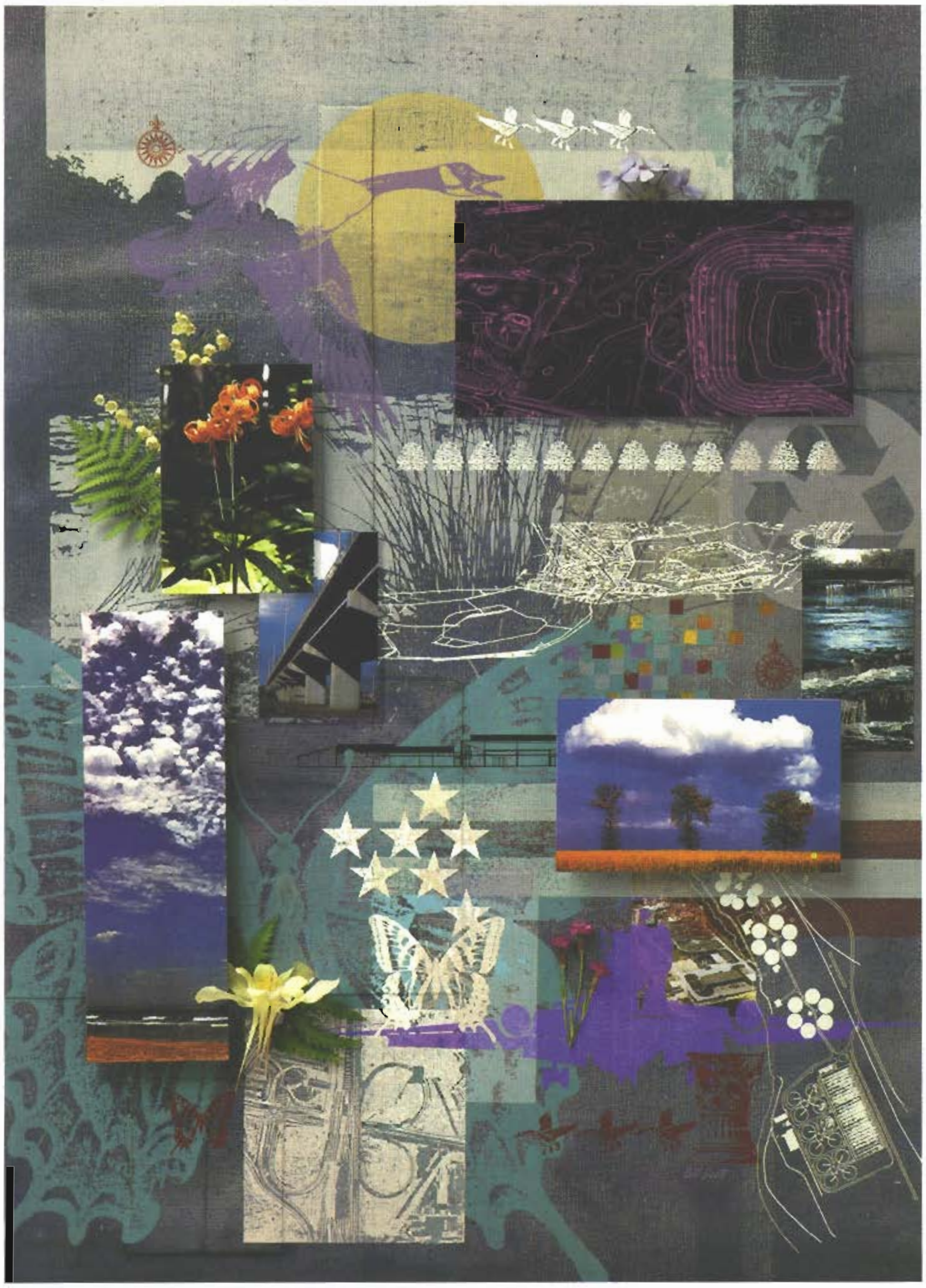
Quality • Integrity • Creativity • Responsiveness



Quality through teamwork

Paddock Lake Investigations

Water Quality Review and Nonpoint Source Control Alternatives

Prepared for:

Village of Paddock Lake and Paddock Lake Protection and Rehabilitation District

April 1994

Rust Environment & Infrastructure

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1.0 INTRODUCTION

1.1 Project Background

Paddock Lake, is a 132 acre "kettle" lake located in Kenosha County Wisconsin. The lake is entirely surrounded by the corporate boundaries of the Village of Paddock Lake.

Under a grant from the Wisconsin Department of Natural Resources' (WDNR) Lake Planning Grant Program, the Paddock Lake Protection and Rehabilitation District (PLPRD) and the Village conducted a study of the lake's water quality, pollution sources, and water budget in 1993. This study was documented in a 1994 report: *Paddock Lake Investigations and Management Plan.* (Woodward-Clyde Consultants, 1994).

As a continuation of that study, the Village and the PLPRD, carried out two of the recommendations from that report. In 1994, the PLPRD received a second Lake Planning Grant from the WDNR to conduct this second study. The two recommendations addressed in this report are:

- Continuation of the water quality monitoring of the lake's trophic conditions, and
- Investigation of the feasibility of structural verses non-structural nonpoint source control measures in the sub-basin identified as "U4" in the 1994 report.

1.2 Scope of Work

The scope of work for this study are described below.

<u>Water Quality Monitoring.</u>

Lake sampling was conducted five times during 1995. Samples were obtained:
winter (February)
spring (April)
summer - (June, July, and August)

Sampling was conducted at a site near the deepest point of the lake.

At each trip the following parameters were measured:

- temperature-dissolved oxygen profile
- Secchi disk
- total phosphorous: sampled near the surface and bottom for winter and spring samples; hypolimnion, thermocline, and epilimnion for summer samples)
- chlorophyll *a* (surface measurement)

The State Laboratory of Hygiene (SLOH) in Madison, WI analyzed the samples for phosphorous and Chlorophyll *a* samples. Sample handling procedures followed protocol specified by the SLOH.

Nonpoint Source Pollution Controls Analysis for Sub-watershed U4.

Control of nonpoint source pollution in sub-watershed U4 was recommended in *Paddock Lake Investigations and Management Plan* (1994). This project analyzed two alternative pollution control measures on this area:

- Land Acquisition/Stabilization: Acquiring the agricultural land within U4 and stabilize the site with permanent vegetation.

- Installation of a nonpoint source pollution control structure either near the corner of 248th Avenue and 66th Street and/or near the storm sewer outlet pipe at the lake.

The analysis of each alternative included:

- positive and negative aspects,
- pollution reduction that can be achieved,
- physical, economic, political, constraints,
- legal and/or administrative obstacles,
- implementation and maintenance costs, and
- potential sources of funding (state and/or federal).

The overall goal of this analysis is to allow the Village and the PLPRD to be in a position to begin design and/or implementation of a recommended nonpoint source pollution control alternative.

2.0 WATER QUALITY MONITORING

2.1 Water Quality Data Sources

Water quality data collected on Paddock Lake comes from these sources:

- Wisconsin Conservation Department (WCD)
- Wisconsin Department of Natural Resources (WDNR) - Bureau of Research,
- Paddock Lake Volunteer Lake Monitoring
- *Paddock Lake Investigations and Management Plan* (Woodward-Clyde Consultants 1994)
- Rust E&I, 1995 sampling

The type of data and the years each was collected are summarized in Table 2.1.

Table 2.1. Water Quality Data Sources

Data Source	Dissolved Oxygen	Temperature	Total Phosphorus	Chlorophyll *a*	Secchi Disk	Years Sampled
WCD	X	X			X	1951
WDNR	X	X			X	1970
WDNR	X	X	X	X	X	1973-1975
Woodward - Clyde	X	X	X	X	X	1993
Volunteer Monitoring					X	1993 - 1995
Rust E&I	X	X	X	X	X	1995

In 1995, water quality samples were obtained on February 28, April 22, June 22, July 20, and August 19.

2.2 Water Quality Sampling Methods

Water quality sampling was conducted on regular basis since 1993. The procedures and methods used by Woodward-Clyde are discussed in their reported cited above. Since 1994 a volunteer has measured Secchi depths on a weekly to biweekly basis between May and September. Rust E&I coordinated more comprehensive water and temperature sampling with the volunteer effort in 1995. On a monthly basis water samples were collected, immediately placed on ice, and submitted to the

Wisconsin Laboratory of Hygiene (SLOH) in Madison within 24 hours of sampling. Temperature and dissolved oxygen measurements throughout the lake's water column at the deepest point of the lake. Water samples were taken from the surface, middle, and bottom of the lake on a monthly basis and analyzed for chlorophyll *a*, and total phosphorous.

2.3 Water Quality Indicators

The 1995 sampling focused on three parameters which closely relate to a lake's trophic status. The trophic status is a description of how "fertile" and lake is. A lake with high fertility, has a greatly potential for supporting nuisance levels algae and/or macrophyte growth. Three trophic status indicators are described below.

Water Clarity: Secchi disk measurements are an easily understood measure of water clarity. This procedure has been accepted and in long use due its simplicity, ease of measurement, cost, and ability to be understood. Water clarity in southern Wisconsin lakes is usually directly related to the algae level in the lake, or the turbidity in the lake from sediment (soil particles).

Chlorophyll-*a*: Chlorophyll-*a* pigment is found in algae and is directly correlated with the amount of algae in a lake. The amount of chlorophyll-*a* varies according to the bloom cycle of algae in a lake and therefore, is highly time dependent during the growing season.

Phosphorous Concentrations: The nutrient of most concern in terms of algae and/or macrophyte growth is phosphorous. High levels of phosphorous in the surface layer of a lake can supply algae with a necessary nutrient for a high level of production.

2.4 Water Quality Results and Trends

Secchi Disk Measurements

Figure 2.1 shows the average summer Secchi disk measurements on the lake from 1951 through 1995. The number of measurements used to obtain the average value are listed in the figure's sidebar. Time dependent trends in water clarity can not be determined due to the lack of data. Only since 1993 has regular sampling taken place such that the value on the graph represents an average from several samples taken at various times over the summer. The years with only 1 measurement may or may not represent average summer conditions. Therefore, it is not possible to determine a positive or negative trend in water clarity over the period sampled.

Figure 2.2 plots late July and early August Secchi depth measurements from the data available. This graph was constructed to show water clarity conditions during the same part of the summer over the sampling period. If a year had no late July or early August measurement it was not included in this plot. It shows no noticeable trend in water clarity over time. Again, with so few measurements and the influence of highly variable parameters, such as precipitation, it is not possible to positively identify trends over the sampling period.

Figure 2.1: Average Summer Time Secchi Depth Measurements on Paddock Lake

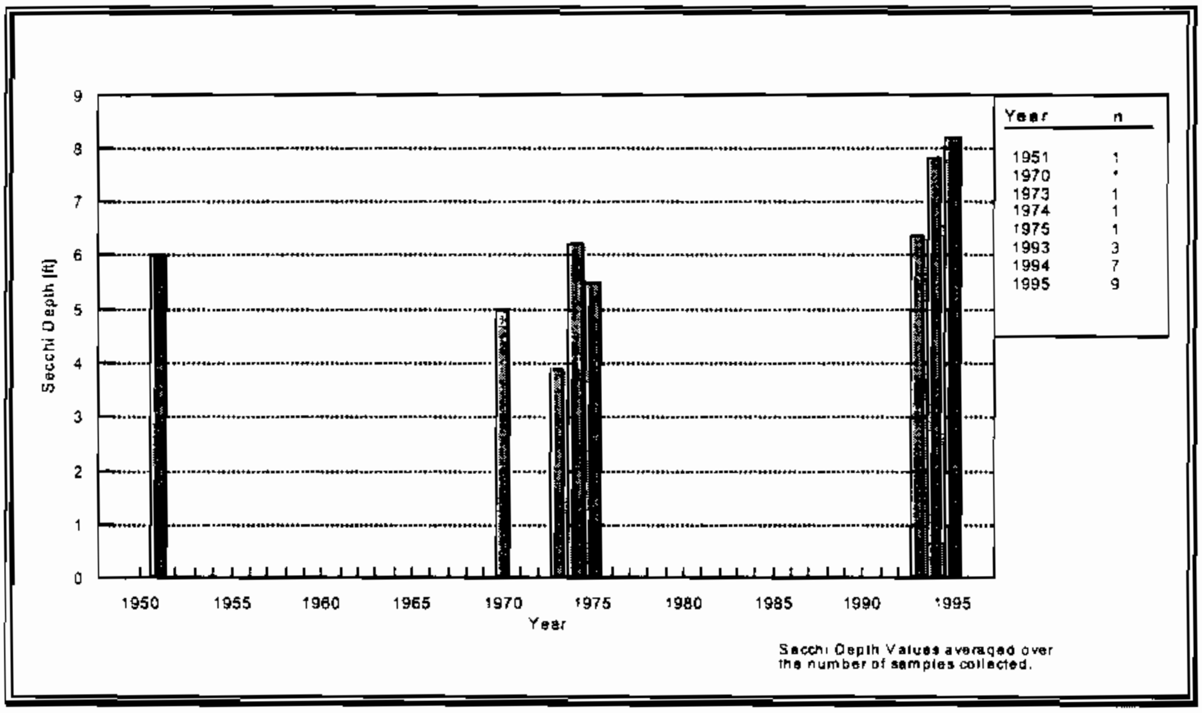
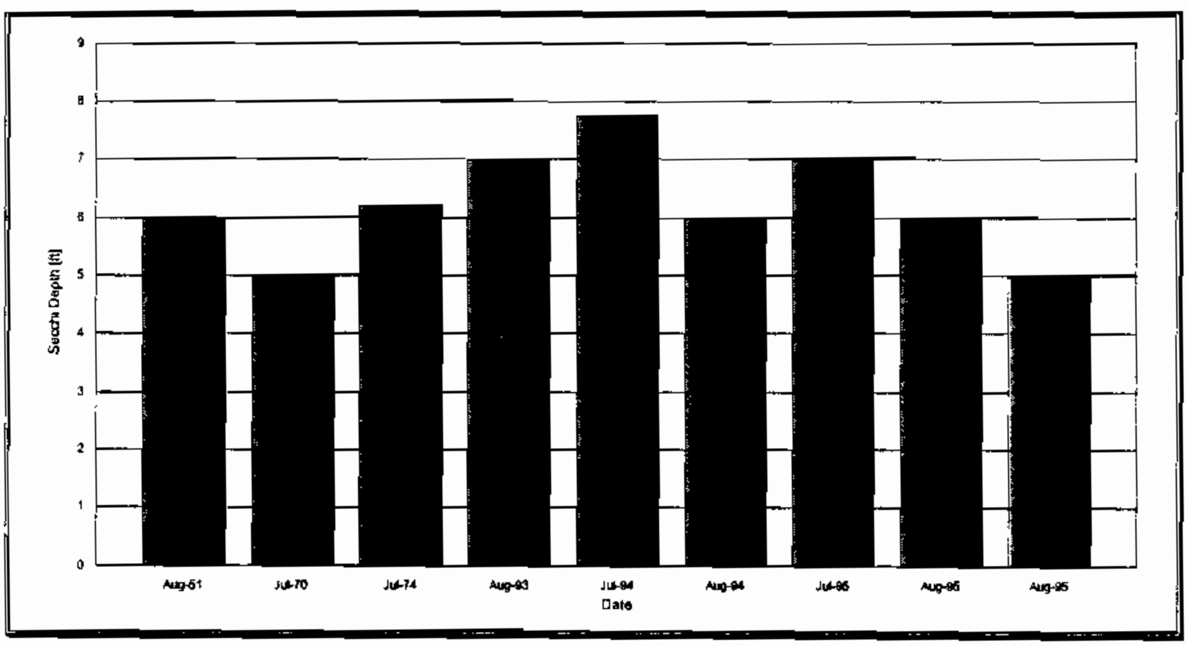


Figure 2.2 Late July and Early August Secchi Depth Measurements on Paddock Lake

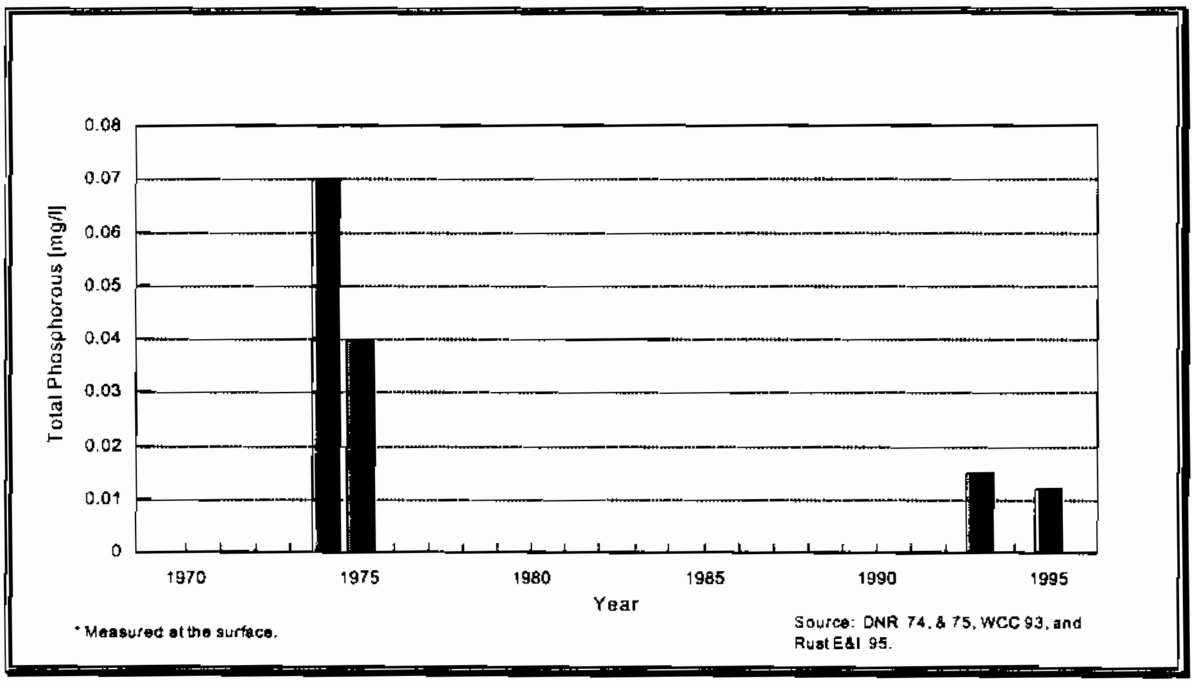


Total Phosphorous Concentrations

Spring (turnover) total phosphorous concentrations on Paddock Lake are available for 1974, 1975, 1993, and 1995. Figure 2.3 shows the spring total phosphorous concentrations determined from water samples collected from the surface from the four years of existing data. Spring concentrations of nutrients are important because this material will support early aquatic plant growth in the lake. Also, during the spring the lake's waters completely mix (top to bottom) because the water's temperature (and density) are equal from top to bottom. This means that phosphorous "trapped" in the deeper layers of the lake are available to the upper layers where algae growth takes place.

With only four years of data no trend in phosphorous levels can be identified with certainty and therefore, no changes were noted.

Figure 2.3 Spring Total Phosphorous Concentrations on Paddock Lake



Dissolved Oxygen

Five sets of dissolved oxygen and temperature profiles were gathered in 1995 from the deepest part of Paddock Lake. The graphs of these profiles are shown in Figure 2.4. The five 1995 profiles were collected between February 28 and August 19. These can be compared with the complete set of historical profiles included in the 1994 report by Woodward-Clyde

Late winter and early spring dissolved oxygen - temperature profiles show nearly uniform temperatures from the surface to the bottom of the lake and only a small decline in dissolved oxygen

Fig. 2.4a: Paddock Lake

Temperature / Dissolved Oxygen Profiles

February 28, 1995

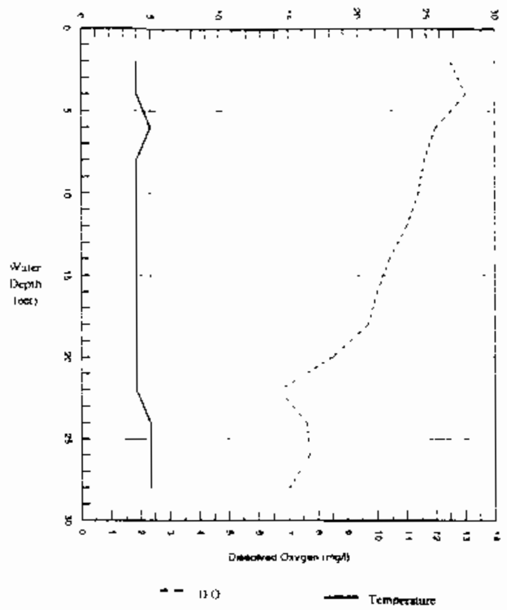


Fig. 2.4b: Paddock Lake

Temperature / Dissolved Oxygen Profiles

April 22, 1995

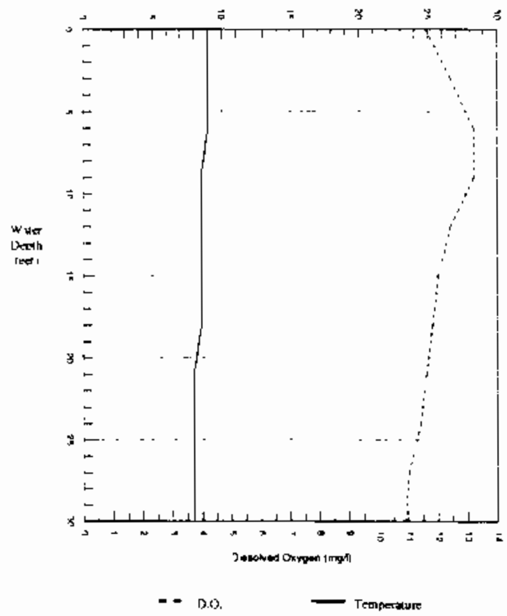


Fig. 2.4c: Paddock Lake

Temperature / Dissolved Oxygen Profiles

June 22, 1995

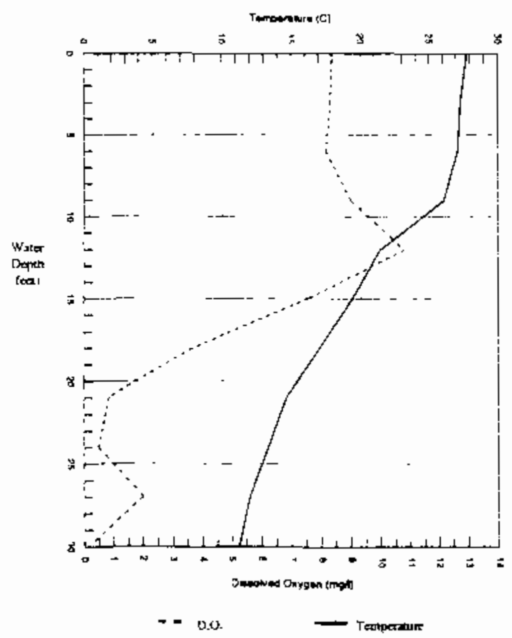


Fig 2.4d: Paddock Lake

Temperature / Dissolved Oxygen Profiles

July 20, 1995

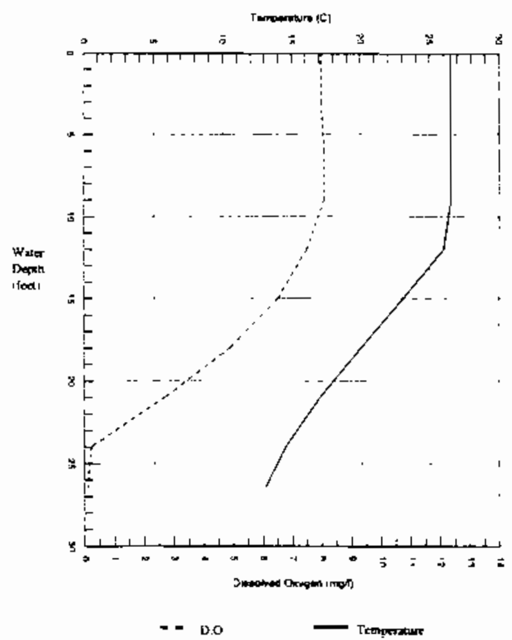
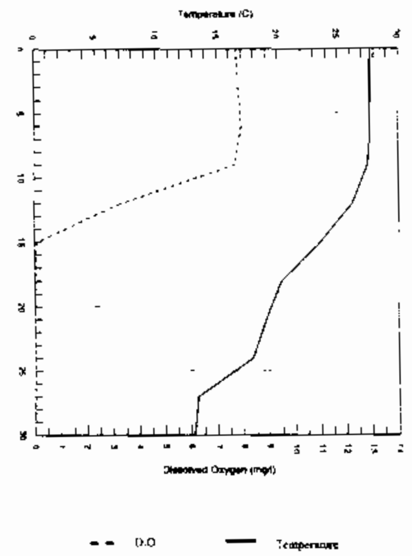


Fig 2.4c: Paddock

Temperature / Dissolved Oxygen Profiles

August 19, 1995



with increased depth. As summer progresses, the profiles show increased temperature and dissolved oxygen stratification. Two distinct layers are identifiable; the upper one is warmer with higher levels of dissolved oxygen and the lower one is cooler with decreased levels of DO until in July and August DO levels at the bottom of the lake are zero. From July to August the depth at which the DO is zero became shallower, starting at 24 feet in July as compared to 15 feet in August.

No significant changes in the oxygen depletion condition of Paddock Lake has been found over time. The data from 1995 is similar in magnitude to that collected previously. A decline in dissolved oxygen levels would indicate water quality degradation in Lake Paddock but this was not evidenced based on the previous monitoring in the 1970's

2.5 Trophic Status Modeling

Further update to the work completed by Woodward-Clyde was not warranted. No change in important parameters, nutrient concentrations in the lake, monthly rainfall, land use, etc., was found which would justify an update to previous modeling. Only for a noticeable change in the watershed or when the existing water quality database is large enough will a new modeling effort be justified. A larger water quality database would allow model calibration specific to Paddock Lake which improve the prediction and accuracy of the modeling effort.

3.0 COMPARISON OF NONPOINT POLLUTION CONTROL PRACTICES

3.1 Background Information

Previous work (Woodward-Clyde, 1994) delineated the Paddock Lake Watershed into sub-basins and modeled the nutrient and pollutant loadings each contributes to the lake. The sub-basins were ranked according to the amount of loading each contributed to the lake. Two sub-basins with the largest contributions of pollutants were identified as U1 and U4. Sub-basin U1 contained the only concentration of commercial land use. This type of land use is commonly found to contribute increased loads of nonpoint source pollution. One reason for this is the lack of open, vegetated areas which allow for rainfall to soak into the ground, as opposed to running off to the storm sewer system and into the lake. Due to the available open space of the two identified sub-basins (U1 and U4) it was determined that the application of practices to U4 would be most feasible. Sub-basin U-4 has open, agricultural lands in the western portion of the area.

3.2 Modifications to Sub-Basin Boundaries

Field investigations revealed that the previous sub-basin boundary delineations required modification to more accurately reflect the storm sewer network impact on sub-basin delineation. Changes were made to the boundaries of sub-basin U4, U5, and U6. The field investigations corrected the following:

- creation of a new sub-basin to the east of U5 and south of the U4 outlet to Paddock Lake (designated as U5a on the map),
- part of U6 as drawn in the 1994 study actually belongs to U4, at the corner of 248th Avenue and 67th street, and
- U5 was sub-divided into U5 and U5a sub-basins

Table 3.1 below summarizes the original, and revised sub-basin conditions for the areas analyzed.

Table 3.1: Revised Areas for Paddock Lake Sub-basins
(revised from 1994 report)

Sub-basin	Original Area (1994 report) (acres)	Revised Area (acres)
U4	47	50
Residential	33	32
Undeveloped (agricultural)	14	18
U5 (all residential)	18	14
U5a (all residential)	0	4
U6 (all residential)	33	22

Figure 3.1 (map pocket in the back of the report) shows the corrected sub-basin boundaries, as well as the storm sewer network of sub-basin U4. The figure also shows the location of the proposed wet detention pond alternative for sub-basin U4 which is discussed below.

3.3 Modification to the Estimated Pollutant Load from U4 Agricultural Area

Area U4 accounts for 18 percent of the total watershed area. It is comprised of 71 percent residential area and the remaining 29 percent is undeveloped (agricultural). The annual pollutant loadings from U4 to Paddock Lake based on the 1994 Woodward-Clyde report are shown in Table 3.2.

Table 3.2: Pollutant Loading of Sub-Basin U4 to Paddock Lake

Parameter	Quantity
Sediment Load	4.11 tons/year
Phosphorous	17.33 lbs/year
Lead	3.61 lbs/year

Source: Woodward-Clyde Consultants 1994 based on SLAMM

Since this analysis, it has been shown that using the Source Loading and Management Model (SLAMM) for agricultural areas can underestimate pollutant loadings. Annual cropland erosion rates can be estimated using an equation called the Universal Soil Loss Equation (USLE). This equation is expressed as:

$$T = R \times K \times C \times LS \times P$$

where:
- T = soil loss rate in tons of soil/acre/year
- R = rainfall intensity factor (Kenosha County = 140)
- K = soil erosivity (silt loam soil = 0.37)
- C = cropping factor (2 corn, oats, 3 hay = 0.174)
- LS = slope length factor (800 ft at 4.5% = 1.1)
- P = practice (no contour plowing)

For the field located in sub-basin U4 the factors for the USLE equation are:

$$T = (140) \times (0.37) \times (0.174) \times (1) \times (1.1)$$
$$= 9.9 \text{ tons/acre/year}$$

This soil erosion rate <u>is not</u> the amount of soil delivered to the lake - it is the amount of soil being detached and moved - much of it stays on the field each year. For purposes of this report it will be assumed that 50% of the soil erosion on the 18 acre cropland is actually reaching the sub-basin outlet point (the lake) each year (Wishchmeier and Smith, 1978). This factor is often called a "sediment delivery ratio". The rest of the eroded soil is temporarily trapped in the small depressions on the field. This assumption results in an annual sediment loading from the 18 acre agricultural field of 89.1 tons per year (18 acres x 9.9 tons/acre/year x 50%).

3.4 Discussion of Alternative Nonpoint Source Control Practices

Three practices/measures were analyzed to reduce the pollutant loadings from sub-basin U4. The three measures analyzed were

- Baffled Sedimentation Chamber (structural),
- Purchase of cropped field (permanent vegetative cover), and
- Detention Pond (structural).

Baffled Sedimentation Chamber

The Village owns a 16 foot wide easement along the lake at the stormwater pipe outlet to Paddock Lake (between 243rd Court and the Lake). The potential to install an underground baffle chamber in the easement was investigated. The baffle chamber would consist of an underground concrete vault with partial walls and/or chambers to slow the velocity of the runoff waters, and trap coarse sediment in the runoff. The baffle chamber requires sufficient area to be effective in slowing the water and providing storage space. It was determined that the space available in the easement was not adequate to design and construct an effective baffle chamber. The cost and effort would not justify the small pollutant control capability.

Purchase of Cropped Field and Conversion to Permanent Vegetative Cover

The cropped field at the northwestern portion of sub-basin U4 is the only undeveloped land which can reasonably be changed or altered. This area encompasses approximately eighteen acres. The rest of the sub-basin is residential land use and thus not easily changed. Therefore, management practices were analyzed which would lower the pollutant and sediment loads off of the cropped field. The conversion of this land from a cropped field to a condition with permanent vegetative cover would lower the sediment eroding off the land and entering Paddock Lake. To estimate the erosion control that could be achieved though the conversion from cropped field to permanent vegetative cover the "C" factor of the USLE equation was changed to represent a permanent meadow condition. This change reduced the per acre annual erosion rate from 9.9 tons/year. to 1.1 tons/year. Thus the control achieved through this practice would be:

current condition:	18 acres x 9.9 x 50% =	89.1 tons/year
permanent vegetation:	18 acres x 1.1 x 50% =	9.9 tons/year
sediment controlled:		79.2 tons/year

To convert this area to permanent vegetative cover would require purchase of this parcel or the purchase of a perpetual easement by the Village. This is essential to insure control and management of the land use by the Village. Several realtors were contacted in the area to estimate the cost of the land purchase. Parcels of land close to Paddock Lake of similar size and land use were used to approximate the cost. Values in the range of $10,000 to $12,000 per acre were reported. Due to fluctuations in land values and the uncertainty associated with real estate negotiations the costs presented are only approximate and should be used for comparison purposes only.

The cost estimates to shape and seed the property with typical grass species is presented in Table 3.3. Table 3.4 gives the cost to convert the property to native grasses (prairie) type condition. The final "look" of the land would depend on the Village's needs and desires regarding open space use. All operation costs, such as disking, spraying, or drilling, include the necessary machinery (tractor and implement) and operator time.

Table 3.3: Cost to Convert the Agricultural Land to Permanent Meadow with Typical Grass/Pasture Species

Operation	Cost/Unit	Total Cost	Comments
Chisel Plow	$15/ac	$210	required after corn crop
Disk	$15/ac	$420	2 passes
Spray	$30/ac	$420	includes 2 qt Round-up/ac
Drill	$20/ac	$280	w/out seed
Seed*	$19 - $27	$275 - $400	cut no shorter than 6"
Total Conversion Cost		$1605 - $1730	

*2 possible seed mixtures are:

Option 1: $65 per 40 lb bag, 15 - 18 lb/ac required
50% - Vernal Uncert Alfalfa
27% - 333 Brand Red Clover
18% - Climax Timothy
5% - Alsike Clover

Option 2: $36 per 40 lb bag, 20 lb/ac required.
34% - KY 31 Tall Fescue
25% - Climax Timothy
15% - Alsike Clover
12% - Potomac Orchard grass
9% - Perennial Ryegrass
5% - 85/80 KY Bluegrass

The cost to maintain the area in typical grasses, such as cutting and possible fertilization, is extra. It is difficult to determine the amount of maintenance because of many unknown factors. The costs shown above are for a "meadow-like" vegetative cove - not for a short grass "recreational field" type cover.

Table 3.4. Cost to Convert the Agricultural Land to Permanent Vegetation with Native Grass/Mesic Prairie Species

Operation	Cost/Unit	Total Cost	Comments
Chisel Plow	$15/ac	$210	required after corn crop
Disk	$15/ac	$420	2 passes
Spray	$30/ac	$420	includes 2 qt Round-up/ac
Drill	$20/ac	$280	w/out seed
Seed*	$175/lb	$26,950	requires 11 lb/ac
Total Conversion Cost		$28,280	

*Seed cost is approximate average cost of the following mesic prairie species:
Golden Rod; Compass Plants; Prairie Dock; Cone Flowers; Black Eyed Susans; and Marsh Blazing Stars

Mesic prairie maintenance would require burning every two or three years to control weeds and to promote native grass growth and development. Also, if the agricultural field has had atrazine or an atrazine like compound applied within the last 2 years these would prohibit native grass growth.

This alternative gives the Village complete control of present and future land use with allowances for controlled development in the future. This could include development of a park or residences which could be required to meet nonpoint source pollution control standards prior to construction.

Table 3.5 below compares the land purchase/permanent vegetation with the wet detention pond for annual sediment reduction and construction/implementation costs. Due to the uncertain nature of maintenance costs these are not included in the cost comparison.

Wet Detention Pond

The construction of a wet detention pond west of 248th street and north of 67th street was another alternative that was investigated. This is the most feasible location to provide sufficient runoff storage and accomplish the nonpoint pollution control goals. The detention pond would consist of a permanent pool and sufficient storage space to allow for temporary storage of the 100 yr event from this area. A more detailed conceptual drawing of the location of the wet detention pond is shown in Figure 3.2.

Wet detention ponds have been found to be more effective in terms of sedimentation than dry detention ponds. The reason is that each time a dry pond fills with runoff, the water re-suspends sediments on the bottom of the pond as it fills. These re-suspended sediments are then carried out of the pond to the lake. Properly designed and constructed wet ponds effectively minimize this problem and therefore more sedimentation and less re-suspension occurs. Properly designed wet detention basins have been shown to reduce total sediment loads by 80 - 90%. For this analysis 80% control was applied to the delivered sediment load from 18 acre cropland. Thus:

80% x 89.1 tons/year = 71.28 tons of sediment controlled

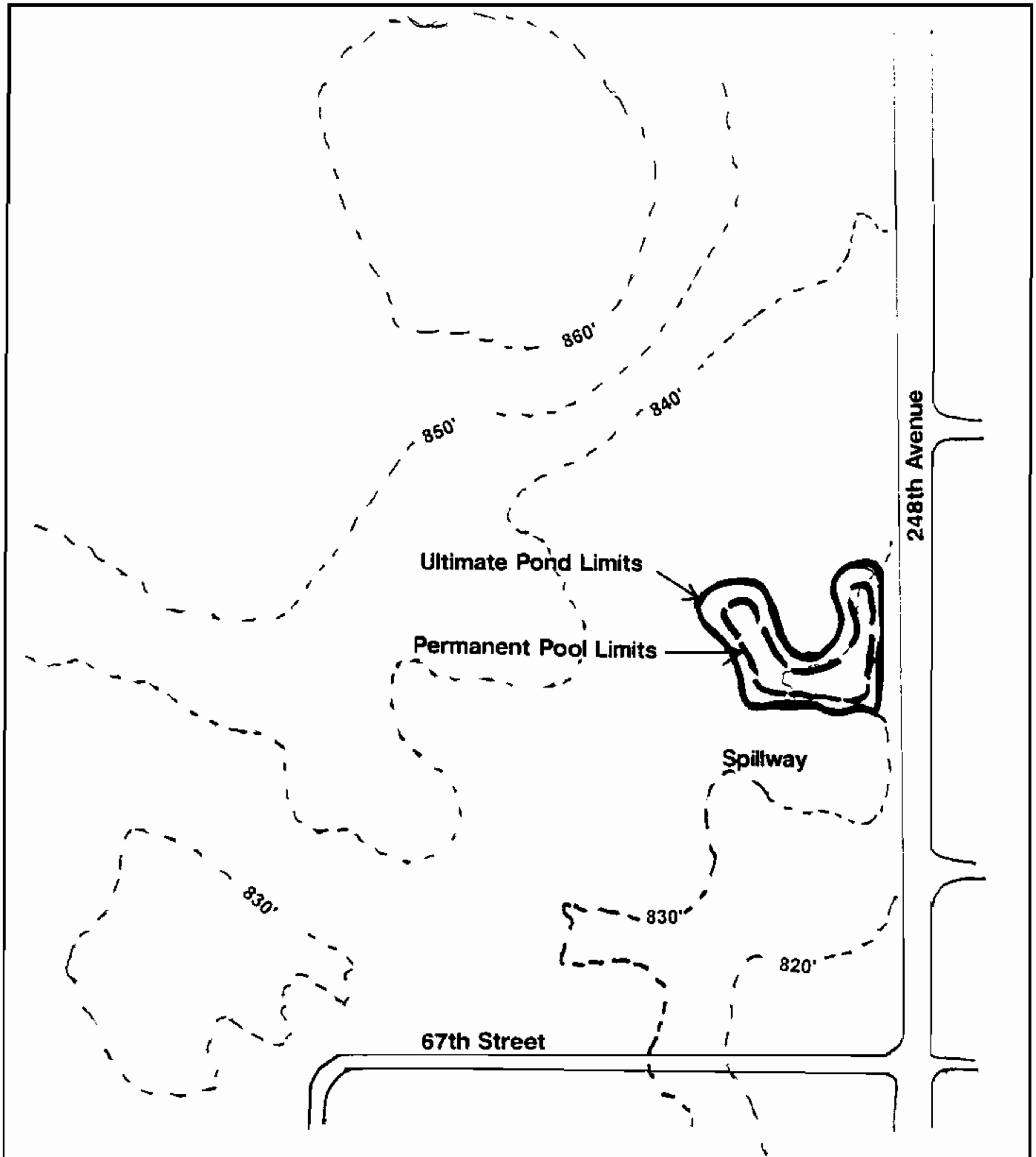
The proposed pond would have an outlet to handle normal flows and an overflow spillway to handle emergency flows. This outlet would discharge to the existing storm water conveyance system. A cross-section of the wet detention pond with water elevations for important recurrence interval rainfall events is presented in Figure 3.3.

To properly size the wet detention pond an assumed future land use condition was used for calculating runoff. This scenario assumed development of the eighteen acres of land that would contribute to the basin in a similar fashion to the surrounding residential area. Three rainfall events, 1.5 inch (approximately the 2 year- 24 hour), 10 year - 24 hour, and 100 year - 24 hour, were used to determine both flow rates and volumes. Table 3.5 gives the data determined from the hydrologic analysis. The wet detention pond was sized using future developed conditions so that changes in land use could be accounted for in this analysis. If future development was significantly different than current residential conditions the sizing of the wet detention pond may need to be revised.

Table 3.5: Preliminary Hydrologic Data for Sizing Wet Detention Basin

Design Criteria		Value
2yr-24 hr:	runoff volume peak flow	0.44 acre feet 3.36 cfs
10yr-24hr:	runoff volume peak flow	2.57 acre feet 18.93 cfs
100yr-24 hr:	runoff volume peak flow	4.23 acre feet 31.27 cfs
Minimum Permanent Wet Surface Area		0.50 acres
Minimum Pool Depth		5.0 feet

A cost breakdown for construction and area-volume relationship analysis for the sedimentation basin is included in Appendix A.



Village of Paddock Lake

Fig. 3.2 Wet Detention Basin Conceptual Design (plan view)

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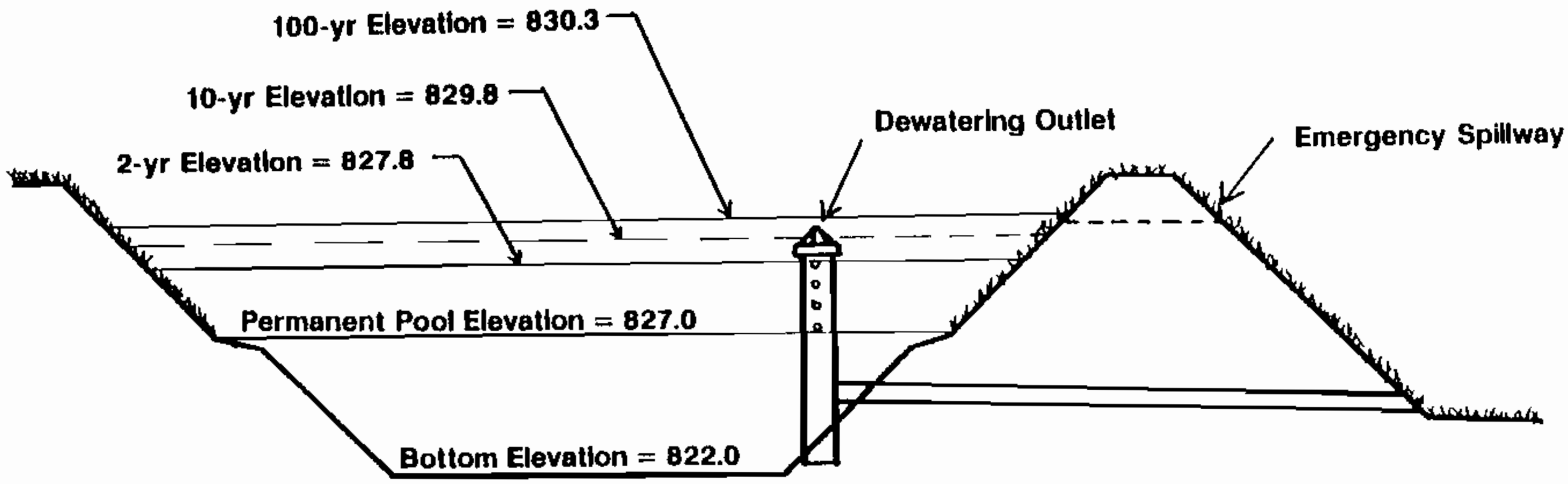

Village of Paddock Lake

Fig 3.3: Wet Detention Basin Conceptual Design
(profile view)

RUST ENVIRONMENT & INFRASTRUCTURE

3.5 Comparison of Alternative Nonpoint Source Control Methods

Table 3.6 below compares the estimated costs of each of the alternatives analyzed.

Table 3.6: Cost Comparison of Alternative Management Measures to Reduce Pollutant Loads from Sub-Basin U4

Control Measure	Annual Sediment Reduction [tons/year]	Approximate Cost[1] ($)	Cost Per Ton of Sediment Reduction ($/ton)
Wet Detention Pond	71.3		
Construction Costs		$64,000 - $69,000	$1,037 - $1,164
Land Purchase for Pond		$10,000 - $12,000	
Total:		$74,000 - $83,000	
Land Purchase (16 ac with Permanent Vegetation)	79.2		
Land Costs		$180,000 - $216,000	
Plant Typical Vegetation		$1,730 - 28,000	
Total:		$181,730 - $244,000	$2,295 - 3,081

[1] Costs does not include legal/administrative costs

Additional considerations must be analyzed when balancing the advantages and disadvantages of selecting a nonpoint source control measure. Considerations such as: secondary benefits, maintenance costs, local acceptability, aesthetics, etc. These issues are summarized below on Table 3.7 for the two primary alternatives: wet detention basin, and establishment of permanent vegetation.

Table 3.7: Comparison of Nonpoint Source Pollution Alternatives for Paddock Lake Sub-Basin U4

Issue	Land Acquisition Permanent Vegetative Alternative	Structural Best Management Practice Alternative
Pollution Reduction (sediment)	79.2 ton/year	71.3 ton/year
Constraints: physical, etc.	- Land privately owned	- Soils ok - Open space available - Land privately owned
Legal/Administration	- Village must purchase land: 18 acres - Property tax base impacts - Long term commitment	- Village must purchase land or acquire easement: approximately 1-2 acres - Long term commitment - Open water liability
Implementation Cost and Cost/ton Pollution Reduction	- Higher initial cost - Higher cost per ton of pollution reduction	- Lower development cost - Lower cost per ton of pollution reduction
Funding Sources	- WDNR Lake Protection Grant (75% state share - $100,000 maximum) - WDNR Nonpoint Program (70% max. state share; no maximum amount) - LAWCON/Urban Greenspace/ADLP State funded urban parks programs (50% for acquisition/improvements)	- WDNR Lake Protection Grant (75% state share - $100,000 maximum for design & construction) - WDNR Nonpoint Program (70%-100% state share for design fees; 50%-70%. state share for construction; no maximum)
Maintenance	- Park/Open space maintenance: mowing possible weed control	- Landscape maintenance - Dredging: once per 15 - 20 years; must dispose of dredged sediments - Dredging costs could be $15 - $25/cu yd of material ($16,000 - $25,000 every 15 - 20 years)
Other Benefits	- Recreational/educational uses - Wildlife habitat - Community open space - Future development for park or for other purposes.	- Wildlife habitat - Village water feature
Other Detractions		- Occasional nuisance algae growth: - odors

3.6 Discussion

Both alternatives achieve approximately the same control level of sediment reduction to Paddock Lake. From strictly a nonpoint source reduction criteria, the permanent vegetative cover alternative is slightly better. Although, this approach is higher in cost "per ton of sediment controlled" there are secondary issues which must be considered by the Village when selecting an alternative. Open space needs, recreational benefits, and long term maintenance costs are all factors. Both alternatives also have equal potential for partial funding support through WDNR programs.

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"BUILDPND" - DETENTION POND DESIGN AND COST ESTIMATING WORKSHEET

Input Information

DETENTION BASIN INPUT SHEET

Project : ***Paddock Lake***

DIMENSIONS OF POND AT PERMANENT POOL (L x W; FT)	L =	255	W=	85
DEPTH OF PERMANENT POOL (FT)	D =	5.00		
DOES THE POND HAVE A SAFETY BENCH ? (ASSUMES 10:1 SLOPE UNDER PERMANENT POOL)	(Y/N)	Y		
SIDE SLOPES OF POND UNDER PERMANENT POOL (X 1)	X =	2.00		
SIDE SLOPES OF POND ABOVE PERMANENT POOL (Y:1)	Y =	4.00		
PERCENT OF EXCAVATED MATERIAL LEFT ON SITE (0-1)	(0-1)	100%		
PERCENT OF EXCAVATED MATERIAL HAULED (0-1)	(0-1)	0%		
ESTIMATED TRAFFIC FOR HAUL (Low, Medium,High)	L,M,H ?	L		
ESTIMATED HAUL LENGTH (Round Trip Miles)	Miles =	1		
ESTIMATED COST FACTOR (Low, Medium, High)	L,M,H ?	L		
SITE CONDITIONS (C=CLEAR, B=BRUSH, W=HEAVILY WOODED)	C,B,W ?	C		
SOIL CONDITIONS (C=CLAY, E=COMMON EARTH, S=SANDY)	C,E,S ?	C		
STORAGE VOLUME REQUIRED (ACRE FEET)	VOL =	2.00	10Yr 24Hr Event	
POND FREEBOARD (FT) {Include Additional Excavation Depth}	FRBD =	1.00		
ENGINEERING DESIGN COST (0 - 1)	CONT =	20%		
CONSTRUCTION CONTINGENCY (0 - 1)	CONT =	15%		

DETENTION BASIN OUTPUT SHEET

DIMENSIONS OF POND AT PERMANENT POOL (L x W; FT.)	L =	255	W =	85	
SURFACE AREA OF PERMANENT POOL		0.50	ACRES	21,675	SQ-FT
DEPTH OF PERMANENT POOL		5.00	FT		
VOLUME OF WATER TO PERMANENT POOL		1.29	AC-FT	56,197	CU-FT
REQUIRED POND STORAGE VOLUME		2	AC-FT	87,120	CU-FT
HEIGHT ABOVE PERMANENT POOL TO ATTAIN STORAGE (Approxmate)		4.00	FT		
STORAGE VOLUME AT ABOVE DEPTH		2.25	AC-FT	97,924	CU-FT
TOTAL POND DEPTH (INCL FREEBOARD)		10.00	FT		
TOTAL POND EXCAVATED VOLUME (INCL FREEBOARD)		4.18	AC-FT	182,242	CU-FT
SURFACE AREA REQURED FOR CONSTRUCTION (INCL FREEBOARD)		0.66	ACRES	28,875	SQ-FT
ULTIMATE DIMENSIONS OF POND (L x W; FT.)	L =	275	W =	105	
ESTIMATED POND COST		$64,173			

Detention Pond Cost Estimate
Village of Paddock Lake - Sub-basin U4

Item #	Description	Quantit	Unit	Unit Price	Total Cost
	Mobilization/Demobilization				
1	Mobilization/Demobilization	1	project	$1,000	$1,000
	Subtotal				$1,000
	Basin Construction				
2	Clearing and Grubbing	0.70	ac	$8,275	$5,760
3	Strip and Stockpile Topsoil	281	cy	$1.52	$427
4	General Excavation	6,469	cy	$2.06	$13,318
5	Place and Compact Spoil	6,469	cy	$1.10	$7,116
6	Haul and Dispose Spoil	0	cy	$1.79	$0
7	Respread Topsoil	281	cy	$1.61	$452
8	Hydroseed	1,684	sy	$0.35	$590
9	Riprap	135	cy.	$28.50	$3,840
10	Basin Inlet	1	ea	$7,000	$7,000
11	Basin Outlet	1	ea	$7,000	$7,000
	Subtotal				$45,502
	Construction Subtotal				$46,502
	Project Contingencies	1	project	15%	$6,975
	Construction Total				$53,477
	Engineering Fees (20% of Total Construction Cost)	1	project	20%	$10,695
	Project Total				**$64,173**

Paddock Lake: 1995 Water Quality Monitoring Data (Rust E&I Sampling)						
Date	**Sample Depth [ft]**	**Dissolved Oxygen [mg/l]**	**Temp C°**	**Secchi Depth [ft]**	**Total Phosphorous [mg/l]**	**Chlorophyll *a* [*u*g/l]**
2/25/95	2	12.5	4.0	6.5	0.02	7.49
	4	13.0	4.0			
	6	12.0	5.0			
	8	11.6	4.0			
	10	11.4	4.0			
	12	11.0	4.0			
	14	10.4	4.0			
	16	10.0	4.0			
	18	9.7	4.0			
	20	8.5	4.0			
	22	6.7	4.0			
	24	7.6	5.0		0.02	
	26	7.7	5.0			
	28	7.0	5.0			
4/22/95	0	11.6	9.0	9.5	0.015	4.26
	3	12.4	9.0			
	6	13.2	9.0			
	9	13.2	8.5			
	12	12.4	8.5			
	15	12.0	8.5			
	18	11.8	8.5			
	21	11.6	8.0			
	24	11.4	8.0			
	27	11.0	8.0			
	30	10.9	8.0		0.025	
5/22/95				10.0		
5/30/95				10.5		
6/4/95				10.5		
6/14/95				12.0		

Paddock Lake: 1995 Water Quality Monitoring Data (Rust E&I Sampling)						
Date	**Sample Depth [ft]**	**Dissolved Oxygen [mg/l]**	**Temp C°**	**Secchi Depth [ft]**	**Total Phosphorous [mg/l]**	**Chlorophyll *a* [*u*g/l]**
6/22/95	0	8.36	27.8	9.5	0.012	1.19[1]
	3	8.33	27.3			
	6	8.17	27.1			
	9	9.00	26.1			
	12	10.80	21.4		0.014	
	15	7.53	19.4			
	18	3.63	17.0			
	21	0.83	14.6			
	24	0.47	13.3			
	27	1.99	12.0		0.053	
	30	0.12	11.2			
6/30/95				9.5[2]		
7/7/95				10.0[2]		
7/20/95	0	8.0	26.5	7.0	0.010	0.42[1]
	3	8.0	26.5			
	6	8.1	26.5			
	9	8.1	26.5			
	12	7.5	26.0			
	15	6.5	23.0			
	18	4.9	20.0		0.050	
	21	2.7	17.0			
	24	0.2	1435			
	26.5	0.1	13.0		0.072	
8/4/95				6.0[2]		
8/17/95				5.0[2]		
8/19/95	0	7.75	27.7	4.0	0.024	23.2
	3	7.82	27.7			
	6	7.94	27.7			
	9	7.70	27.5			
	12	3.29	26.2		0.046	
	15	0.09	23.5			
	18	0.02	20.3			
	21	0.01	19.0			
	24	0.00	17.9			
	27	0.00	13.4		0.123	
	30	0.00	13.1			

[1] Remark from the State Laboratory of Hygiene: Low Absorbance, Result Approximate.

[2] Self-Help Monitoring