L.F.	9500	$10.00	$95,000
4" IPS PVC Watermain	L.F.	6000	$8.00	$48,000
2" IPS PVC Watermain	L.F.	2100	$6.00	$12,600
6" Gate Valve	Each	4	$400.00	$1,600
4" Gate Valve	Each	2	$300.00	$600
Flushing Hydrants	Each	5	$1,500.00	$7,500
1-1/2" PE Service pipe	L.F.	8550	$7.00	$59,850
1-1/2" Saddle	Each	285	$120.00	$34,200
1-1/2" Curb Stop w/Box	Each	285	$170.00	$48,450
				$317,800

Total Costs	
Supply	$112,000
Treatment	$30,000
Storage	$110,000
Distribution	$317,800
Estimated Construction Cost	$569,800
Contingencies (15%)	$85,000
Engineering -Basic Services (8.5%)	$48,000
-Construction (7.5%)	$43,000
Legal, Fiscal and Administrative (2%)	$11,000
Total Estimated Cost	$756,800

ALTERNATIVE 2

Rural Type Distribution with Filtration Plant

Supply	**Wells into the deeper aquifer**	
	2- 120 gpm wells into deeper aquifer	$80,000
	Test Drilling	$12,000
		$92,000
Treatment	**Filtration Plant**	
	Water filtration plant	$500,000
		$500,000
Storage	**Pump/control equipment and ground storage**	
	Pump controls	$40,000
	High Service Pumps	$25,000
	Ground storage reservoir	$75,000
		$140,000

Distribution **"Rural" type distribution piping**

Item Description	Unit	Quantity	Unit Price	Cost
Mobilization	L.S.	1	$10,000.00	$10,000
6" IPS PVC Watermain	L.F.	9500	$10.00	$95,000
4" IPS PVC Watermain	L.F.	6000	$8.00	$48,000
2" IPS PVC Watermain	L.F.	2100	$6.00	$12,600
6" Gate Valve	Each	4	$400.00	$1,600
4" Gate Valve	Each	2	$300.00	$600
Flushing Hydrants	Each	5	$1,500.00	$7,500
1-1/2" PE Service pipe	L.F.	8550	$7.00	$59,850
1-1/2" Saddle	Each	285	$120.00	$34,200
1-1/2" Curb Stop w/Box	Each	285	$170.00	$48,450
				$317,800

Total Costs	
Supply	$92,000
Treatment	$500,000
Storage	$140,000
Distribution	$317,800
Estimated Construction Cost	$1,049,800
Contingencies (15%)	$157,000
Engineering -Basic Services (8.5%)	$89,000
-Construction (7.5%)	$79,000
Legal, Fiscal and Administrative (2%)	$21,000
Total Estimated Cost	$1,395,800

ALTERNATIVE 3

Municipal Type Distribution with Filtration Plant

Supply — **Wells into the deeper aquifer**

2- 120 gpm wells into deeper aquifer	$80,000
Test Drilling	$12,000
	$92,000

Treatment — **Filtration Plant**

Water filtration plant	$500,000
	$500,000

Storage — **Pump/control equipment and ground storage**

Pump controls	$40,000
Pumps	$25,000
Ground storage reservoir	$100,000
Fire Pump	$25,000
	$190,000

Distribution — **"Municipal" type distribution piping**

Item Description	Unit	Quantity	Unit Price	Cost
Mobilization	L.S.	1	$15,000.00	$15,000
8" PVC Watermain	L.F.	9700	$18.00	$174,600
6" PVC Watermain	L.F.	7500	$15.00	$112,500
8" Gate Valve	Each	5	$700.00	$3,500
6" Gate Valve	Each	32	$400.00	$12,800
Hydrants	Each	27	$1,500.00	$40,500
Fittings	Each	11	$500.00	$5,500
1" Copper Service	L.F.	8550	$12.00	$102,600
1" Corporation Stop	Each	285	$100.00	$28,500
1" Curb Stop w/ Box	Each	285	$100.00	$28,500
				$524,000

Total Costs

Supply	$92,000
Treatment	$500,000
Storage	$190,000
Distribution	$524,000
Estimated Construction Cost	$1,306,000
Contingencies (15%)	$196,000
Engineering -Basic Services (8.5%)	$111,000
-Construction (7.5%)	$98,000
Legal, Fiscal and Administrative (2%)	$26,000
Total Estimated Cost	$1,737,000

6. ESTIMATED COST PER USER

This section of the report provides an estimate of cost per household (lot) for the water system. This study is only preliminary in scope, and costs estimated are approximate.

In order to estimate user costs; operation, maintenance and replacement (OM&R) costs for the system are needed. Since no cost history for this system exists, an estimate based on other systems is the only available basis for a cost estimate. For Alternative 1 the OM&R costs would be the least and are estimated at $15,000 per year. Alternatives 2 and 3 have the additional expense of the water treatment plant costs and are estimated at $25,000 per year.

In developing estimated user costs OM&R typically is charged monthly on a water bill. Capitol (construction) retirement cost can either be included with the water bill or assessed to the benefiting properties.

	Alternative 1	Alternative 2	Alternative 3
Annual OM@R cost	$ 15,000	$ 25,000	$ 25,000
Monthly OM&R payment per user (based on 242 lots)	$ 5.17	$ 8.61	$ 8.61
Estimated Capitol Cost	$ 756,800	$ 1,395,800	$ 1,737,000
Intrest Rate	6%	6%	6%
Term (yr)	20	20	20
Annual Payment for System	$ 65,981	$ 121,692	$ 151,440
Monthly Payment per User for Capitol Cost (based on 242 lots)	$ 22.72	$ 41.91	$ 52.15
Total Monthly Payment per User (OM&R plus Capitol Cost (based on 242 lots)	$ 27.89	$ 50.51	$ 60.76

7. CONCLUSIONS AND RECOMMENDATIONS

Detroit Township ordered completion of this Water System Feasibility Study because a Wastewater Facility Plan is being completed, and it would be cost effective to install a water system concurrently. If a wastewater project proceeds, it is our recommendation that a water system be seriously considered at the same time. By constructing a water system concurrently with the wastewater system, considerable cost savings can be realized. Cost to complete the water distribution system would approximately double if surface restoration of paved roads is included. These costs are now included in the wastewater project.

Based on the information presented in this report, the recommended alternative is Alternative 2. This alternative would provide filtration-type treated water through a "rural" type distribution system. The estimated project cost is $1,395,800.

1,395,800
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