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FINAL

REPORT ON TWO WATER SYSTEMS
ALPINE VISITOR CENTER
WILD BASIN PICNIC GROUND
ROCKY MOUNTAIN NATIONAL PARK

for

DENVER SERVICE CENTER
NATIONAL PARK SERVICE

CONTRACT NO. CX-2000-3-0021

20 January, 1984

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1.0 INTRODUCTION

J.F. Sato and Associates, Inc. of Littleton, Colorado, under a contract with the Denver Service Center of the National Park Service, evaluated the public water supply systems at two locations within the Rocky Mountain National Park (RMNP). The systems are located at the Wild Basin Picnic Grounds (WBPG) and the Alpine Visitors Center (AVC). (See Figure 1.1) Contract No. CX-200-3-0021 was issued 10 August, 1983.

This report represents the 100 percent review for Title I services. The final report will incorporate comments from the NPS and will be submitted January 5, 1984.

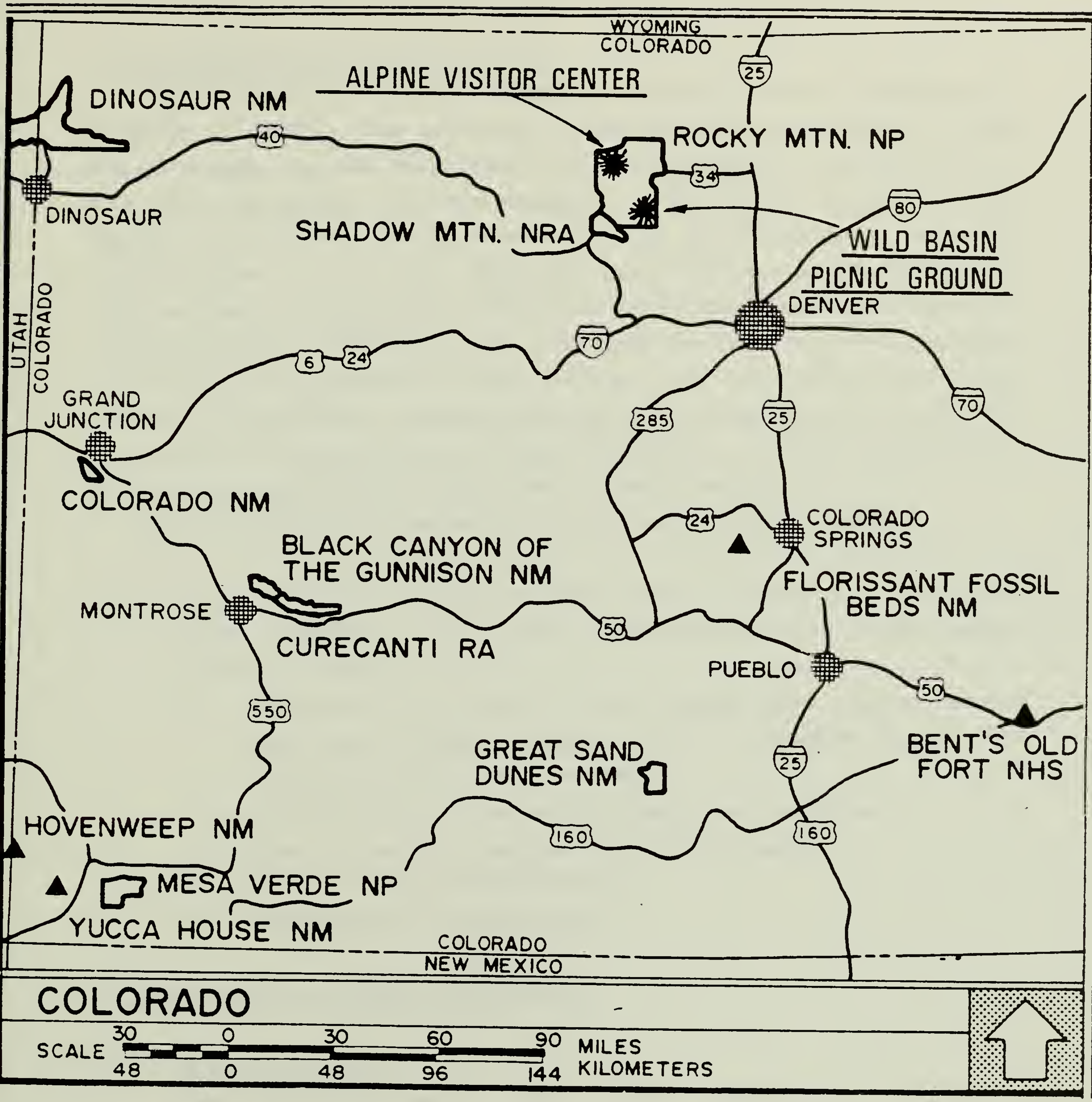


FIGURE 1.1 LOCATION OF PROJECT AREA

2.0 WILD BASIN

2.1 Background and Scope of Work

The Wild Basin Picnic Ground is located in the southeastern portion of RMNP. The primary concern with the existing surface water supply is the potential for contamination, especially by the microorganism Giardia lamblia. Water is obtained from Hunters Creek and is chlorinated, but not filtered. A water sample taken on July 21, 1983 and analyzed by the Laboratory of the College of Veterinary Medicine and Biomedical Sciences at Colorado State University was positive for Giardia and resulted in closing the system to the public. As of the date of this report, a filtration system designed by the O&M group of the RMNP is still in the process of being installed. Both the existing and the new systems are described in more detail in 2.2.

The scope of work under this contract for Wild Basin is:

- Make a study of the existing water system and potential water demands for the Wild Basin Picnic site, considering the following:
  1. Evaluation of potential for groundwater source versus existing surface intake, with recommendations for location of well if advisable.
  2. Configuration of existing piping and valving.
  3. Need for water treatment and chlorination.
  4. Water storage requirements.
  5. Preliminary cost estimate.

2.2 Description of Existing System

2.2.1 Physical Layout

The water system for WBPG draws from Hunters Creek, a tributary of North St. Vrain Creek. Changes to the system were initiated in July, 1983 in a manner, and for reasons, described below. The intake of the system in place prior to July, 1983 consisted of a 2-inch diameter, 3-foot long screened well point

placed in a shallow pool formed by a low rock barricade in the main channel of Hunter's Creek. (Figure 2.1) A 2-inch diameter galvanized steel pipe laid on the surface conveyed the water to a 200 gallon storage tank and an aerofeed chlorinator powered by compressed air since no electrical power was available at that point on the system. From the storage, a 2-inch galvanized pipe buried in the cobble and soil matrix carried water to the first residence. A 3/4 inch polyethylene pipe then carried water to the picnic area, the ranger station/residence and the horse stable. The picnic area has one hydrant for public use. A drinking fountain with hose tap on the corner of the ranger station is also available to the public. The on-site staff reported that for the current level of use, the 2 public taps are adequate. The original system operated entirely by gravity.

The new system designed by RMNP staff is currently being installed and is expected to be operational for the spring 1984 season. The intake point will be moved downstream to the point of an existing 4 foot high concrete weir at the site of the current storage tank/aerofeed tank. A screened well point placed in the pool of water behind the weir will be used. The elevation of the intake point at this lower location is insufficient to provide sufficient pressure for the new system. Thus, a booster pump was added. The pump is a 1/2 HP jet pump which boosts the inlet pressure of about 20 psi to a discharge pressure of 60-70 psi. A filter system, consisting of two Katadyn 0.7u units (Model MF-3) with 3 candles each, has been added. Storage is now obtained by two pneumatic pressure tanks with a combined storage capacity of about 200 gallons. The pump, filter and storage tanks are located in a small wooden structure, formerly a generator shed, immediately behind the first residence. A schematic of the new system is provided in Figure 2.2.

2.2.2 <u>Operational Analyses - Existing System</u>

This section discusses the surface water quality and use patterns as they affect the selection of equipment.

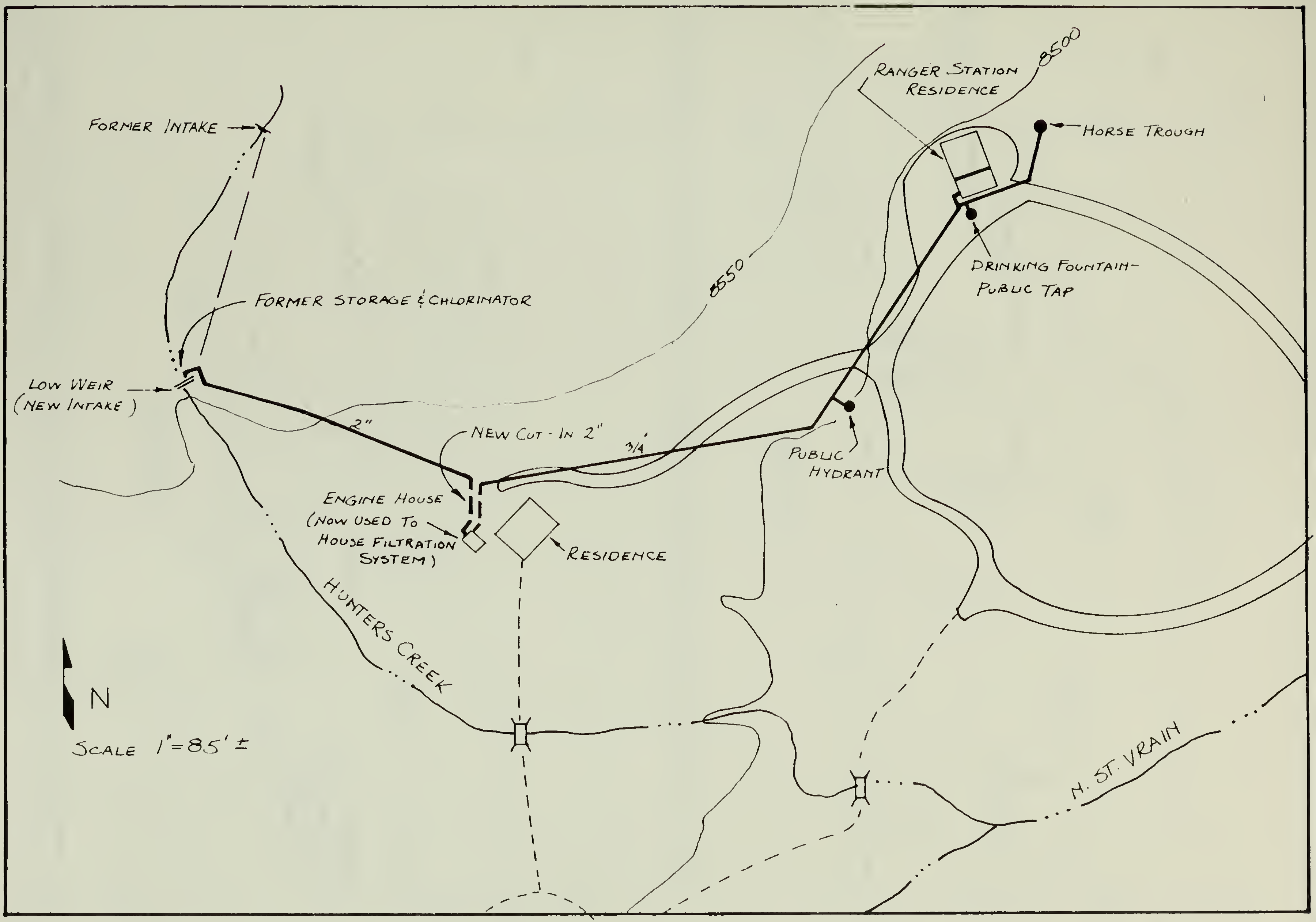


FIGURE 2.1 WILD BASIN — GENERAL ARRANGEMENT OF WATER SYSTEM

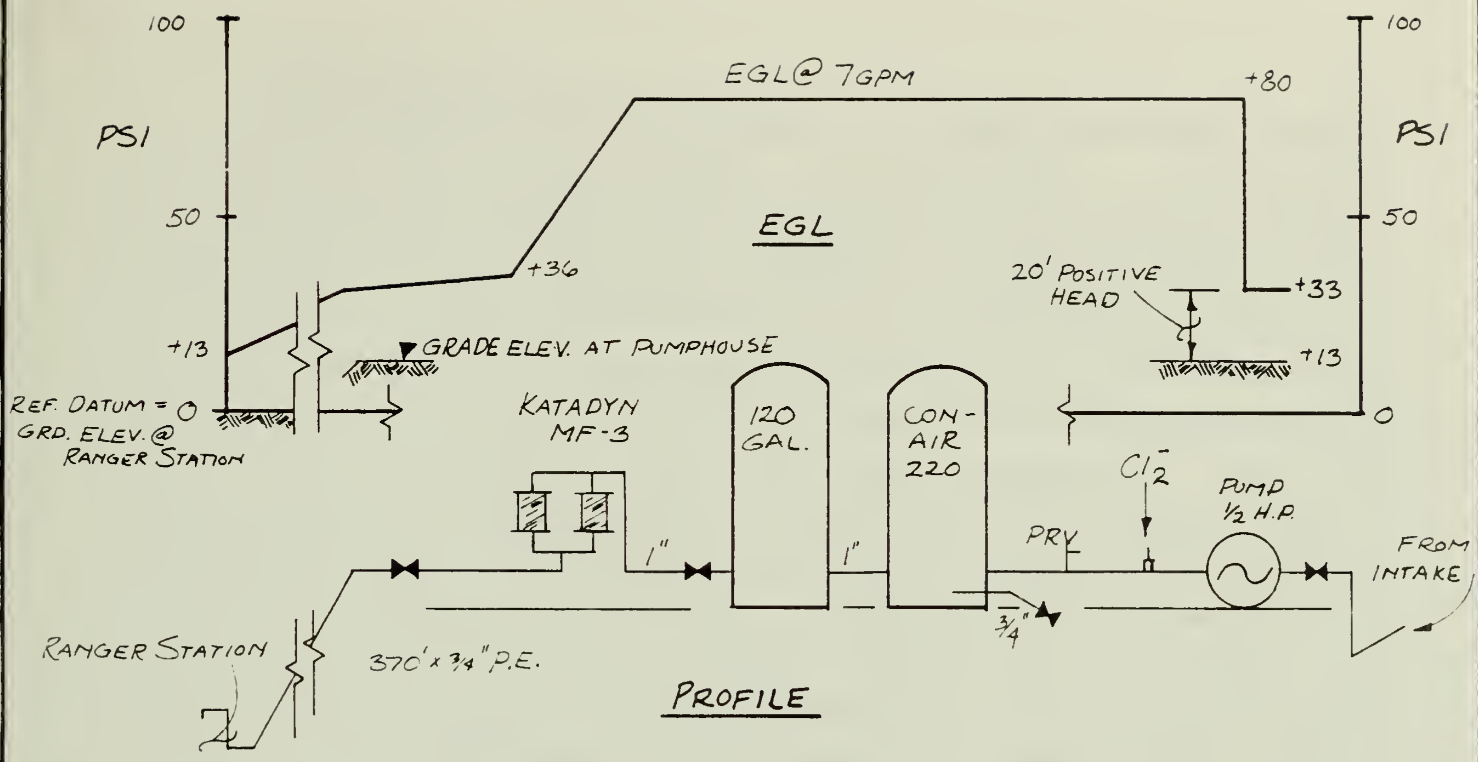


FIGURE 2.2 WILD BASIN - LAYOUT OF SYSTEM BEING CONSTRUCTED

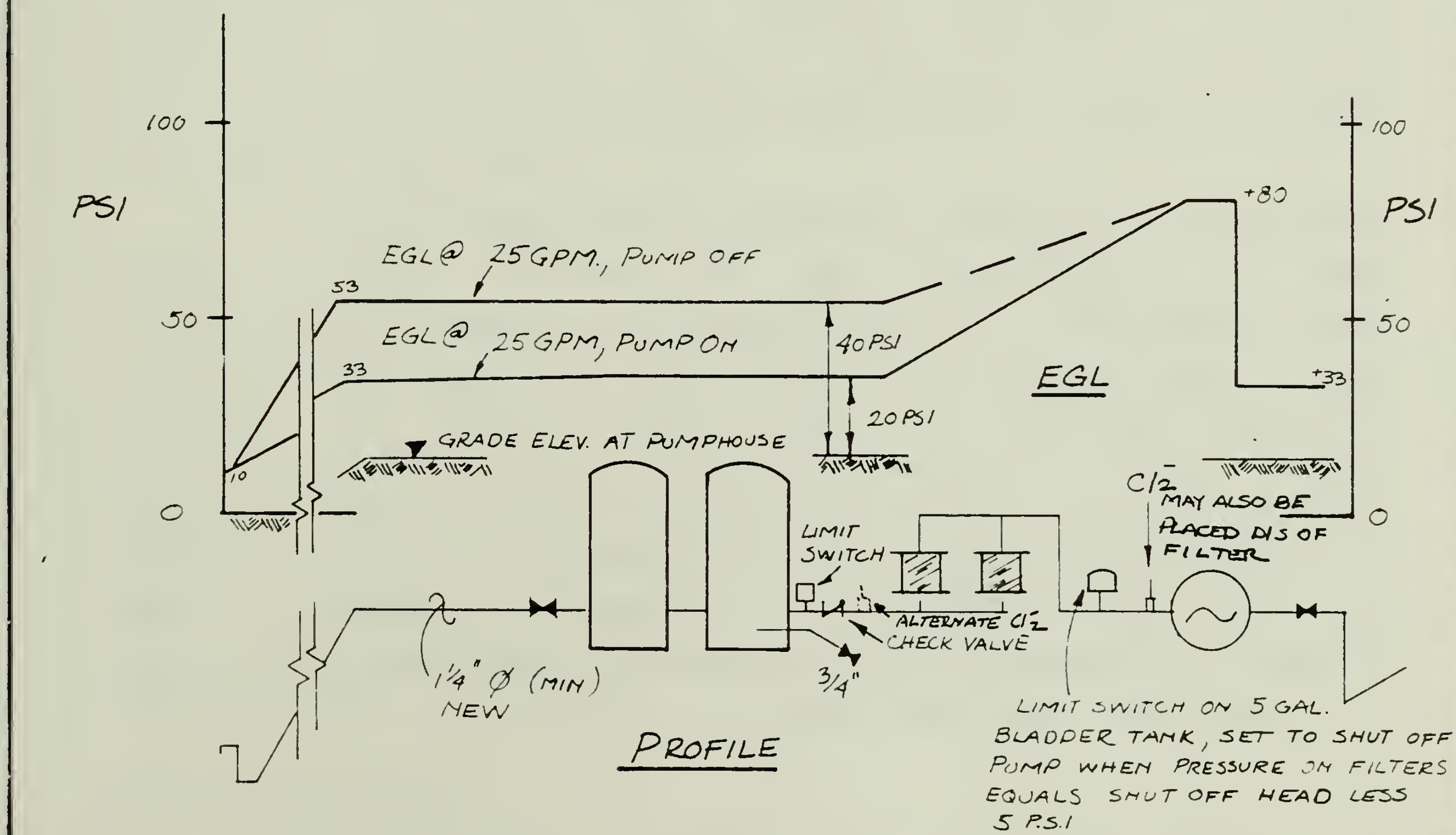


FIGURE 2.3 WILD BASIN - LAYOUT OF REARRANGED SYSTEM (SUGGESTED)

2.2.2.1 Water Quality

The Hunters Creek watershed is highly protected and no problems with synthetic organics are anticipated. Chlorination may yield some potential for the formation of trihalomethanes, however, this is generally not a problem in surface waters within this region if the chlorine dose is not excessive. Based on chemical analyses that were made available, the surface water appears to be of high quality and could be characterized as having low turbidity, low iron and manganese, and low concentrations of those metals which may be of concern from a health standpoint. One sample, taken by the Colorado Department of Health on September 6, 1973, indicated the presence of a significant level of gross alpha acitivity. Although the drinking water standard is not exceeded by the measured level, periodic monitoring should be performed to ascertain the extent of occurrence. In addition, the water has a low total dissolved solids content and low levels of alkalinity and hardness. These conditions may create some problems associated with the corrosivity of the water, though no problems of corrosion have been reported with the existing system which is believed to be more than 15 years old.

The major water quality concern is exposure to waterborne Giardia lamblia because of the association of this disease-causing organism with animal carriers. Although beavers are very common carriers, other mammals can also be a host to the pathogen. The source of this disease is a protozoan pathogen which typically exists in the environment as a cyst. Upon ingestion these cysts are transformed to an active form which infects the host. Waterborne Giardia has been implicated as a cause of disease in a number of circumstances similar to those found at the Wild Basin Picnicground and the presence of Giardia lamblia has been confirmed in one sample from the water source.

2.2.2.2 Hydraulics

The water use at the WBPG can be estimated using water meter records available for the two residences and making an

educated guess on usage at the public taps and horse trough. The results are shown in Table 2.1, below.

TABLE 2.1. WBPG - Water use estimate based on 1982 meter readings (in gallons)

User	1982 use, gallons (1)	Days of Operation (2)	Peak Month Use (3)	Avg. Daily use gallons (4)
Residence (Meter No. 32)	7,100	90	2600 (July)	84
Residence (Meter No. 251)	5,700	90	2600 (July)	84
Horsestable & Picnic Ground (est.)	9,000	90	3100 (July)	100
TOTALS	21,800			268

Avg. Daily Use Rate: 268 gallons/(10 hrx60 min/hr) = 0.45 gpm

The system should be designed to handle peak flow rates. A peak value cannot be obtained from the average daily value for a system this small. The preferred method is to use the fixture-unit method as presented in the Uniform Plumbing Code. Based on a summary of fixtures in the existing system a peak demand flow of 21 gpm is estimated. See Table 2.2. In comparison, the Katadyn system that has been installed has a nominal capacity of 15.6 gpm at a pressure across the filter of 88 psi (ref. telephone conversation with P. Krupin, manufacturer's representative). Because of the location of the filters between the storage tanks and the distribution system, the hydraulic capacity of the filters will dictate the capability of the system to meet demand flows. Considering the characteristics of the 1/2 HP pump, the system output is expected to be on the order of 7 gpm when the filters are clean. Therefore, a modification of the process sequence should be considered.

Table 2.2. Wild Basin - UPC fixture-unit method used for estimating peak flow.

1. Cabin No. 32

Fixtures	Number	FU/each	Total FU
Kitchen Sink	1	2	2
Bathroom Sink	1	2	2
Bathtub	1	2	2
Toilet (flush tank)	1	3	3

2. Ranger Station

Fixture	Number	FU/each	Total FU
Drinking Fountains	2	2	4
Horse Faucet	1	3	3
Caretaker Trough	1	3	3

3. Apartment in Ranger Station

Fixture	Number	FU/each	Total FU
Shower	1	2	2
Kitchen Sink	1	2	2
Bathroom Sink	1	2	2
Toilet (flush tank)	1	3	3

4. Campground

Fixture	Number	FU/each	Total FU
Faucet	1	3	3

Total FU = 31

Demand Load (Curve 2, Chart A-3, UPC) = 21 gpm

It is recommended that the capability to meet demand flows be evaluated when the system is placed in service in the spring of 1984. If the system does not perform satisfactorily, it may be necessary to rearrange the system. In order to eliminate the filters as the constraint on flow, the filters should be placed ahead of the hydro-pnuematic storage tanks. (Fig. 2.3). Currently, the hydro-pneumatic tanks have been placed ahead of the filters to allow settling of suspended material. However, with the low turbidities reported, suspended material does not appear to be a serious problem (except possibly following intense precipitation events) and placing the tanks after the filters should not have a significant adverse impact on the operation.

If the tanks are relocated, the limiting factor on flow will become the 3/4-inch pipe to the Ranger Station. To meet the 21 gpm peak, a pipe with a minimum diameter of 1 1/4-inch should be installed. Also, the maximum increase in pressure that the pump will deliver is 78 psi, which is less than the pressure drop that may develop across the filters. To ensure that the pump will not run continuously against a dirty filter, a pressure switch should be installed between the pumps and the filters. The shut-off setting should be at least 5 psi below the shut-off pressure of the pump. A small hydro-pneumatic tank with an air bladder used in conjunction with the pressure switch will facilitate proper operation. Costs for these remedial works are estimated as $5675. (Appendix A)

2.2.2.3 <u>Treatment Approach</u>

At the time of the site visit, the proposed system was not operational. The treatment system employs cartridge filtration in conjunction with chlorination. In addition, it is proposed that diatomaceous earth be used to provide a coating on the surface of the cartridges. It is hoped that this will achieve a degree of pretreatment thereby prolonging the run time on the cartridges.

Cartridge filters generally rely on a straining approach for removal of particulates from the flow stream. The cartridges, as installed, are rated at removals to 0.7 microns as compared to the size range of 7 to 12 microns for Giardia cysts. Bacteria are generally in the range of 1 micron and viruses are in the range from 0.001 to 0.1 micron. Therefore, this filter would be expected to be effective for Giardia and other protozoan pathogens, and be capable of achieving significant reductions in bacterial pathogens. However, viral pathogens are less likely to be removed, and as a consequence, the system must rely on chlorination for reduction of viral pathogens. Because of the minimal exposure to human waste within the tributary watershed, concern for viral pathogens is somewhat reduced. Nonetheless, caution should be employed and the chlorination system should be maintained in a satisfactory operating condition at all times. It should also be noted that chlorination is an important supplemental treatment process for the control of Giardia.

From an operational standpoint, the proposed use of diatomaceous earth for pretreatment should be evaluated when the system is placed in service. Although this approach has been reported to be successful in some locations, problems with plugging have been reported at others. The supplier of the Katadyn filter indicates that success depends upon the proper selection of the grade of diatomaceous earth. The supplier's recommended grade is Eagle Picher FW-12.

Another potential problem that should be evaluated relates to sloughing of diatomaceous earth as a result of an intermittant mode of operation. Diatomaceous earth systems are generally operated on a continuous flow basis because of problems with sloughing of the coating when there is no flow. Because diatomaceous earth is used for pretreatment in this case, the concerns for process effectiveness are reduced. If the sloughed material recoats the filter when flow is restarted, it may achieve its goal.

2.3 Groundwater vs. Surface Water

A common alternative to the filtering of surface water is to utilize groundwater in the area. The major advantage is that treatment costs can be greatly reduced since filtration would normally not be required. The disadvantage is higher operation and maintenance costs due to the power costs for pumping water and the replacement costs of the pump and control equipment. Thus, there is a trade off between higher filtration costs for a surface water system as opposed to higher pumping costs for a ground water system.

The first step in the evaluation is to determine if groundwater may be available in the area. Appendix B includes a groundwater report by the project hydrogeologist which indicates that a well supply of 5 gallons per minute can be expected in the alluvial deposits along North St. Vrain Creek not more than 600 feet from the picnic area. The geologic features are such that filtration would not be expected to be required.

The remainder of section 2.3 deals with the water quality and costs aspects of a groundwater vs. a surface water system.

2.3.1 Water Quality - Groundwater vs. Surface Water

Based on experience with ground water quality within this area, the most significant water problem associated with the use of a well supply is likely to be high concentrations of iron and manganese. However, the chosen site for the well is expected to minimize this problem. If high concentrations of iron and manganese are present, treatment processes capable of removal of both iron and manganese to satisfactory levels will be required. For the purpose of this preliminary evaluation, it was assumed that standard "off-the-shelf" process units would be suitable. The process would consist of oxidation of iron and manganese with a green sand filter followed by chlorination for disinfection. The manufacturer (Culligan) indicates that this approach is appropriate for combined levels of iron and manganese less than 10 mg/l. Therefore, applicability of this approach should be confirmed prior to a final process selection by analyzing the

goundwater for iron and manganese. The cost for treatment was developed based on this process configuration.

The proposed location for the well system is more than 600 feet from the assumed location of the existing septic system at the Ranger Station. Although this is of some concern, the distance falls within the criteria generally applied for separation from septic systems. Problems could occur if the rock formations were significantly fractured which might provide for direct routing of discharge from the septic system to the inflow of the well. However, it appears that the geology is characterized by an alluvial type of formation and no such problem is anticipated. If a well is drilled, bacteriological analyses should be performed before a final decision on use of the well is made.

The main advantage of the use of a ground water system as compared to the use of a surface water system is a reduction in the risk of exposure to waterborne Giardiasis. Outbreaks of Giardiasis are not generally reported in well systems and it appears that filtration through the soil affords some protection. Exceptions have been reported in two well systems where cross connections, not source contamination, were thought to be the cause.

2.3.2 Costs - Ground water vs. Surface Water

Life cycle costs, expressed in terms of present worth, were developed for several alternatives. An interest rate of 8.5 percent and a period of 20 years were used. All initial costs are based on a conventional design and construction approach at commercial rates. The results are summarized in the table below. The surface supply option has been constructed by National Park Service personnel. Therefore, actual costs were available to provide for direct comparison with other alternatives, labor costs were adjusted to reflect commercial rates and an allowance was made for administrative costs.

Table 2.3. Wild basin - Life cycle costs of groundwater vs. surface water systems

System	Initial Cost[1]	First Year O&M[1]	Present Worth
Well, 25 ft. deep with 1/2 HP pump, pressure tank, controls, chlorination, housing	$30,950	$ 700	$37,600
Well, as above, plus green sand filter for iron and manganese removal	$42,950	$1,600	$58,100
Surface supply, pumped, with filtration and chlorination (as proposed)	$14,600	$1,500	$28,800

[1] Refer to Appendix A

2.4 Fire Protection

Neither the original nor the new water system will provide any meaningful fire protection. The flow rate and storage volume do not meet such standard codes as those of the National Fire Protection Association (NFPA). According to the NFPA publication No. 1231 "Water Supplies for Suburban and Rural Fire fighting, 1975", the volume required is calculated based on the use of the building and the volume of the building as follows.

Table 2.4. Wild Basin Water volume and flow rate required according to NFPA No. 1231.

Structure	Hazard Classification (1)	Structure size W x L x H (2)	Structure size Volume, ft^3 (3)	Volume of water, gallons Col. 3/ Col. 1
First residence	7(dwelling)	22 x 35 x 8	6160	880
Ranger Station/ residence	7(dwelling)	22 x 29 x 8	5100	730

Minimum volume is 2000 gallons (4-2.1)

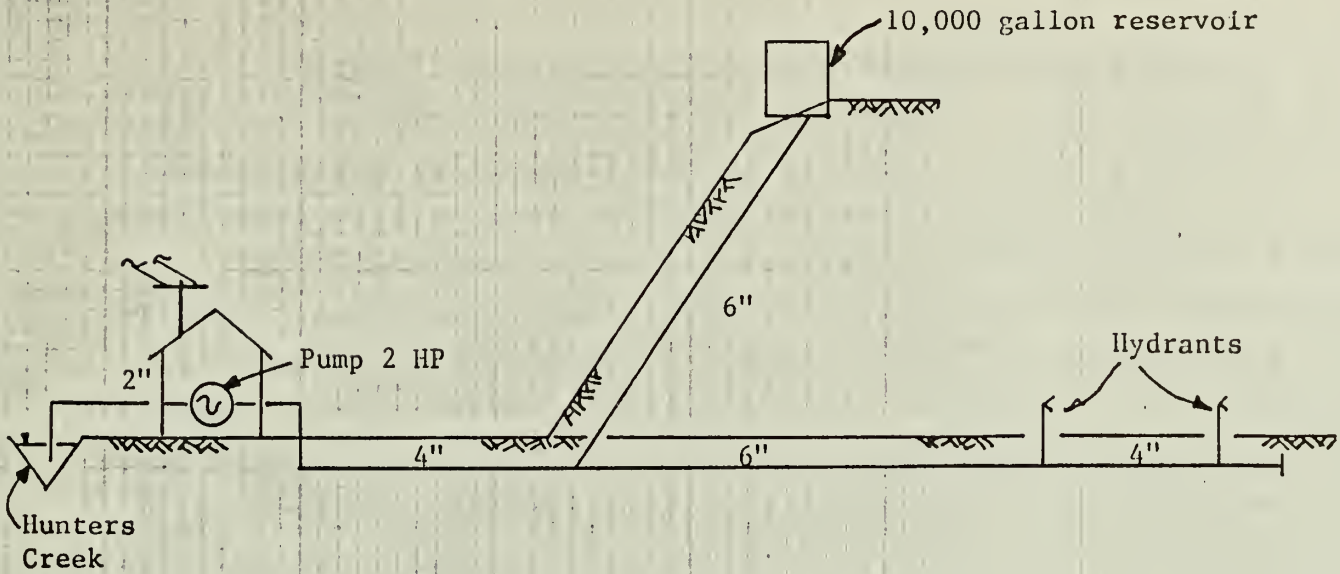
Minimum flow rate is 500 gallons/min (4-2.2)

Thus, to meet NFPA standards, a storage volume of at least 2000 gallons available at a rate of 500 gallons per minute would be necessary. In practice 2000 gallons of storage would be insufficient. At least 10,000 gallons should be available. Whether these limits should be met, or alternative fire protection considered, is a matter of safety and economics. The choices can be broken down into on-site and off-site methods as follows (Figure 2.4):

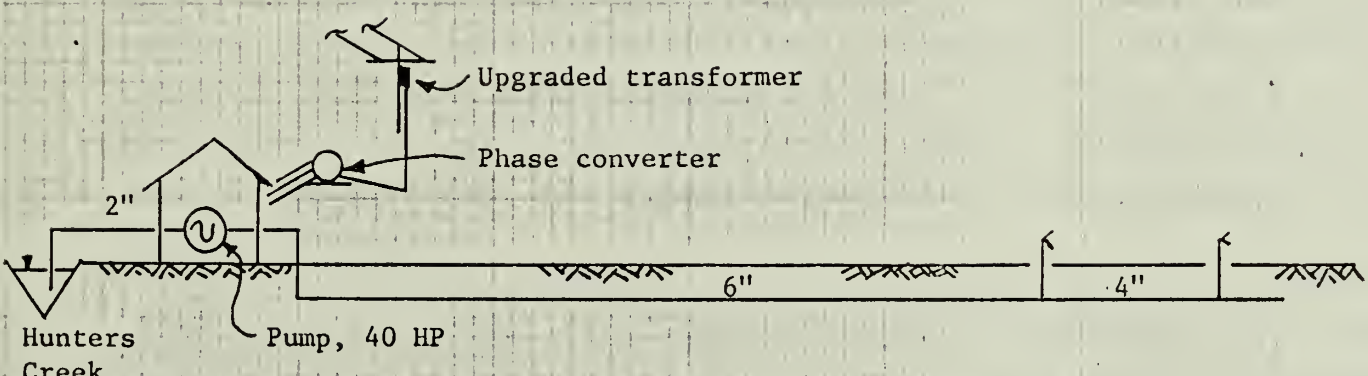
	Comparative Cost[1]
o On-site	
o Elevated storage with hydrants	$ 60,300
o Auxiliary fire pump and ground storage	$ 49,900
o Sprinkler system, add to above	$ __,___
o Off-site	
o Fire apparatus (pumper truck, etc)	$ 35,000

[1]See Appendix A.

The on-site systems require both high capital costs and high maintenance costs in order to ensure reliability. Further, except for the sprinkler system, trained manpower would be required to be on-site to effectively fight a fire. Such manpower is not available on-site at all times.



Alternate 1 - Elevated storage.



Alternate 2 - Direct pumping with fire pump.

FIGURE 2.4. Wild Basin - Alternatives for on-site fire protection.

A further consideration in determining which method will be utilized is the future use of the WBPG. Installation of a fixed-in-place system will not be advisable if the planned use in the future will be less than the current level of use.

In a telephone conversation with the North District Ranger of RMNP, preference was given to the use of fire apparatus, specifically a mini-pumper, which would be mobile and have greater utility than a fixed-in-place system. Such equipment could pump from Hunters Creek and provide some protection. The pumper would be manned by the existing Allens Park Volunteer Fire Department. Response time would be on the order of 30 minutes. This would not be adequate to save the buildings in a major fire, but could be sufficient to keep the fire from spreading.

2.5 Conclusion and Recommendations

The general treatment approach, as provided by the facilities currently being installed, should be adequate to meet the desired quality criteria for drinking water. The 0.7 micron filter should be adequate, if properly maintained, to remove Giardia cysts and meet water quality needs. It is possible that there may be a need to rearrange the system to meet water quantity needs. Since this system is nearly completed, the NPS should operate the new water supply system for a test period to determine if it meets the needs of the users. If water quantity demands are not met, the suggested remedial works in section 2.2 can be implemented.

Fire protection from the existing water supply system is inadequate. A decision on whether or not to implement an on-site system to meet common fire protection standards needs to be made by the NPS based on safety, economics and future planned site use.

3.0 ALPINE VISITOR CENTER

3.1 Background and Scope of Work

The Alpine Visitor Center is located at an elevation of 11790 feet near the Fall River Pass in the northern portion of the RMNP. The primary concern regarding the water supply has been the potential for contamination and the lack of filtration. Water is obtained from the melting of the local snowpack which infiltrates into, and migrates through, shallow colluvium to a poorly defined watercourse. A small weir on the watercourse causes the water to pond prior to entering the supply system. The pool of water is used by wildlife, which are the major source of contaminants. Lesser concerns about the water supply are the inconsistent chlorination of the water and the adequacy of fire protection. Water quantity is not a concern. A concern not directly related to the water supply is the noise level within the generator building as it impacts workers.

The scope of work under this contract is:

> Make a study of existing water system and potential water demands for the Alpine Visitors Center considering the following:
>
> 1. Configuration of piping and valving in generator house.
> 2. Pump usage, interchangeability, redundancy and reliability.
> 3. Fire protection condition and capability.
> 4. Need for filtration and chlorination.
> 5. Identification and evaluation of alternate treatment systems.
> 6. Muffling of diesel engine exhaust.
> 7. Noise absorption material on generator walls.
> 8. Space requirements for water treatment equipment.
> 9. Insulation of pump area from generator noise.
> 10. Preliminary cost estimate.

3.2 Description of Existing System

The Alpine Visitor Center (AVC) is located on Trailridge Road at an elevation of 11790 feet near the top of the Fall River Pass. It is open to the public from the period June to October, weather permitting. The site contains three buildings - the former museum now used as concessioner building, the Alpine Visitor Center, and the generator/pump building. (Figures 3.1.1. and 3.1.2). The term AVC is commonly used to refer to the entire site and will be used as such in this report unless otherwise noted.

A description of the piping and electrical systems follows. Table 3.1 gives characteristics of the existing equipment.

TABLE 3.1. Alpine Visitor Center - Equipment description

ITEM	No.	Description	Use
1. Generator Set:			
Prime Mover	2	Detroit Diesel, 1200 rpm, sea level rating - 135HP, 6 cylinder.	Primary power supply for AVC complex.
Alternator*	2	KatoLight 50 kW, 1200 rpm 120/208V, 3 phase	
2. Water Pumps*	6	Regenerative turbines made by Fairbanks Morse, Model BR702-C7	4 used solely for fire protection, 2 for pumping from 60,000 gallon tank to 20,000 gallon tank and fire protection.
3. Pump motors	6	General Electric, 5HP, 230V, 1735 rpm, 22 amps, Code G(3) H(3), single phase	
4. Submersible* pumps	2	REDA, 5HP, 230V, Model No. 51A18E	pumping from lower intake to either 60,000 or 20,000 gallon tank.

*Performance curves provided in Appendix C.

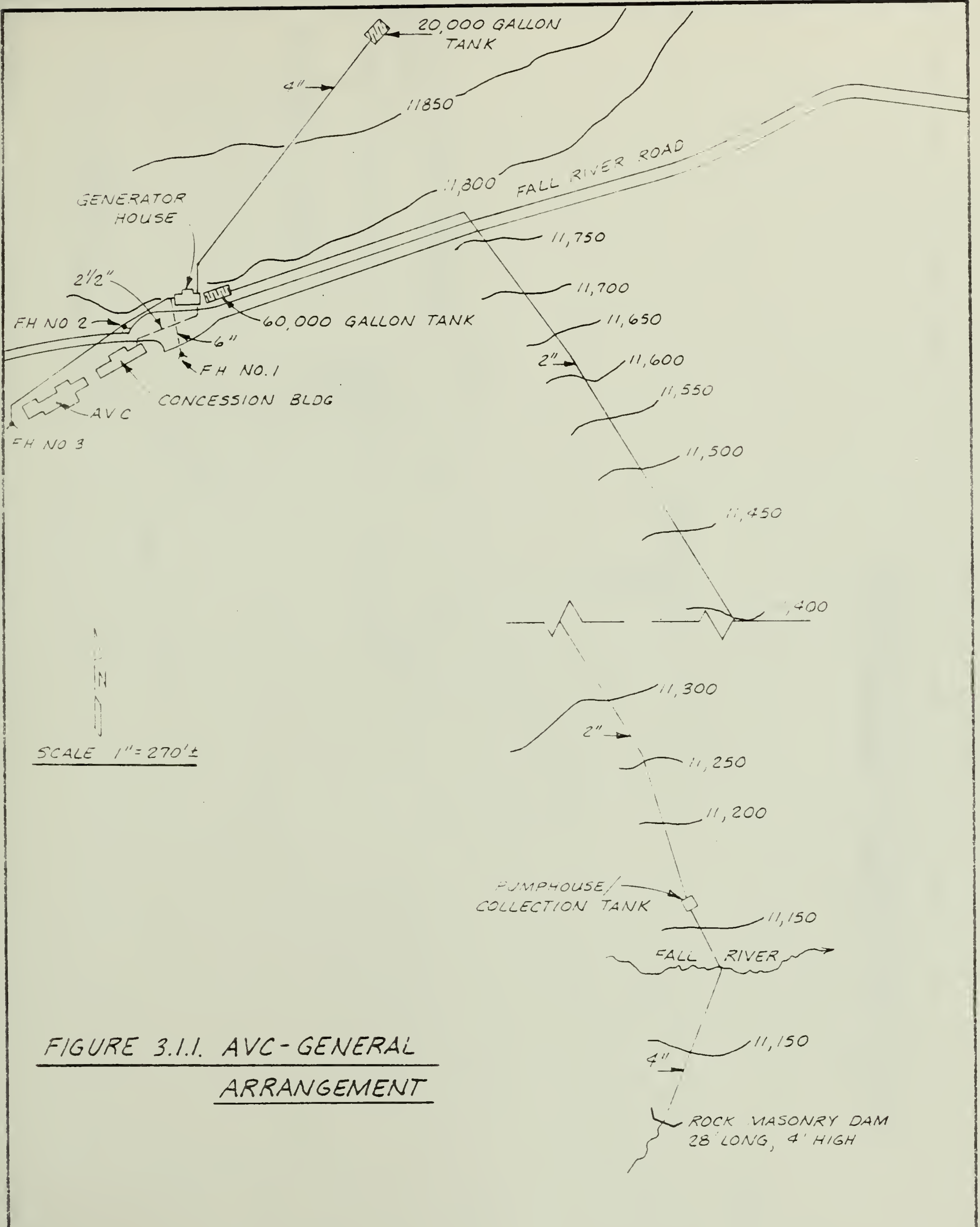


FIGURE 3.1.1. AVC-GENERAL ARRANGEMENT

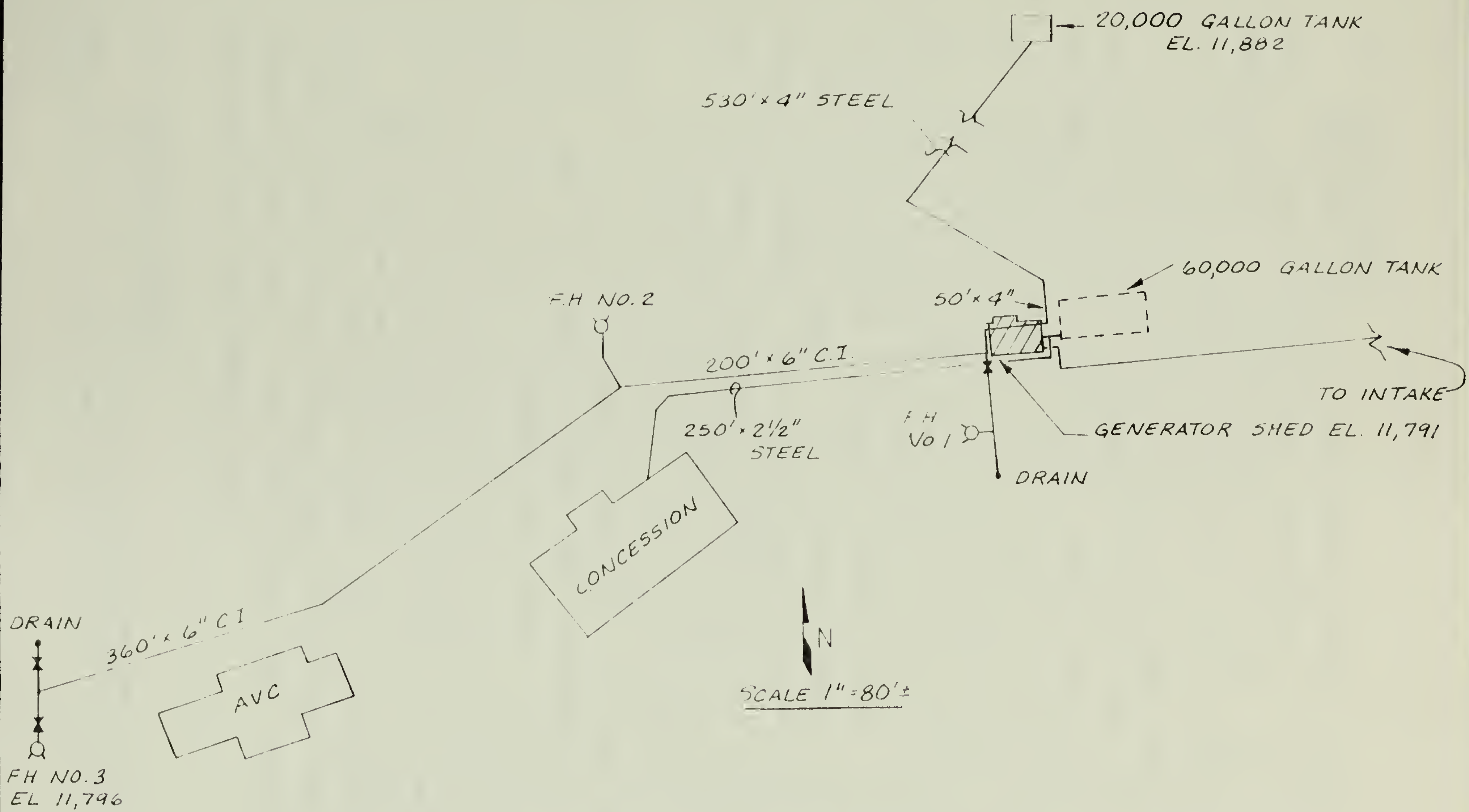


FIGURE 3.1.2. GENERAL ARRANGEMENT

3.2.1 Piping System

The water supply is taken from an unnamed tributary of Fall River. As mentioned earlier, the snowmelt is impounded by a masonry dam/weir 28 feet long and 4 feet high. The water flows by gravity in a buried 6-inch diameter conduit across the valley to a collection tank/pump station at elevation 11160 from which it is pumped by two 5 HP submersible pumps about 640 feet vertically to a buried concrete 60,000 gallon tank. The water is then pumped from the 60,000 gallon tank by one of two 5 HP pumps to a 20,000 gallon buried concrete tank at elevation 11890 from which the flow is by gravity to serve the normal needs of the AVC. The system piping is arranged so that water can also be pumped directly from the lower intake to the 20,000 gallon tank. A simplified schematic of the system is shown in Figure 3.2. A complete pipe diagram is shown in Drawing 81230-1 in the pocket at the end of the report. A 2 1/2-inch diameter line feeds the Concession building. The AVC building is served from a tap off the 6-inch main. According to drawings available, the amount of cover over the 6-inch main ranges from 2 feet to 4 feet.

Chlorination takes place within the generator building. The point of input is on the raw water line from the lower intake. A chlorine solution is pumped into the line from a small holding tank by a metering pump. The chlorinated water can go directly into the 60,000 gallon tank (normal operation), into the 20,000 gallon tank, or directly into the lines feeding the Concession and the AVC building if the demand from these users is high during periods of pumping to the 20,000 gallon tank.

The AVC has an existing fire protection system that can utilize up to six 5 HP pumps drawing from the 60,000 gallon tank to feed into a 6-inch diameter main with three fire hydrants located on the site. The 20,000 gallon tank can also gravity feed into the 6-inch diameter main.

3.2.2 Electrical System

Electricity for the site is provided solely by two 50 kW generating sets. The prime movers are diesel engines each rated

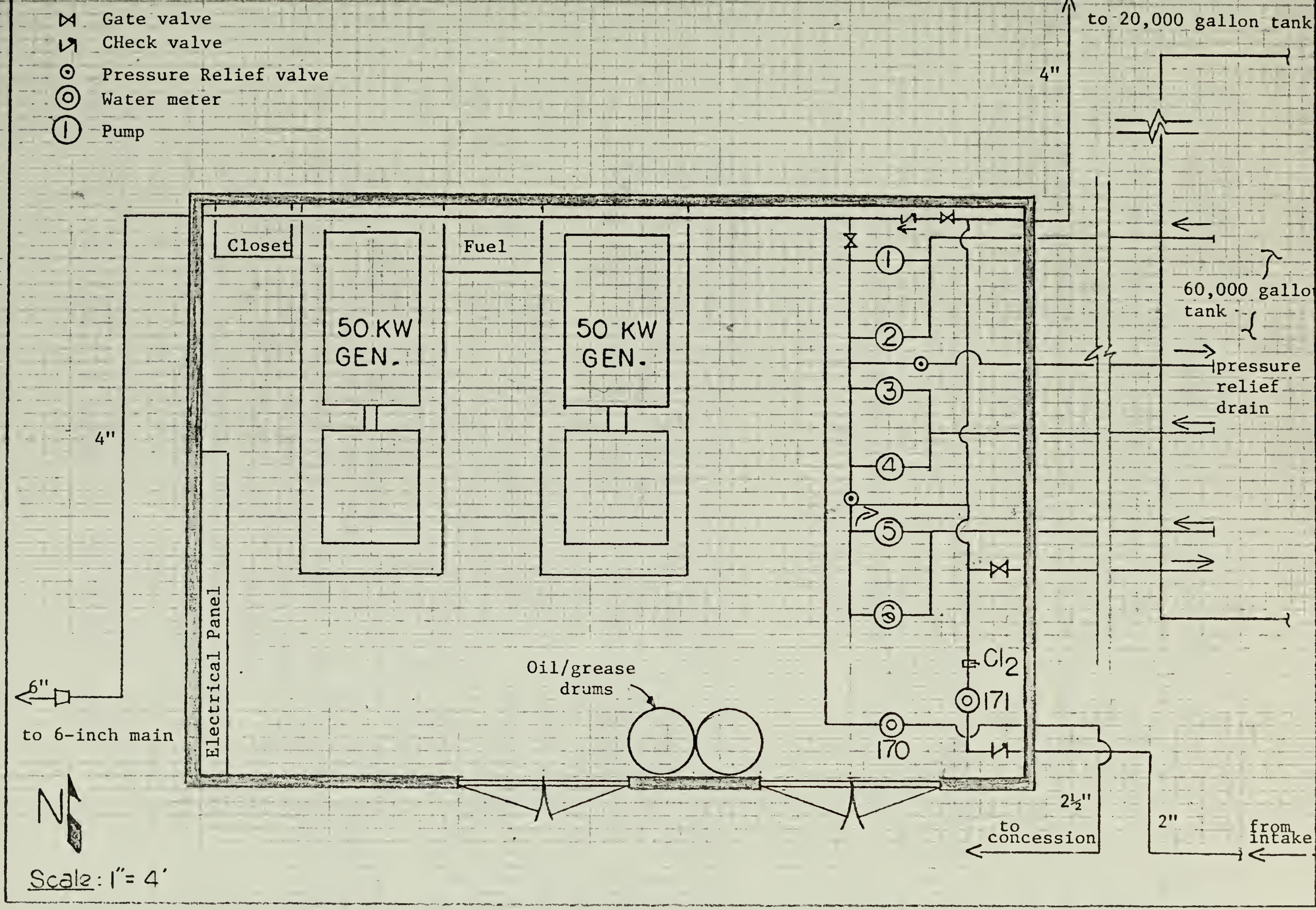


FIGURE 3.2. ALPINE VISITOR CENTER - SIMPLIFIED SCHEMATIC - EXISTING

at 135 HP at 1200 rpm at sea level. Allowing 15 percent derating for altitude, the diesels' can produce 115 HP each. The units operate alternatively for one week at a time. They are not synchronized and therefore cannot operate together. The generator output at full load is 175 amps. According to RMNP officials, 125 amps is reserved for the Concessioner and 50 amps for the AVC building and other NPS use, including the water and fire pumps.

There are no current drawings of the electrical system. It has been reworked several times, most recently in 1980, since it was initially installed. Several of the automatic systems, such as a series of push-buttons by each hydrant that would automatically start the fire pumps and sound an alarm, have been disconnected.

3.2.3 System Operation

Under normal operation one of the two 5 HP submersible pumps from the lower intake is run only at night. This is required since the daytime electrical load on the generators does not leave enough reserve capacity to start and operate the lower pump. One pump at a time is operated. The flow rate was measured in the spring of 1982 at the meter by the Park plumber and was reported to be 7 gallons per minute. During the start-up period in the spring, water is pumped directly into the 20,000 gallon tank since it would otherwise require about 14 10-hour days to fill the 60,000 gallon tank at the 7 gpm rate.

In the normal operation, the 20,000 gallon tank is "topped up" daily by the use of either pump No. 5 or No. 6. The pumps are generally operated manually, although float control switches are installed and are wired to either pump No. 5 or No. 6, depending on which pump is in usable condition.

Daily flow requirements were estimated based on water meter readings. However, the readings do not appear to be consistent. (See Figure 3.3). From the total volume of water used per year, the readings indicate that in all years except 1982 the amount of water used exceeded the amount of the water pumped - this is of

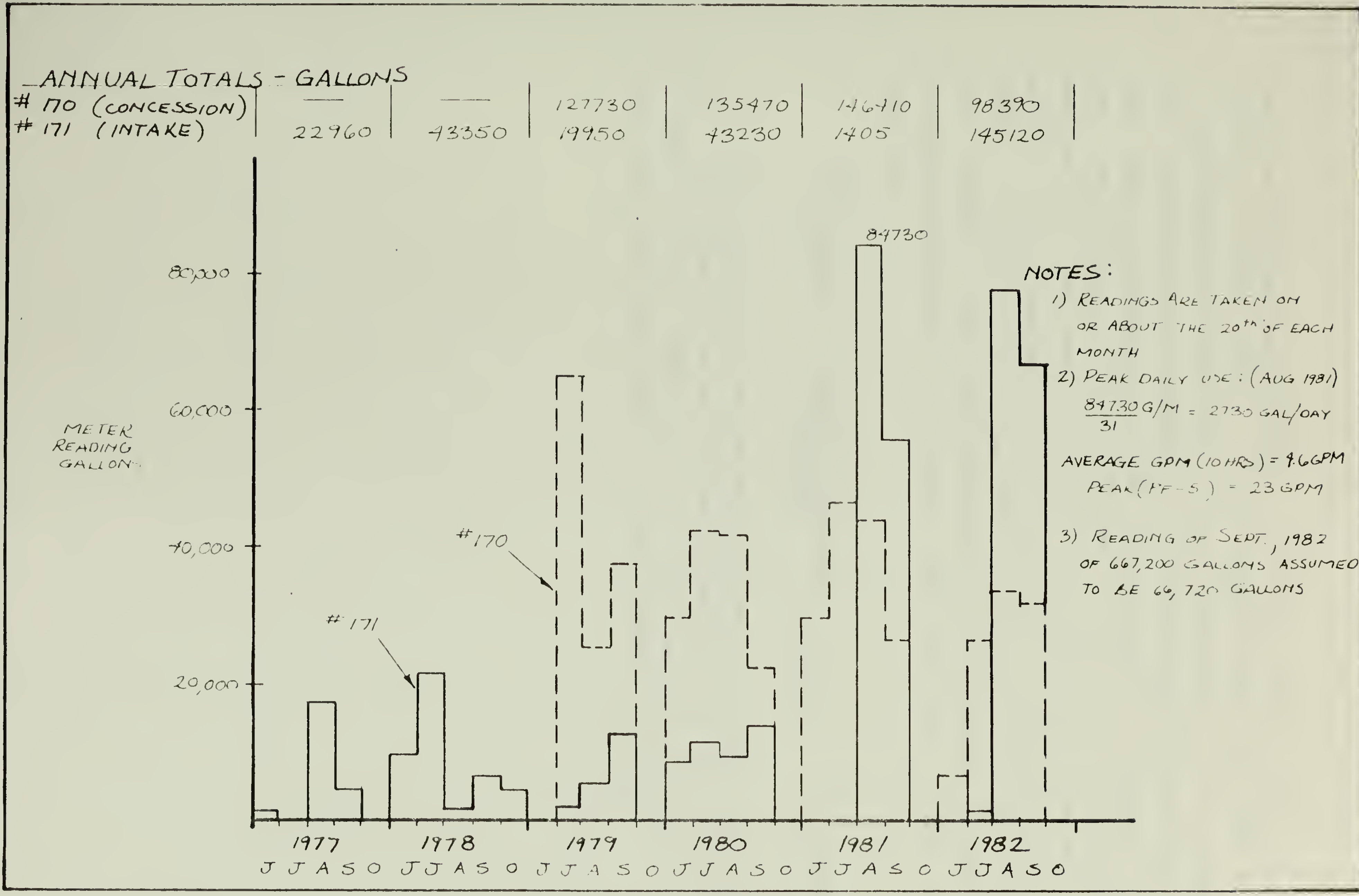


FIGURE 3.3 GRAPHICAL REPRESENTATION OF METER READINGS - AVC

course a physical impossibility. The most likely cause of these readings is faulty meters. From conversations with RMNP staff, it was learned that meter No. 171 was overhauled in the spring of 1982. Assuming that meter No. 170 was operating properly in 1982, then the readings for 1982 can be used for estimating water use. The reading reported for August of 1982 was 78,300 gallons. Assuming this represents 31 days, the daily use rate was 2525 gallons. Using standard peaking factors, the maximum daily rate could be assumed to be twice this, or 5000 gallons/day. If the peak flow was 3 times the average flow on the maximum day and the period of system use is 12 hours, then peak flows in the system would be:

$$\frac{5000 \text{ gallon}}{\text{day}} \times \frac{3(\text{peaking factor})}{12\text{hrs/day}} \times \frac{1}{60 \text{ min/hr}} = 21 \text{ gal/min.}$$

The fixture-unit method was applied to the AVC. See Table 3.2. Note that no water system toilets are in use in the AVC building. An oil system is used which requires no water. The peak flow value using the fixture-unit method is 28 gpm.

Table 3.2. Alpine Visitors Center - UPC fixture-unit method used to estimate peak flow.

	No.	Units/Fixture		Units	Peak
1. Concession building					
Water Closet	1	5		5	
Lavatory	3	1		3	
Shower	0	--		--	
Sinks, kitchen	2	4		8	
			sub.	16	9 gpm
2. Alpine Visitor Center					
Lavatories	10	2		20	
Water Closets	0	--		--	
			sub.	20	12 gpm
3. Apartments					
Lavatories	2	1		2	
Water Closets	2	5		10	
Shower	2	2		4	
Sink, kitchen	2	2		4	
			sub.	20	12 gpm
			Total	56	28 gpm

Operation of the system during a fire has not been documented. The official responsibility for fighting a fire rests with the Park Rangers, not with the Operation and Maintenance employees. However, as a practical matter, should a fire occur and the operation and maintenance staff be on site, it is probable they would initiate fire fighting operations. According to the operator on site during the visit of 15-16 September, 1983, the procedure would be:

- o Evacuate building
- o Notify Park Rangers

- Shut off power within Concession building to ensure that the generator is not overloaded by the fire pumps
- Start all 6 fire pumps, one at a time
- Open/close valves within generator building to direct pump output to 6-inch main. (See Drawing 81230-1)
- Connect fire hoses to hydrant(s), open hydrant(s)

According to available drawings, a water level switch in the 60,000 gallon tank will shut off the fire pumps when the level reaches the prescribed minimum setting.

The six 5 HP pumps and motors are all essentially the same in terms of their electrial/mechanical performance. The pumps can be interchanged directly, the motors would require a minimal amount of rewiring of the controls. In terms of operation, Pumps 5 and 6 are the only pumps in the generator building that can currently pump to the 20,000 gallon tank. Pumps 1 thru 4 are prohibited from pumping to the 20,000 gallon tank by the 50 psi pressure relief valve, which also acts as a check valve. Should Pumps 5 and/or 6 fail, it would be necessary to physically move one of pumps 1 - 4 to replace the faulty pump and continue the transfer of water from the 60,000 to the 20,000 gallon tank.

3.2.4 <u>Current Condition of System</u>

As part of the contract requirement to evaluate the reliability of the existing equipment, notes were made of staff reports and visual observations.

The generator sets appear to be in satisfactory condition. Normal electrical loads are in the 100-120 amp range, within the unit's capacity. However, it was reported that loads can increase to the point whereby the unit will overheat and automatically shut down. This causes interruption of power until the second unit can be started, which is dependent on a member of the building staff being on-site. One unit was overhauled within the last two years and the second unit will reportedly be overhauled next season (1984). The wiring within the generator

shed does not utilize the generator capacity efficiently, according to the electrician on-site. An imbalance in load exists which limits the output of the machine.

All of the pumps and pump motors could not be evaluated since only three of the pumps, Nos. 2, 3, and 5 could be started. Pump No. 1 has a blown fuse and blew a replacement fuse, indicating a failed motor. Pump No. 4 was missing the line starter from the control box and could not be operated. Pump No. 6 was inoperable since the current wiring system only permits either Pump No. 5 or No. 6, but not both, to be wired into the system at the same time. Of the pumps that were operable, minor leakages around seals were observed. The pumps built up design pressures, in fact the pressure gauge within the generator building registered 88 psi with all discharge lines closed off. This is in excess of the 75 psi for which the pressure relief valves are supposed to operate. Considering that pumps Nos. 1-4 have reportedly not been operated for the last several years, it is likely that the PRV's are in need of adjustment. The pumps and motors are presumed to be those installed in 1963, or thereabouts. With minor, but necessary repairs, all could be expected to be in workable condition and reliable for several years to come. There is no need to replace equipment from the point of wear and tear.

During the field visit the pumping system for the lower intake was inoperable since it had been shut down and drained for the season so it was not possible to measure the flow rate. From the reported flow rate of 7 gpm, it would appear that either the pump impellors are worn or that there is leakage in the system. According to the pump curves, the pump should discharge about 18 gpm into the 60,000 gallon tank (640 foot head) and 16 gpm into the 20,000 gallon tank (740 foot head). The diminished discharge could also be thought to represent unexpected head losses, causing the pump to sense a greater head. However, an existing pressure switch set at 320 psi (741 feet) will turn the pump off when this head is exceeded. Thus, it would appear that leakage or worn impellors are the likely causes for the lower discharge rate.

The 6-inch water main servicing the AVC building and the hydrants had also been shut off and drained during the field visit. Pressurizing the lines requires shutting of at least two drain valves and opening at least one valve with the generator building. This process takes 20 to 30 minutes. Thus, even though the Concession building and the AVC building were in use at the time of the visit, the water supply to the hydrants was off. The lines are drained to avoid freezing and bursting of the lines.

As mentioned earlier, the automatic push-button system for control of the fire pumps has been dismantled. The fire alarm has also been disconnected. Vandalism and misuse were given as the reasons.

3.3 Water Quality

3.3.1 General

Water quality concerns for this source are similar to those at the Wild Basin Campground as discussed in section 2.2.1. The water quality can be characterized as being low in turbidity, hardness, alkalinity, iron, and manganese. Because of the sparseness of vegetation in this area there is a potential for periods of high turbidity during storms. Water quality data do not suggest a problem with respect to metals of concern to health. The protected nature of the watershed would suggest no problems with respect to synthetic organic chemicals. Formation of trihalomethanes should not present a problem if proper chlorine dosage control is employed. The main concern is for diseases, such as Giardia, that are transmitted by animal carriers. Filtration should correct this problem, as discussed in the following section.

3.3.2 Alternative Solutions

3.3.2.1 General

The selection of alternative solutions is affected by considerations for the availability of space in the existing facilities, a desire to minimize visual impact, and a desire to minimize the labor required to operate the system. Consideration was given to the possibility for the use of one of the following processes:

- o conventional rapid sand filtration
- o direct filtration
- o diatomaceous earth filtration
- o slow sand filtration
- o ceramic cartridge filters

Because of the requirements for operator control to assure adequate treatment, the processes of conventional rapid sand filtration, direct filtration, and diatomaceous earth filtration were not considered to be appropriate for a system of this size. The use of a slow sand filtration process was considered to be inappropriate because the larger area requirement would result in a higher degree of visual impact. Cartridge filtration affords a compact system which does not place a high degree of reliance on operator control to provide an adequately treated water. Nonetheless, a continuous operations effort is required to maintain the filters in a clean condition. However, water quality is typically not impacted by the cleanliness of the filter.

The length of a filter run varies depending upon the quality of a given raw water and it is difficult to predict the frequency of necessary cleaning. This frequency is also determined by the availability of an acceptable pressure drop across the filters. Typically, filter runs of one to three days can be achieved and it may be possible for runs of greater length. In this situation, a pressure sand filter before the

cartridge filter will remove sediment that would otherwise shorten the cartridge filter run. The treatment capabilities relative to the quality of water have been discussed in section 2.2.2, "Operational Analyses", with respect to application at the Wild Basin Campground. The water quality concerns are similar at both locations and it is concluded that cartridge filtration would also be an acceptable approach at the Alpine Visitor Center.

An additional concern at the Alpine Visitor Center is the maintenance of a consistently acceptable chlorine residual. Long retention times are afforded by both the 60,000 gallon storage tank and the 20,000 gallon storage tank. Based on past usage figures, storage retention in excess of one month may frequently occur. The chlorine introduced on the raw water intake line dissipates naturally over such a time period. This raises concerns for contaminants that may enter the storage system. During the field visit it was noted that the 20,000 gallon tank offered at least 3 points of contaminant entry. First, the manhole ring on the inspection cover was not sealed, permitting surface runoff to enter the tank. Second, a series of 4-inch diameter holes around the upper perimeter of the tank were said to be improperly sealed, allowing seepage of water into the tank. Third, the end of the overflow pipe from the instrument well located adjacent to the tank was not covered. As the 20,000 gallon tank has a leak that drains into the instrument well, the possibility exists for contamination within the well to enter the tank if the water level in the well is ever greater than the level in the tank.

Present practice is to add calcium hypochlorite to the 20,000 gallon storage tank to retain a chlorine residual in the system. The residual is measured daily and fluctuates considerably (from 0 to 2.1 mg/l) as evidenced by the readings in Figure 3.4.

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(3/81)

1983

PUMP AND CHLORINATOR RECORD

Water System Alpine Visitor Center

Date July	Time	Gallons of Bleach	Residual	~~Pump Time~~	~~Hours Run~~	Taken By
8-24	11:00 AM		0.1	STORE		T.D.
8-25	10:00 AM		0.5	A.V.C		T.D
8-26	10:00 AM		0	A.V.C	STORE 0.1	T.D
8-27	1:30		2.1	KITCHEN SINK	AVC DRINKING FOUNTAIN 0.9	RC
8-28	10:30		2.0 KITCHEN	FOUNTAIN [illegible]	2.2 [illegible]	RC
8-29	9:00 AM		1.1	A.V.C		T.D
8-30	10:00 AM		0.2	STORE	A.V.C 0	T.D
8-31	10:00 AM		0.2	STORE		T.D
~~10:00 AM~~		Sept				
9-1	10:00 AM		0.2		A.V.C	T.D
9-2	10:00		0.1	A.V.C		T.D
9-3	1:45 pm		1.8	KITCHEN SINK		RC
9-4	1:25 PM		1.7	Kitchen Sink		J.S.
9-5	10:30 AM		0.7	A.V.C.	STORE 0.5	TD
9-6	11:00 AM		0.6	A.V.C.		T.D
9-7	10:00 AM		0.7	A.V.C.		T.D
9-8	2:00 PM		0.2	STORE		T.D.
9-9	2:00 PM		0.8	A.V.C		T.D
9-10	1:30 pm		2.3	KITCHEN SINK		RC
9-11	2:20 pm		1.4	kitchen sink		SJ
9-12	11:00 AM		0.4	A.V.C		T.D
9-13	2:00 PM		0.5	A.V.C		T.D

FIGURE 3.4. Alpine Visitor Center - Sample of chlorine residual results.

3.3.2.2 Recommended Treatment System:

The proposed treatment scheme consists of a ceramic cartridge filtration system with a pressure type sand filtration module to provide the option for pretreatment at times when the raw water turbidity is high. The existing raw water pumps, when in good condition, have a capacity of 15 to 17 gpm each. The existing raw water flows are adequate for overall demands at the AVC and the treatment system is sized based on the treatment of raw water at the present capacity of 15 to 17 gpm. Chlorination of the raw water should be continued in its present form. Because of concern for depletion of chlorine during storage, it is recommended that an additional hypochlorite feed system be added to provide for chlorination of water from the storage tanks before it enters the distribution system. The preferred point is below the junction of the lines from the 60,000 gallon and 20,000 gallon tanks. To ensure that improperly treated water does not enter the distribution line to the Concession building, the existing 2 1/2-inch diameter line to the Concession building should be removed. The replacement will be a new tap from the 6-inch main. It is also recommended that the existing piping be modified so influent water is routed to a point downstream of the inflow from the storage tanks. This will avoid "double" chlorination of the influent flow stream. This system will allow better control of chlorination. Adequate contact time will be met considering the length of piping and the volume of water in the pipe. Further, if the points of potential contamination are corrected, then hand dosing of the 20,000 gallon tank should not be necessary.

3.3.2.3 Options for Housing the Treatment Systems

Figure 3.5 shows the option for preliminary layout of treatment facilities within the existing generator building. As can be seen, the availability of space within the existing generator building is limited and the addition of treatment units to this building will add to existing space problems. This will result in an inefficient piping layout and will require several additional air release valves at high points in the piping. The

[illegible]

[illegible]

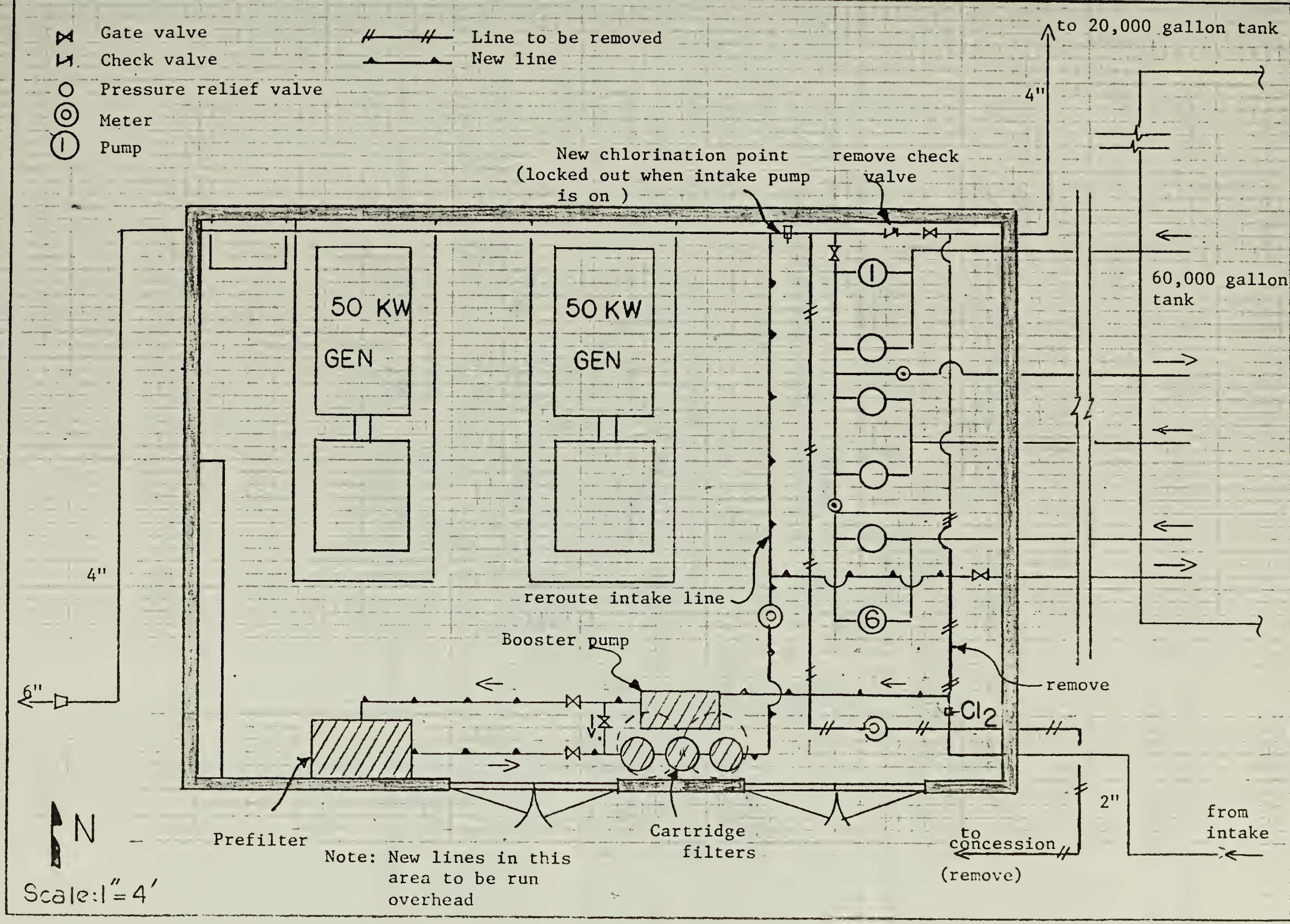

FIGURE 3.5. ALPINE VISITOR CENTER - LAYOUT OF WATER TREATMENT PROCESS IN GENERATOR BUILDING.

layout as shown requires the location of an alternative storage space for oil drums that are presently stored within the building.

An alternative is to locate a new building in the space between the existing generator building and the 60,000 gallon storage tank. A preliminary layout for this option is shown in Figure 3.6. The advantage of this approach is that it permits a more compact layout of equipment and allows better access for operation and maintenance. The major disadvantage is that it will require the construction of an additional building, thereby adding to the overall costs. There will also be some added visual impact to the area. However, this visual impact should be minimal because the overall building size is small, 10 feet x 10 feet. An additional concern is the need to provide for protection of existing piping between the 60,000 gallon storage tank and the existing generator building. This piping would be covered by the floor of the proposed building and access for any repair would become limited. Therefore, it is recommended that consideration be given to providing additional structural protection of this piping by concrete encasement.

Life cycle costs, expressed in terms of present worth, were developed for the two alternatives for housing the proposed treatment systems. An interest rate of 8.5 percent and a period of 20 years were used. All initial costs are based on a conventional design and construction approach at commerical rates. The results are summarized as follows:

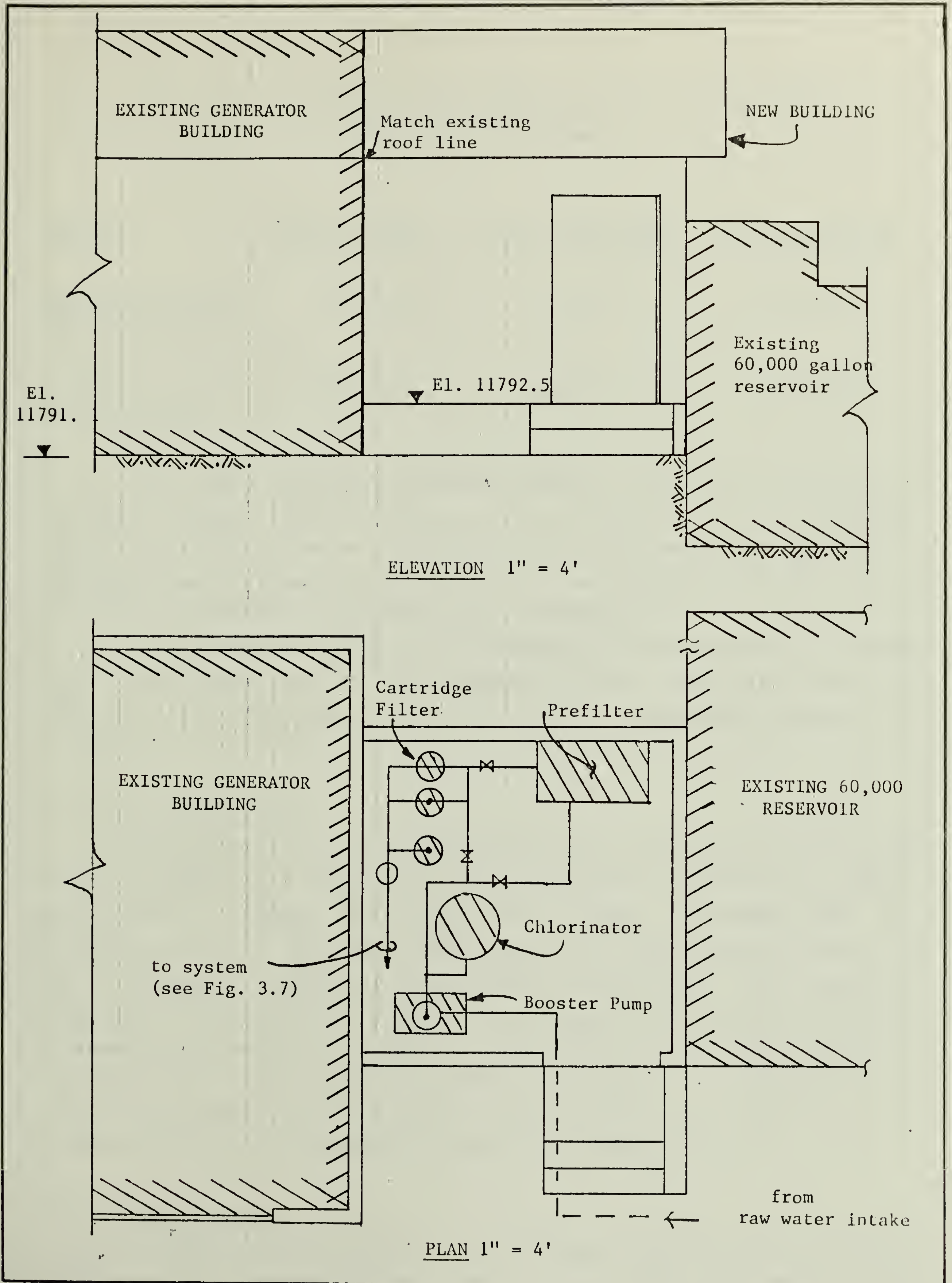

FIGURE 3.6. Alpine Visitor Center - Layout of water treatment process in new building.

Table 3.3. Alpine Visitor Center - Life cycle costs of housing options

Option	Initial Cost	First Year O&M	Present Worth
Construction in Existing Building	$42,900	$2,500	$66,600
Construction in New Building	$52,300	$2,500	$76,000

In terms of the estimated present worth, the difference in cost between the two options is not great. A new building will result in a more efficient working condition and will achieve some savings in costs that are not reflected in the level of detail associated with this cost comparison.

The final selection of equipment location should be made after the evaluation of the adequacy of the existing layout to provide fire protection. In this way an integrated approach is possible.

3.4 Fire Protection

The adequacy of the existing system was judged by testing the system against the National Fire Protection Association (NFPA) guidelines. These guidelines are widely accepted and in conversation with the RMNP North District Ranger were agreed to be a reasonable guideline for minimum protection. The Ranger's preferred performance would be 500 gpm with 80 psi nozzle pressure as needed to fight a structural fire. This section describes the requirements of NFPA, the results of a hydrant flow test, the results of hydraulic analysis of the system and the recommendations to provide improved fire protection.

3.4.1 Guidelines

The NFPA Publication No. 1231 "Water Supplies for Suburban and Rural Fire Fighting" was used as the basis for determining

the required water supply. The water requirement is based on the use and volume of the largest building as follows:

Table 3.4. Alpine Visitor Center - Water volume and flow rate required according to NFPA No. 1231

VOLUME

Structure	Hazard Classification (1)	Structure Size WxLxH (2)	Volume, ft^3 (3)	Volume of water, gallons Col. 3/ Col. 1
AVC	4	40x100x8	32,000	8,000
Concession Bldg.	4	50x104x8	41,600	
+ basement 10%			4,160	
		Total	45,760	11,500

RATE

If volume <20,000 gallons, flow rate shall be available on the fire ground at a flow rate not less than 500 gpm (4-3.3).

Thus, to meet NFPA standards, a volume of 11,500 gallons available at a minimum of 500 gpm should be available. The storage requirement is easily met by the 20,000 gallon and 60,000 gallon storage tanks. Based on the operation and water use of the facility, the 20,000 gallon tank alone would contain enough water in most all cases. The flow rate requirement was tested both by performing a flow test in the field and by analyzing the system hydraulically.

3.4.2 Results of Flow Test and Hydraulic Analysis

A flow test was carried out on the 16th September, 1983 with the assistance of the O&M staff of the RMNP. As the 6-inch main had been drained, it was necessary to recharge the system prior to testing. Hydrant No. 3, located just west of the AVC

building was used as the flow measurement point. Hydrant No. 2, located opposite the Concession building was used for measuring residual pressure. At the time of the test the 20,000 gallon tank was full. Flow measurements were first made without the pumps running and secondly with the 3 working pumps operating.

The results of the flow test are shown below. The test and calculation procedures outlined in "Water Supplies for Fire Protection" published by the International Fire Service Training Association were followed. A pitot tube was used to measure the pressure at the discharging hydrant.

Table 3.5. Alpine Visitor Center - Fire flow test results

DATA	Pressure at hydrant, psi No. 1	No. 2	No. 3	Flow at No. 3, gpm[1]
Test No. 1				
Static-no flow	40	39	38	--
Test No. 2				
Pumps off, No. 3 open	--	17	8	430
Test No. 3				
Pumps 2, 3, 5 on, No.3 open	--	20	10	470

[1] Computed from equation GPM = 29.83 x c x d^2 x P**0.5 (pg. 69) where c = 0.8, d = 2.5 inches, P = pitot tube reading.

AVAILABLE WATER

Standard residual pressure requires 20 psi at hydrant No. 2. For Test No. 2, the flow for a residual pressure of 20 psi is:

$$Q_R = Q_F \times \frac{h_R^{0.54}}{h_F^{0.5}}$$

Q_F = flow during test

h_R = P to desired residual

h_F = P during test

$$Q_R = 430 \times \frac{(38-20)^{0.54}}{(38-17)^{0.54}}$$

Q_R = 395 gpm with 20 psi residual.

For Test No. 3, the residual was 20 psi with Q = 470 gpm.

The results indicate that the 500 gpm flow rate is not met at Hydrant No. 3, with just under 400 gpm available by gravity feed from the 20,000 gallon tank and 470 gpm available with 3 pumps running.

A hydraulic analysis was performed to confirm these figures and estimate the flow with 6 pumps running, with and without a

contribution from the 20,000 gallon tank. The results are summarized in the table below.

Table 3.6. Alpine Visitor Center - Results of hydraulic analysis

	Pumps	20,000 gallon tank	Discharge, gpm at Hydrant No. 3	500 gpm requirement met?
Case 1	Off	on-line	400	No
Case 2	On	off-line	400	No
Case 3	On	on-line	575	Yes

Thus, with all 6 pumps operating and the 20,000 gallon tank contributing, the 500 gpm flow requirement can be met.

Pump sizes to meet the Park Ranger's request for 80 psi nozzle pressure and 500 gpm were estimated. Four of the 6 existing pumps would be removed and replaced with two 30 HP pumps with 3 phase motors. Each motor would be driven from one of the 50 KW generators, requiring both generators to be in operation, but not necessarily synchronized. To achieve this would require considerable rewiring of the electrical system and rearrangement of the plumbing.

3.4.3 Discussion

Although the current system, if placed in operating condition, could meet the minimum NFPA requirement for storage and flow, it does have disadvantages. The primary disadvantage is that the trained staff needed to be available on-site in order to operate the system and effectively fight a fire are not currently available. The O&M staff are not trained as fire fighters, while the Park Rangers in Estes Park are 1 hour away by road and are not thoroughly familiar with the operation of the system.

There are two independent options for improving the system performance. First, the valving and control system in the generator building could be redesigned to minimize the need for operator involvement. Secondly, a sprinkler system could be installed in each building. The optimum case would be to combine both options.

The redesign and implementation of a new pipe layout would result in a more reliable system. A more thorough description of the system is presented in the next section.

A sprinkler system would need to be designed to NFPA codes as discussed in publication No. 13 "Installation of Sprinkler Systems". As the system would have to be drained during the winter, the dry pipe valve system would be used. To operate the system, 4 of the 6 5HP pumps would have to operate.

The installation of two 30 HP pumps to provide 80 psi nozzle pressure would improve fire fighting capabilities if trained fire fighters were on-site. However, the reliability of the system would be less as it requires both generators. Also, it may be necessary to re-evaluate the ability of the existing piping to handle the increased pressures, especially at points of change in flow direction where existing thrust blocks would be inadequate.

3.5 Conclusions and Recommendations

The water quality concerns at the Alpine Visitor Center can be adequately addressed by the installation of cartridge filters, a pressure sand filter, one additional chlorinator and correcting potential areas of contamination. The filtration equipment can be installed in the generator house, but by placing the filtration equipment in a new building a more efficient operation will result. The 2-1/2 inch line to the Concession should be removed and the Concession should instead be fed from the 6-inch main.

The condition of the existing equipment is good, although a lack of maintenance has resulted in some equipment not functioning. The electrical wiring system does not utilize the

generator output efficiently and does not provide the automatic mode of operation desired. Rewiring should be done as described below.

Fire protection on the site is presently adequate when all equipment is operating properly. However, the overall reliability can be improved by rearranging the plumbing and electrical system. A simplified schematic is shown in Figure 3.7. The operation of this system is described in the flow diagrams of Figures 3.8 and 3.9 and in the Instrumentation and Control notes in Figure 3.10. With this system the six 5 HP pumps can all be used as transfer pumps and fire pumps. Each 5 HP pump will be used in turn so that system use is more even and to ensure that faulty equipment is recognized and repaired. This system could be used in conjunction with the existing fire protection system or with a sprinkler protection system. The sprinkler system is recommended since it provides rapid response to a fire with no operator input.

3.5.1 Costs

The costs of implementing those actions recommended previously are tabulated below. Details of the cost estimates are in Appendix A.

Table 3.7. Alpine Visitor Center - Capital costs

ITEM			
1.	Filtration system		
	a. Cartridge Filters, Pressure Sand Filter, Chlorinator, in Generator Bldg.	$42,900	
	b. same as 1a but in new building	$52,300	*
2.	New tap to Concession from 6" main. Cap 2 1/2" line, remove plumbing inside generator shed, relocate meter.	$ 3,290	*
3.	Rewire and replumb system as per recommended plan (Fig. 3.7)	$ 6,600	*
4.	Install sprinkler system in AVC and Concession buildings	$27,460	*
5.	Add new fire pumps (2 ea x 30 HP)	$20,800	
	Total of recommended items "*"	$89,650	

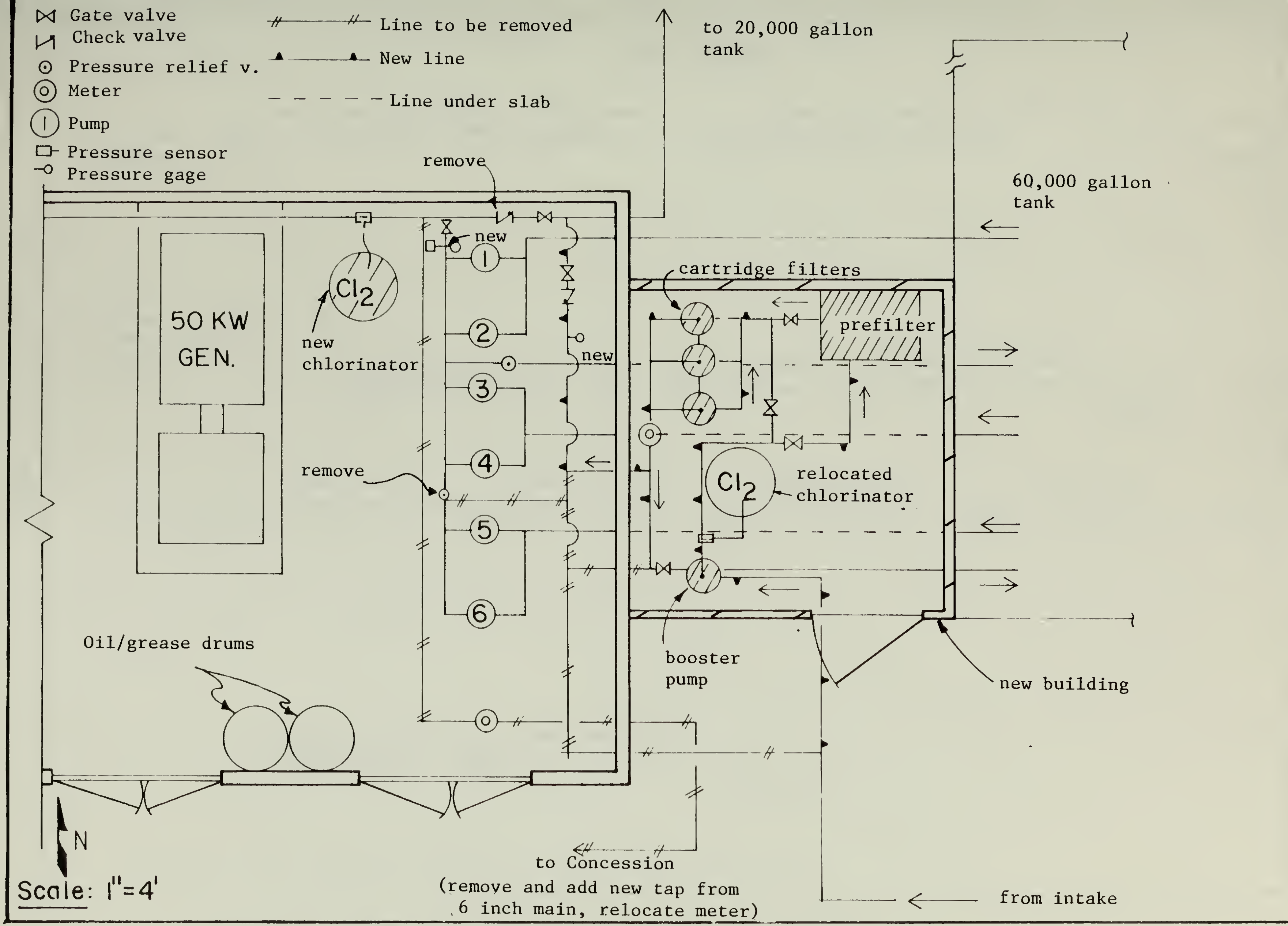

FIGURE 3.7. ALPINE VISITOR CENTER-SIMPLIFIED SCHEMATIC OF PREFERRED LAYOUT.

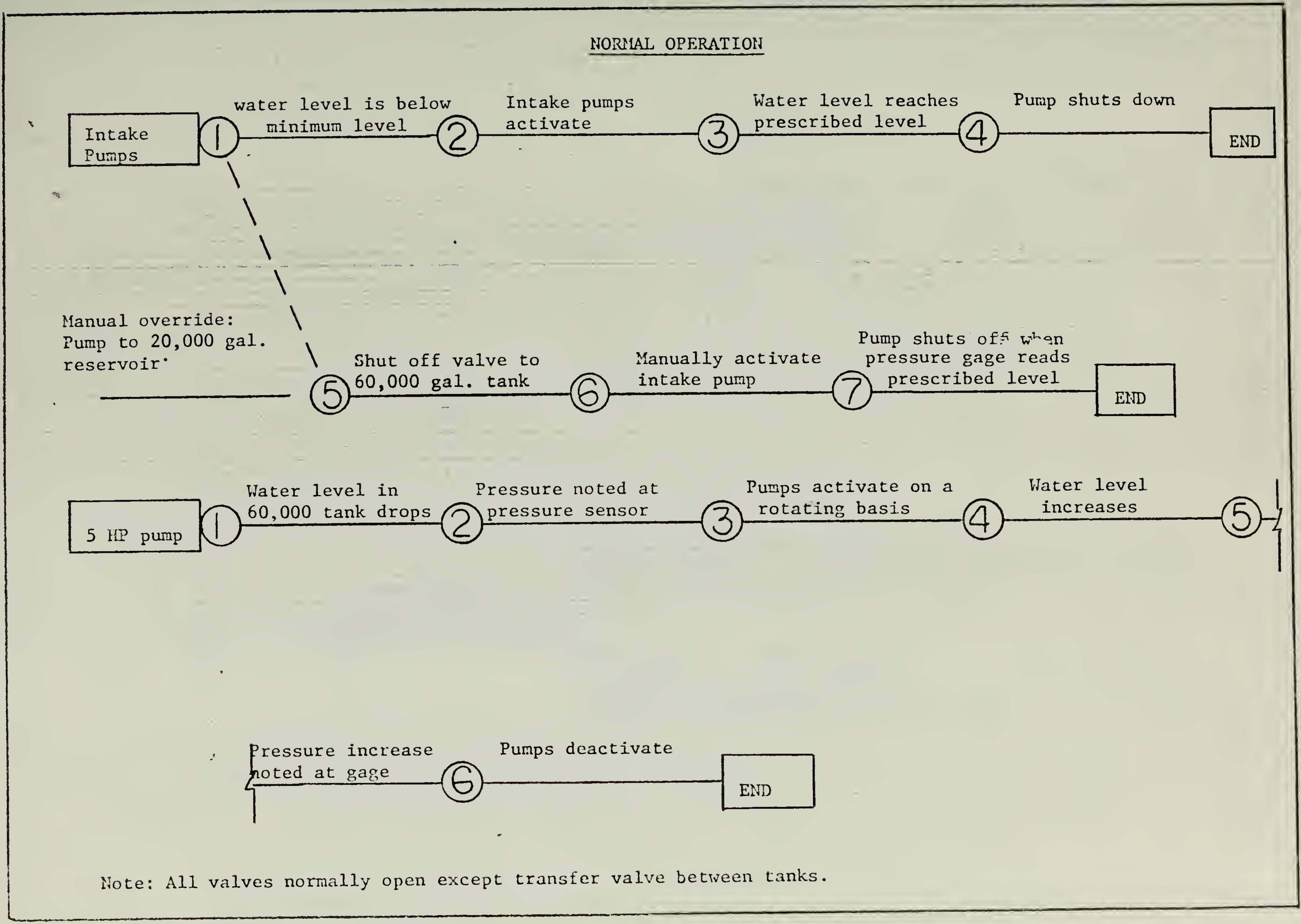

FIGURE 3.8. Alpine Visitor Center - Normal operation flowchart.

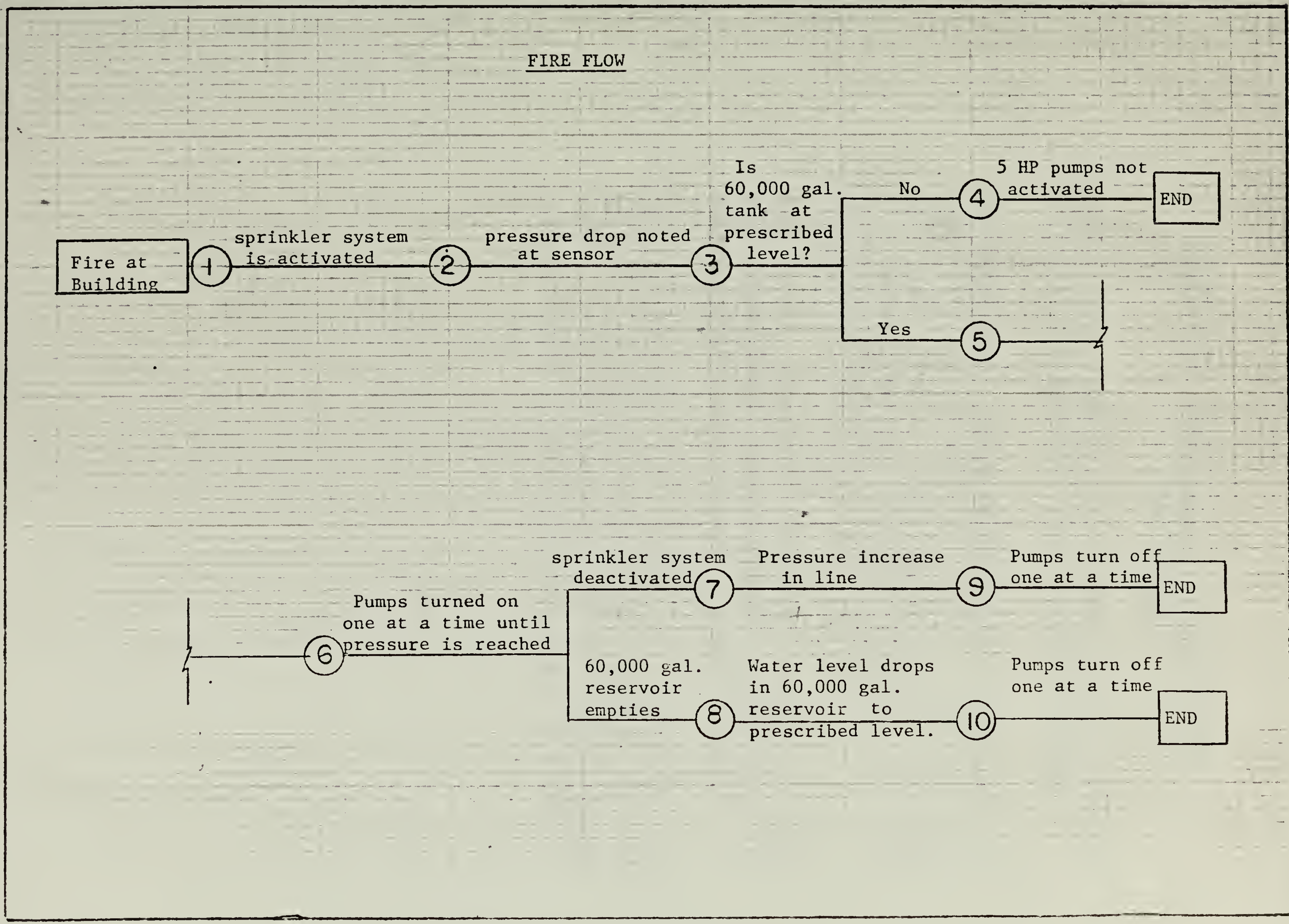

FIGURE 3.9. Alpine Visitor Center - Flow chart for fire flow scenario.

FIGURE 3.10. Instrumentation and Control Pump System

1. Water level recorder in 60,000 gallon reservoir activates and shuts off pump located at intake.

2. Pressure sensor switch activates and shuts off 5 HP pumps located in generator shed. Pumps will be activated one at a time and shut off in the same order when prescribed minimum and maximum pressures are recorded at pressure sensor switch.

3. An automatic override will prevent starting of 5 HP pumps should the water surface in 60,000 gallon reservoir be below a minimum prescribed level.

4. Over-pressurizing of system is prevented by providing redundancy of pressure relief valve that opens and discharges back into the 60,000 gallon reservoir when the prescribed pressure is reached.

3.6 Noise Suppression

Noise levels within the generator building have been identified as a possible health concern to those people who work within the building on an intermittent basis. The primary source of noise is the diesel engine(s) of the generator set(s). The exhaust system and the type of floor mounts used on the generator frame are not believed to be major contributors to the noise levels. The muffling system is contained within a concrete block chimney and is inaccessible. According to staff reports, there is no muffler per se on the exhaust, instead a series of baffles within the chimney reduces noise levels outside the building to an acceptable level. During the field visit sound level measurements were taken. A description and analysis of the measurements are included in Appendix D.

The findings indicate that at current sound levels the exposure time of workers should be limited to 2 hours or less is required in order to comply with the original OSHA requirements. The Hearing Conservation Amendment, published in FR 8 March, 1983, further requires that the employer shall administer a hearing conservation program for any employee exposed to an 8 hour time weighted average of 85 decibels or more. At the 100 decibel level now existing an employee exposed for 1 hour would qualify.

The cost of remedial measures that could be taken and their impacts are described below.

Table 3.8. Alpine Visitor Center-Measures to reduce sound levels in generator building

Method	Decibel reduction	Maximum Exposure Time (OSHA) (hours)	Initial Cost[1]
None	0	2	0
Wall Covering - 1" fiberglass	2-4	2.6 - 3.5	$1000
Enclosure/partitions	>10	>8	$4000
Ear protection device (muffs)	>10	>8	$ 80

[1] See Appendix A.

Of these measures, the most cost effective is the use of hearing protection devices (ear muffs). The partition alternative is not particularly attractive due to space limitations and heat build-up. The generators currently tend to overheat and a partition would accentuate the problem. The wall covering does not result in a significant reduction in sound levels. Regardless of what measure is used, adequate warning signs should be posted in the generator building to make persons aware of the possible adverse negative impact of prolonged exposure.

The National Park Service should investigate in detail its responsibility to those employees who must work on an intermittent basis in the generator shed. Park personnel reportedly have spent up to 4 hours working in the building without protection. If correct, the NPS may find itself in violation of OSHA requirements and liable for claims relating to impaired hearing.

APPENDIX A

COST ESTIMATES

Cost Estimate					Project No. 81230		Date 11/9/83	
	Rocky Mountain National Park							
	Alpine Water Supply							
	by PMP/JFSA							
	Description	No.	Unit	Cost/Unit	Reference		REF	Cost
1.	Water Line	50	LF	11.00	550		C.C.A.	$ 550
	4" PVC							
2.	4" Gate Valve	1	EA	400	400		C.C.A.	400
3.	Remover and Plug Line to	1	LS	400	340			290
	Concession Building							
4.	Relocate Meter	1	LS	175	175			150
5.	Cut and Replace Paving	1	LS	1000	1000			1000
							Subtotal	$ 2390
					Contingencies		10%	240
							Subtotal	$ 2630
					Eng. and Admin.		25%	660
	Additional						TOTAL	3290
	Rewire and replumb as							
	per recommended plan							
	Figure 3.7.							
	Plumber	80	HR	30	2400			$ 2400
	Electrician	80	HR	30	2400			2400
							Subtotal	4800
					Contingencies		10%	480
							Subtotal	5280
					Eng. & Admin.		25%	1320
							TOTAL	$6600

Cost Estimate	Project No. 81230	Date 10/27/83
Rocky Mountain National Park		
AVC - Water Treatment Processes		
by George Budd/RA		

	Description	No.	Unit	Cost/Unit	Reference			Cost
	Construction in Existing Building							
1.	Katadyn - Ceramic Cart.							
	Filter 3-M7R'S							
	a. Purchase	1	LS	$7,500	Katadyn Pride List			$ 7,500
	b. Installation (40% of purchase)	1	LS	$3,000				$ 3,000
2.	Yardley Prefilter							
	Model IF 1279-1A							
	a. Purchase	1	LS	$2,000	Quote from Chief Eq. (7/21/83)			$ 2,000
	b. Installation (40% of Purchase)	1	LS	$ 800				$ 800
3.	Pipe Cost	100 ft	LF	$20.70	MEANS 15.1 plus $8/ft for fittings (1983)			$ 2,100
	2" Sch. 80 Galvs							
4.	Valves	15	EA	$100	Cost Range from MEANS 15.1 (1983)			$ 1,500
5.	Chlorinator - W&T Model 44-111 with flow pace capability							
	Purchase	1	LS	$2,500	Quote from Goble Samioson (8/8/83)			$ 2,500
	Installation & Misc. (60% purchase)	1	LS	$1,500				$ 1,500
6.	a. Booster Pump	1	LS	$ 500	General price range peerless pumps in 1983 CPS cat.			500
	b. Pump Panel & Switches	1	LS	$ 600	General price range peerless pumps in 1983 CPS cat.			600

Cost Estimate	Project No. 81230	Date 10/27/83

Rocky Mountain National Park

AVC - Water Treatment Processes

by George Budd/RA

Description	No.	Unit	Cost/Unit	Reference			Cost
c. Installation				60% of cost panel & pump			$ 660
7. Electrical	--	--	$1000	MEANS c9.1-170 (1983)			$ 1000
						Subtotal	$21,900
8. Miscellaneous (piping, plumbing, elec., build modif., controls, etc.) @ 15%							$ 3,300
9. Add 10% for remote const.							$ 2,200
						Subtotal	$27,400
10. Contingency and Profit @ 25%							$ 6,900
				Total Const. Cost			$34,300
			Engin.,	Legal, Admin.		@ 25%	$ 8,600
			Total	Project without		Building	$42,900

Cost Estimate	Project No. 81230	Date 11/8/83
Rocky Mountain National Park		
AVC - Water Treatment Processes		
by George Budd/RA		

	Description	No.	Unit	Cost/Unit	Reference			Cost
	Construction in New Building							
1.	Add Building	100sq.ft	$60/sq	ft				$ 6,000
2.	Misc. (concrete encasement, piping modf., etc.) @ 25%							$ 1,500
							Subtotal	$ 7,500
3.	Total Const. without building (see Alt. A)							$34,300
					Total Const. with building			$41,800
				Engin.,	Legal, Admin.		@ 25%	$10,500
					Total Project			$52,300

Cost Estimate	Project No. 81230	Date 9 Nov. 83

Rocky Mountain National Park

Alpine Visitor Center

Fire pumps for 80 psi nozzle pressure

by GSL/JFSA

Description	No.	Unit	Cost/ Unit	Reference			Cost
30 HP pumps 250 gpm x	2	EA	4100	Mclemore			$ 8,200
285 feet				Pump			
Install 40% of costs							3,280
Remove existing 4 pumps & piping	40	hrs	30	Std. Rate			1,200
Control system, electrician	40	hrs	30	Std. Rate			1,200
						Subtotal	$13,880
				Contingencies		20%	2,780
						subtotal	16,660
				Eng. & Admin.		25%	4,140
						TOTAL	$20,800

Cost Estimate				Project No. 81230			Date 9 Nov.83
Rocky Mountain National Park							
Alpine Visitor Center							
Sprinkler System							
by GSL/JFSA							
Description	No.	Unit	Cost/Unit	Reference			Cost
1. Sprinkler System in AVC	1	LS	$9000	Mtn Sts.Fire			$ 9,000
Dry-Pipe (4500 ft^2)				Protection			
2. Sprinkler System in Concession	1	LS	$8000	Mtn Sts Fire			8,000
Dry-Pipe (5000 ft^2)				Protection			
3. Drawing of Building	40	HR	30	Std. Rates			1,200
4. Add'l Piping from main to	70	FT	11	C.C.A.			770
bottom of riser, 4"							
5. Control system, electrical	1	LS	1000	Est.			1,000
						Subtotal	$19,970
				Contingencies		10%	2,000
							$21,970
				Engineer & Admin		25%	5,490
						TOTAL	$27,460

Cost Estimate	Project No. 81230	Date 10/19/83

Rocky Mountain National Park

GROUND WATER SYSTEM for
WILD BASIN PICNIC GROUND

by Tsegaye Hailu / JFSA

	Description	No.	Unit	Cost/Unit	MEANS '82 Reference			Cost
1.	Well Drilling & Completion							
a	o Mobilization	1	LS		2.4-10-60			1,350
b	o Drilling & casing - 12"	1	LS	Total	2.5-40-50			
	diam. casing x8" diam.screen							6,020
	25' deep, plus 50% for							
	drilling in glacial till-							
	incl. gravel pack							
c	o Well development	10	Hr	60.00				600
d	o Pump , inst. to 20', 4"	1	Ea					830
	subm., 1/2 H.P.							
e	o Miscellaneous fittings	1	LS					200
	(pitless & well cap, etc.)							
2.	Pipes, 2" PVC Class 160,SDR	1220	LF	3.03	2.5-30-270			3,700
	26,							
a	o Trenching,doubled for condition	1220	LF	2.04	2.3-19-75			2,500
b	o Backfill	271	CY	12.95	2.3-19-60			3,500
3.	Cable, electrical, copper THW,	6.0	CLF	33.00	16.1-10-12			200
	6 amp #10,							
4.	Tank, Pneumatic, 220 gal cap.	1	Ea		Fair, Inc.			550
	w/accessories							
							sub	$19,450
							Contingencies 10%	1,950
							Profit 10%	1,950
							1982 sub	$23,350
							Escalate to 1983 6%	$24,750
							Engineering, Legal, Admin. 25%	$ 6,200
							Total Project Cost	$30,950

Cost Estimate	Project No. 81230	Date 11/8/83
Rocky Mountain National Park		
Wild Basin Picnic Ground - Ground Water		
Treatment System		
by George Budd/RA		

	Description	No.	Unit	Cost/Unit	Reference		Cost
1.	Greensand filter						
	a. purchase	1	LS	$1000	Culligan-quote		$1000
	b. Installation (40% of purchase)	1	LS	$400			$ 400
2.	Pipe Cost						
	3/4" Sch 80 Galv.	20 ft.	LF	$9.90/ft	MEANS 15.1 plus $4/ft for fittings (1983)		$ 200
3.	Valves	5	EA	$20	Cost Range from MEANS 15.1 (1983)		$ 100
4.	Chlorinator						
	a. Purchase	1	LS	$350	NPS - invoice		$ 350
	b. Install (40% of purch)	1	LS	$150			$ 150
5.	Electrical	1	LS	500			$ 500
6.	Building	100sq.ft	sq.ft.	$ 40			$4000
						subtotal	$6700
					Miscellaneous @	15%	$1000
						subtotal	$7700
				Contingency and Profit		@ 25%	$1900
					Total Const. Cost		$9600
				Engin, Legal, Admin. @		25%	$2400
					Total Project	Cost	$12,000

Cost Estimate	**Project No.** 81230	**Date** 11/8/83

Rocky Mountain National Park

Wild Basin Picnic Ground - Surface Water Treatment System - Equivalent Construction Cost

by George Budd/RA

	Description	**No.**	**Unit**	**Cost/ Unit**	**Reference**	**Cost**
1.	Materials		LS		NPS - invoices	$3,600
2.	Labor		LS		NPS records, adjust	$6,500
	cost to commercial rates to account for overheads, etc. Assume $30/hr for commercial vs. $11.86/hr for NPS salary, use a factor of 2.5 times $2,600 from NPS records.					
3.	Administrative Overhead		LS		25% of Labor	$1,600
					Total Const.	$11,700
					Equiv. Engin, Legal, Admin. @ 25%	$ 2,900
					Total Project (Equiv.)	$14,600

Note: No building costs are included because an existing building was used.

Cost Estimate				Project No. 81230			Date 7 Nov.1983
Rocky Mountain National Park							
WILD BASIN							
Remedial Works to Proposed System							
by GSL/JFSA							
Description	No.	Unit	Cost/Unit	Reference			Cost
1. Pressure switch/5 gal	1	EA	120	Est.			120
pneumatic tank, installed							
2. 1¼ inch diameter Sch 40	400	LF	2.45	MEANS	1982	980	
PVC					1983	add 6%	1040
3. Trenching - 3 feet deep	400	LF	2.04	MEANS	1982	820	
doubled for condition				2.3-19-75	1983	add 6%	870
4. Backfill	50	CY	12.95	MEAN	1982	650	
				2.3-19-60	1983	add 6%	690
5. Plumbing - rearrangement	24	HRS	30	----			720
						sub.	3440
				Contingencies		20%	690
							4130
				Profit		10%	410
						Subtotal	$4540
				Engineering, Admin. 25%			1235
						TOTAL	$ 5675

Cost Estimate	**Project No.** 81230	**Date** 11/8/83

Rocky Mountain National Park

WILD BASIN

Ground Level Fire Pump

by PMP/JFSA

	Description	**No.**	**Unit**	**Cost/Unit**	**Reference**			**Cost**
1.	Pipe, Installed							
	6" PVC	150	LF	15.00	C.C.A.			$ 2,250
	4" PVC	310	LF	11.00	C.C.A.			3,410
	2" PVC	40	LF	9.00	C.C.A.			360
2.	Fire Hydrants	2	NO	1,200	C.C.A.			2,400
4.	Structure	100	SF	50.00				5,000
	10' x 10'							
5.	Electrical	1	LS	1,000				1,000
6.	Plumbing	1	LS	1,000				1,000
5.	Intakes, 4 Intakes,	1	LS	1,200				1,200
	Well Screen							
6.	Roto Phase Unit	1	EA	4,000				4,000
8.	Upgrade on Transformer	1	LS	2,500				2,500
9.	Dump, 500 gpm @ 150' 30 HP	1	EA	7115	Price Quote			7,115
							Subtotal	$30,235
					20% Contingencies			6,047
	Note: C.C.A.						Subtotal	36,282
	Colorado Contractors Assoc.				10% Profit			3,628
	Bid Tabs						Subtotal	39,910
				25% Engineering, Legal Admin.				9,978
							TOTAL	$49,888

Cost Estimate	Project No. 81230	Date 11/8/83
Rocky Mountain National Park		
WILD BASIN		
Elevated Storage Tank		
by PMP/JFSA		

	Description	No.	Unit	Cost/Unit	Reference			Cost
1.	Storage Tank, 10,000 gal.	1	No	12,000	Price Quote			$12,000
	Painted Installed							
2.	Pipe							
	6" PVC	650	LF	$15.00	C.C.A.(83)			9,750
	4" PVC	310	LF	11.00	C.C.A.(83)			3,410
	2" PVC	40	LF	9.00	C.C.A.(83)			360
3.	Hydrants	2	NO	1,200	C.C.A.(83)			2,400
4.	Structure							
	10' x 10'	100	SF	$50				5,000
5.	Electrical	1	LS	$1,000				1,000
6.	Plumbing	1	LS	$1,000				1,000
7.	Intake, Dual Well Screen	1	LS	$ 500				500
8.	Pump	1	LS	$1,100	Price Quote			1,100
	28 gpm @ 150' MEAD 2 HP							
							Subtotal	$36,520
					20% Contingencies			7,304
	Note: C.C.A.						Subtotal	$43,824
	Colorado Contractors Assoc.				10% Profit			4,382
	Bid Tabs						Subtotal	$48,206
				25% Engineering, Legal,			Admin.	$12,052
							TOTAL	$60,258

Cost Estimate				Project No. 81230			Date 11/9/83
Rocky Mountain National Park							
WILD BASIN							
Sprinkler System for Residences							
by GSL/JFSA							
Description	No.	Unit	Cost/Unit	Reference			Cost
1. Sprinker System, Dry Pipe							
2 residences							
a. sprinklers, installed	20	EA	55	MEANS 15.4-60.270			$1,100
b. air compressor, installed	2	LS	700	MEANS 15.4-60.082			1,400
c. valves, installed	2	LS	1000	MEANS, rep			2,000
d. misc. plumbing, labor	24	HR	30	std. rate			720
						Subtotal	$5,220
			Profit & Contingencies			25%	1,300
						Subtotal	6,500
			Engineer and Admin.			25%	1,630
						TOTAL	$8,150

Cost Estimate			Project No. 81230			Date 10-12-83	
Rocky Mountain National Park							
NOISE PROTECTION SYSTEM Page 1							
by GSE							
Description	No.	Unit	Cost/Unit	MEANS 1982 Reference	pg	Item No.	Cost
Partition				escalated to 1983			
2x4" studs - 8'×16" OC	36	LF	7.26		154	31-020	261.
Openings, add	6	LF	1.77L		154	31-160	10.
Gypsum, 1/2"	608	SF	.65		155	42-285	395.
Doors 3'x6'8"	2	EA	209			32-070	418.
Framing	33	EA	4.36			12-042	143.
Option							
Acoustical Doors	2	EA	1128		197	03-020	2256.
Paint							
Door and Frame	2	EA	22		231	05-120	44.
Drywall	608	SF	0.50		232	20-360	304.
Travel Time	6	HR	25L				150.
				Sub -	Std	Door	1730
				Contingencies		10%	173
				Profit		10%	173
				Std Door	1983	Total	$ 2075
				Sub - Acoustical			3430
				Contingencies		10%	340
				Profit		10%	340
				Ac Door	1983	Total	$ 4110

Cost Estimate				Project No. 81230		Date 10-12-83	
Rocky Mountain National Park							
NOISE PROTECTION SYSTEMS Page 2							
by GSL							
Description	No.	Unit	Cost/Unit	Reference			Cost
Insulation board							
1" thick rigid IB 300	700	ft^2	60	Eng. Dynamics			420
Miscellaneous							100
						1983	$ 520
Travel time	6	hr	25	--			150
						Total	$ 670
Muffs							
Ear protection	4	Ea	20	Eng. Dyn.			80

APPENDIX B

GROUND WATER INVESTIGATION

WILD BASIN, ROCKY MOUNTAIN NATIONAL PARK

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GROUND WATER INVESTIGATION
WILD BASIN, ROCKY MOUNTAIN NATIONAL PARK

INTRODUCTION

Wild Basin lies in the southeast corner of the Rocky Mountain National Park about 2.3 miles northwest of Allens Park (Fig. 1). The Wild Basin picnic ground and Ranger Station are located in section 21 of T3N and R73W, at the confluence of Hunters Creek and North St. Vrain Creek. North St. Vrain is the main drainage in the area with headwaters originating in the Continental Divide which is only 5 1/2 miles west of Wild Basin. No well records are available at the State Engineers Office for the area between section 21 and the boundary of the Rocky Mountain National Park which crosses North St. Vrain Creek about a mile downstream from Wild Basin picnic ground. Most of the existing wells in the area are actually located around Meeker Park, Allens Park and along Highway 7, all of which are outside of the Rocky Mountain National Park.

This report looks into the possibility of using ground water sources for water supply to the Wild Basin picnic ground and Ranger Station.

GEOLOGY AND HYDROGEOLOGY

Regional

The geology, mineral deposits and water resources of the Wild Basin area are included in regional studies that cover the Front Range and Boulder County.

The geology and mineral deposits of the Front Range were investigated by Lovering and Goddard (1950). R.F. Madole (1969, 1976) studied the glaciation and Quaternary geology of the St. Vrain drainage basin and the Front Range. More recently, D.C. Hall and others (1979, 1980) have looked into the water resources of the Boulder County.

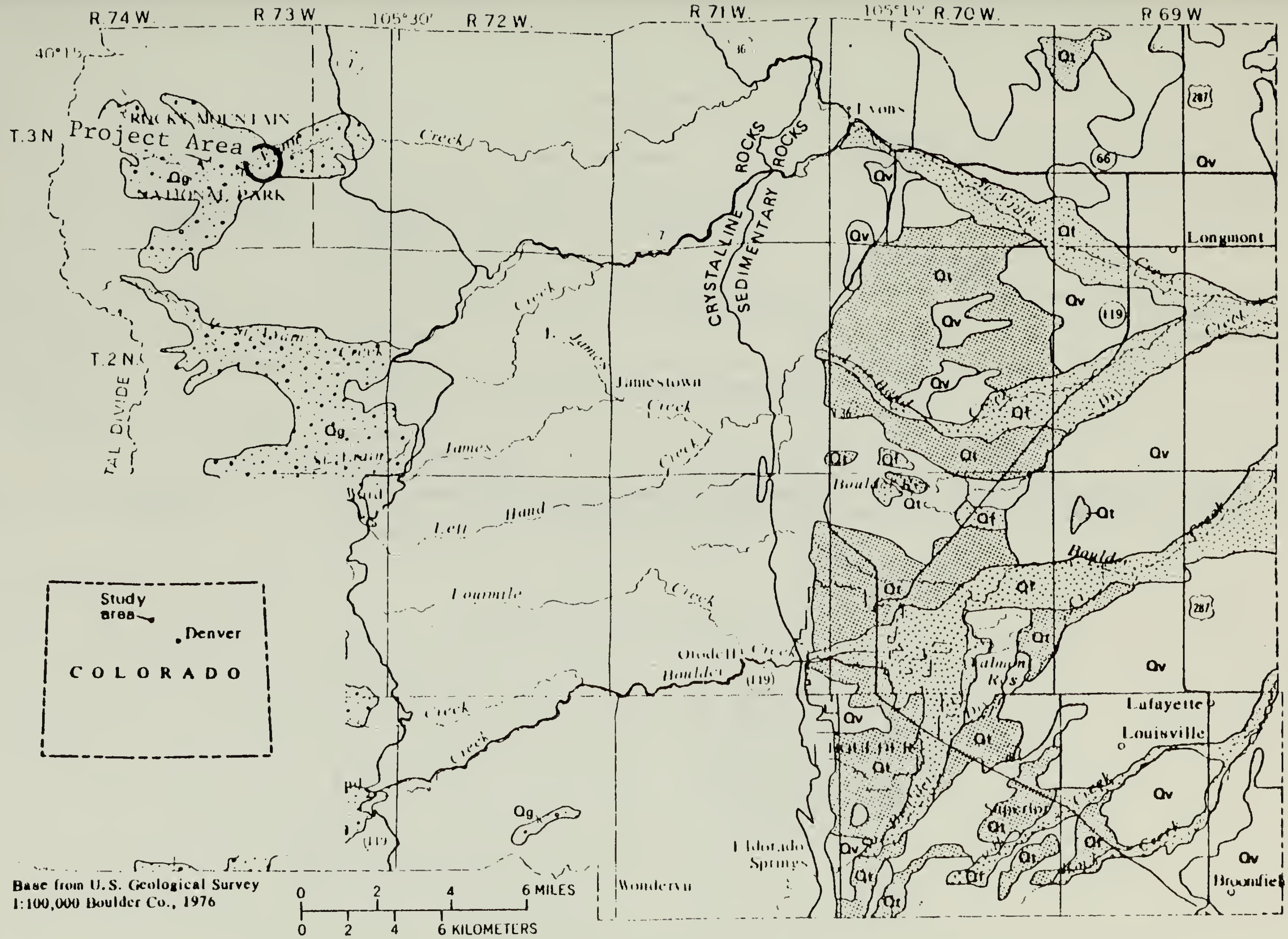
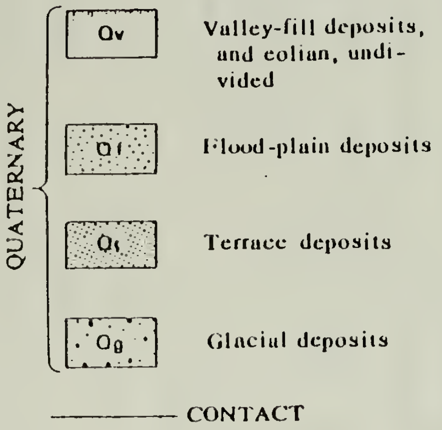


Figure 1 .-- Location of unconsolidated-rock aquifers.
(from Hall and others, 1980)

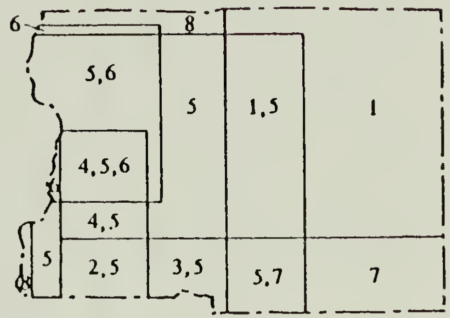
EXPLANATION



Physical description	Approximate thickness (feet)	Aquifer unit	Well yields[1]
Valley fill--Crudely bedded, poorly sorted material deposited on slopes and valley bottoms primarily by sheet wash	0-35	Valley fill	Small to inadequate
Eolian--Wind-deposited fine sand and silt	0-25	Eolian	Small
Stream-deposited boulders, gravel, and sand, with some clay and silt. These deposits are within the flood plain of streams	0-30	Flood Plain	Medium to large in plains, medium to small in mountains
Stream-deposited boulders, gravel, and sand, with some clay and silt. These deposits are above the flood plain of streams	0-30	Terrace	Medium
Material of all sizes from boulders to silt. Deposited by glaciers and outwash	0-50	Glacial	Medium to small

[1]For purposes of this report, reported well yields have been classified as follows: Inadequate yields, less than 1 gallon per minute; small yields, less than 15 gallons per minute; medium yields, 15 to 100 gallons per minute; and large yields, more than 100 gallons per minute

SOURCES OF GEOLOGIC INFORMATION



1. Colton, 1978
2. Gable, 1969
3. Gable, 1972
4. Gable and Madole, 1976
5. Lovering and Goddard, 1950
6. Madole, 1969
7. Trimble and Machette (written commun., 1976)
8. Tweto, 1976

Figure 1 --Location of unconsolidated-rock aquifers--Continued.
(from Hall and others, 1980)

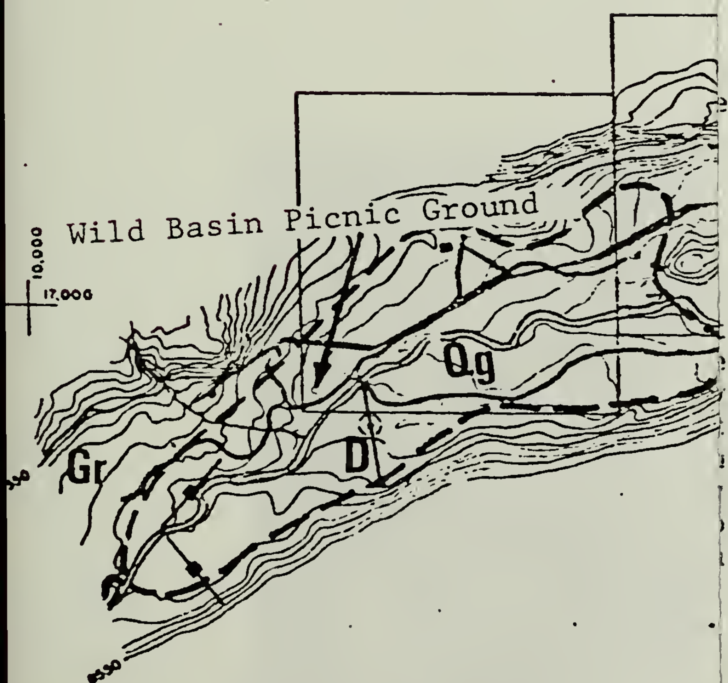
The bedrock in the western two-third of Boulder County is composed of crystalline rocks (Fig. 2). These are essentially impermeable rocks for water storage or movement except along fractured zones. Spring discharges and well yields from fractured zones in crystalline rocks are generally small to inadequate.

The crystalline rocks in the Rocky Mountain National Park area are for the most part exposed or thinly covered with unconsolidated sediments (Fig. 1). The sediments which consist mainly of glacial and fluvial deposits are relatively thicker in the lower reaches of the drainage basins where the stream gradients are gentler. The poorly sorted and unconsolidated deposits are the principal sources of ground water in the area, yielding adequate supply for domestic and livestock needs.

Wild Basin

In the vicinity of the Wild Basin picnic ground, the basement crystalline rocks belong to the Silver Plume granite (Fig 2). The granite forms the valley walls along North St. Vrain and also outcrops at Copeland Falls, about 1,200 ft. upstream from the Ranger Station. This is "a pinkish gray, medium-grained slightly porphyritic biotite granite composed chiefly of pink and gray feldspars, smoky quartz, and biotite, but muscovite is present in some facies, and the percentage of biotite varies from place to place." (Lovering and Goddard, 1950) It is of late precambrian age that was intruded along faults and cross fractures in schist and gneiss. As seen in Photo No. 1, the faint orientation of the biotite (due most likely to flow banding) gives the granite a gneissose texture. It is faulted and jointed. As in other igneous bodies the joint systems in the Silver Plume granite are shrinkage joints developed as a result of cooling. The outcrop at Copeland Falls shows a joint system with two sets of intersecting joints striking 040^{o} and 140^{o} and dipping steeply (Photo No. 2). The surface opening on these joints due to

e 2 - Surficial Geology of Wild Basin



ernary deposits mainly tills of Bull
e and Pinedale Glaciation
ver Plume granite
act inferred
ts, vertical
ting well
posed well
tion of measured sections

HALF-SIZE REPRODUCTION

BASIC DATA

TOPOGRAPHY FROM NP-RM 3540, 4-61
REDUCED FROM 1"=100' TO 1"=400'
EXISTING TOPO OF 1"=40' FROM NP-RM
3839, 4 61

BUILDING
ROADS
CONTOURS
POWER LINE
TRAIL
PRIVATE LA

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF LANDSCAPE ARCHITECTURE
WESTERN OFFICE, DESIGN & CONSTRUCTION

WILD BASIN
PART OF THE MASTER PLAN
ROCKY MOUNTAIN NATIONAL PARK, LARIMER CO., COLO.

REGION
MIDWEST
NP-RI
121-60

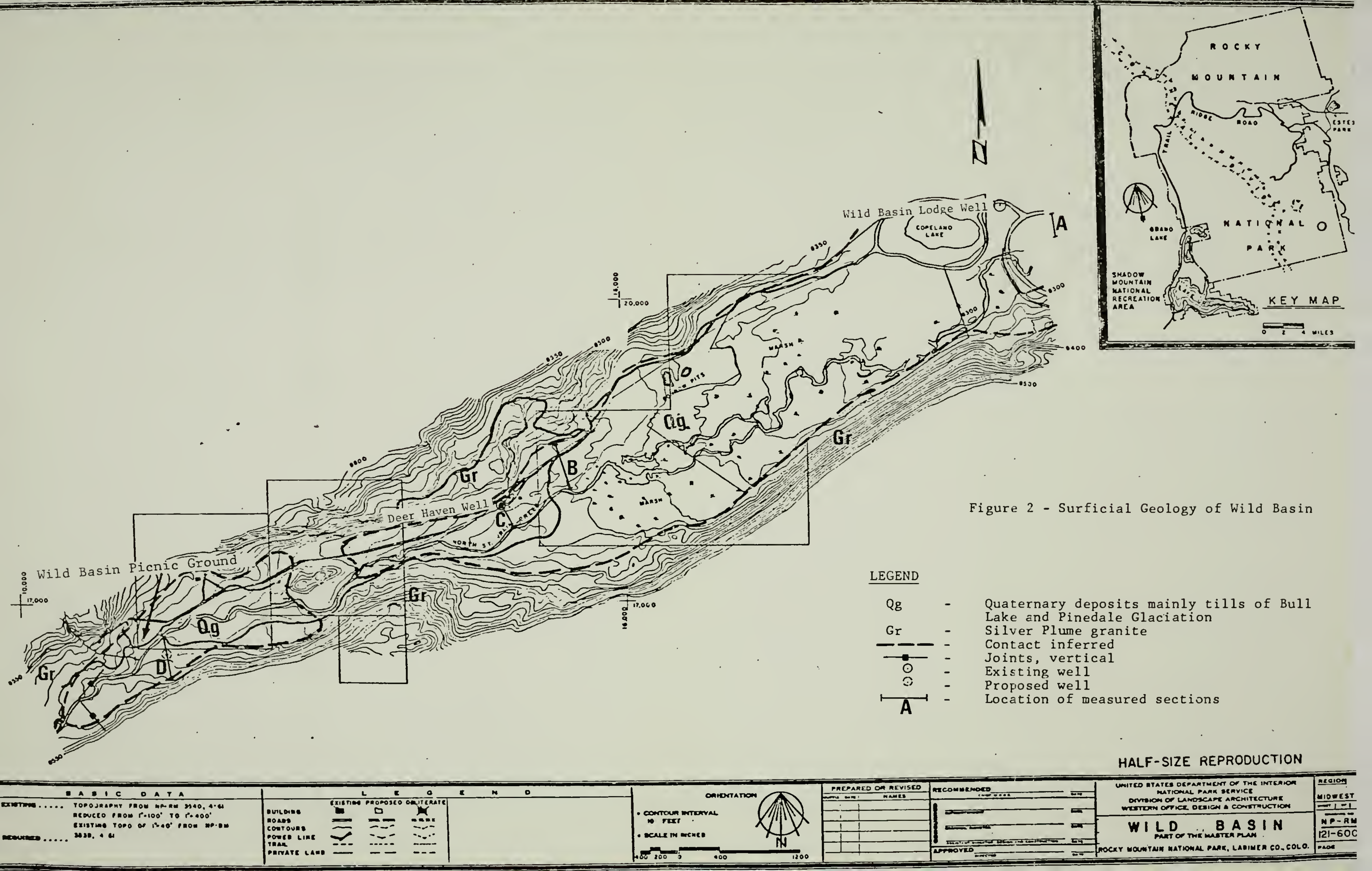


Figure 2 - Surficial Geology of Wild Basin

Photo No. 1 - Unweathered Silver Plume Granite

Photo No. 2 - Joints in the Silver Plume Granite

weathering can be as much as 3 inches. Horizontal or sub-horizontal joints also exist from erosional unloading.

Faulting and fracturing can give crystalline bodies enough secondary permeabilities and porosities to make them aquifers that yield small quantities of water to springs and wells that intercept the fractured zones. Springs are not known to exist in the Silver Plume granite in the vicinity of Wild Basin. For a well to strike water in the granite bedrock, drilling has to intercept the fractures. In the case of the Wild Basin area, since the joint planes are steeply dipping and widely spaced the prospects of intercepting the fractures are not good. If water is struck, the yield is not expected to exceed 15 gpm (Hall and others, 1980) and commonly it is between 1 to 5 gpm. A well drilled 270 feet into the granite at the Longs Peak campground area yielded only one-half gallon per minute (Midwest/Rocky Mountain Team, RDC, 1979). Because of the small yield and the high risk of not intercepting fractured zones, drilling in the Plume granite is not recommended.

Along the valleys, the Plume granite is covered with unconsolidated material generally less than 30 ft. thick, but reaching as much as 50 ft. (Hall and others, 1980) mainly along the lower reaches of the major drainages such as North St. Vrain Creek. At the Wild Basin area the thickness of the fluvio-glacial material is estimated at 20 to 25 feet. The sediments consist of poorly sorted material (i.e. high range in grain size) deposited by fluvio-glacial processes.

Two phases of glaciation are recognized in the upper St. Vrain drainage basin: the Bull Lake Glaciation and the Pinedale Glaciation (Madole, 1969). Till deposits of the Bull Lake Glaciation are exposed at the lower limits of glaciation which is about 1 1/2 miles downstream from the Rocky Mountain National Park boundary along North St. Vrain Creek (Fig. 3). In the upstream direction, only patches of this deposit are exposed

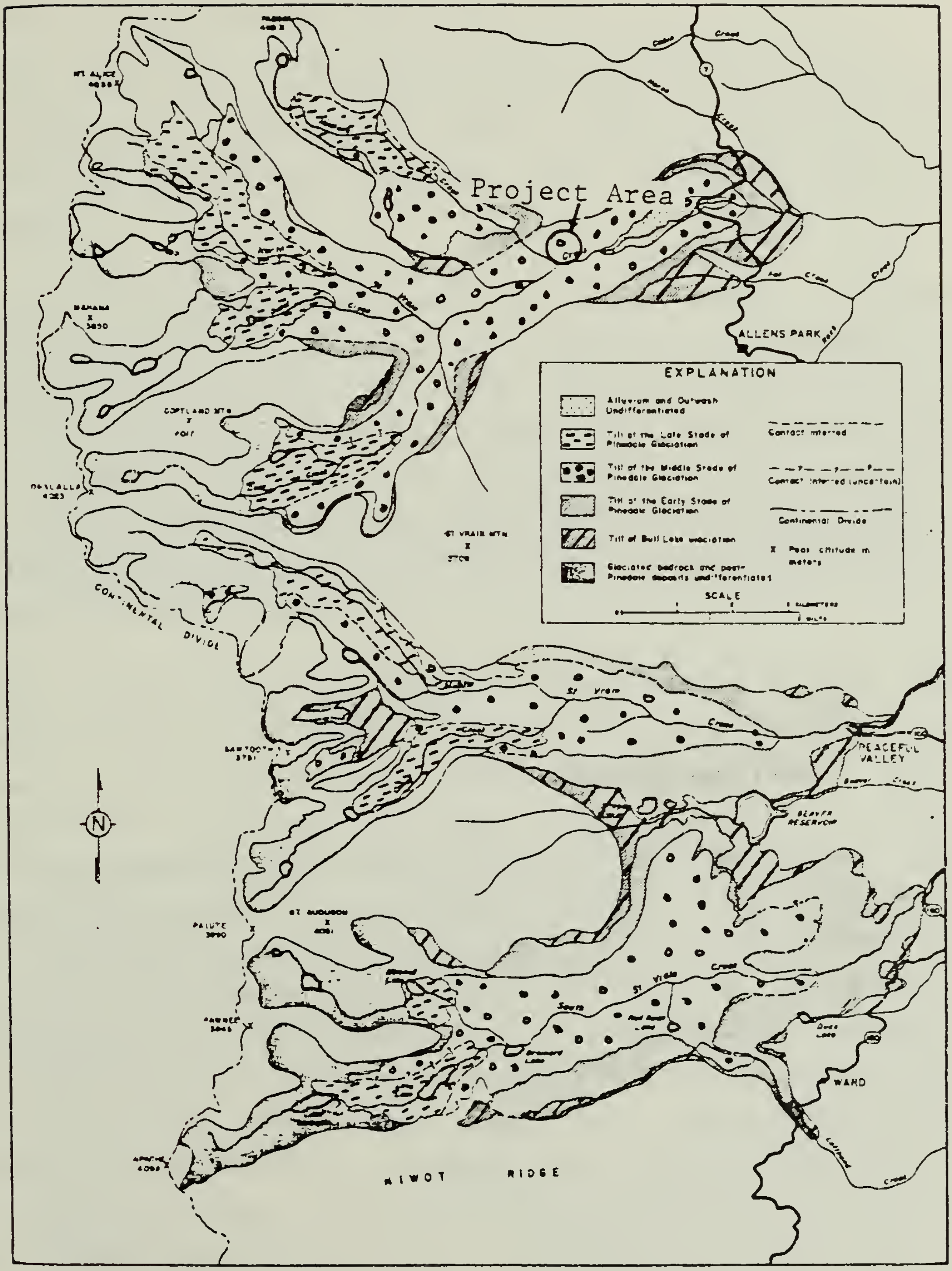


Figure 3. Map of Pinedale Glaciation and Bull Lake Glaciation in upper St. Vrain drainage basin. (from Madole, 1969)

along valley walls. The rest is buried under the younger till deposits of the Pinedale Glaciation.

Glacial material of Pinedale covers 90% of the glaciated part of the North St. Vrain Creek (Madole, 1969). The till exhibits typical knob and kettle topography with abundant sharp-crested moraines.

Glacial deposits are generally poorly sorted and chaotic. In the North St. Vrain Creek the glacials are unsorted, and subangular boulders are found intermingled with well-rounded pebbles in a matrix of sand and sandy clay (Lovering and Goddard, 1950). (See Photo Nos. 3 to 5.) The earlier till of Bull Lake Glaciation is more deeply weathered with soil development of up to 6 feet thick. The till of Pinedale Glaciation is less deeply weathered (Madole, 1969).

Four exposed sections (shown in Figure 2 as A, B, C, and D) of unconsolidated deposits were measured along North St. Vrain. Section A, just east of Wild Basin Lodge, measured 31 feet from the creek bed of North St. Vrain. The deposit is very poorly sorted and chaotic with generally well rounded granite boulders imbedded in a matrix of coarse sand and silt. To the west of the lodge the deposit includes erratics. In the vicinity of the road junction to Deer Haven the deposit appears to be divided into two terraces with a total thickness of about 21 feet from North St. Vrain Creek to the northern edge of the valley (Section B). Except for a few boulders, the deposit is covered with soil and vegetation. Section C is from Deer Haven well to North St. Vrain and it measured about 18 feet. As in Section C, two terraces make up this section. The upper terrace is over 13 feet high. The valley narrows at Deer Haven and widens up again from about 1000 feet upstream up to the Copeland Falls where bedrock outcrops on the valley floor. Near Wild Basin picnic ground the exposed section of the sediments is reduced to less than 9 feet (Fig. 4). The total thickness of the unconsolidated material

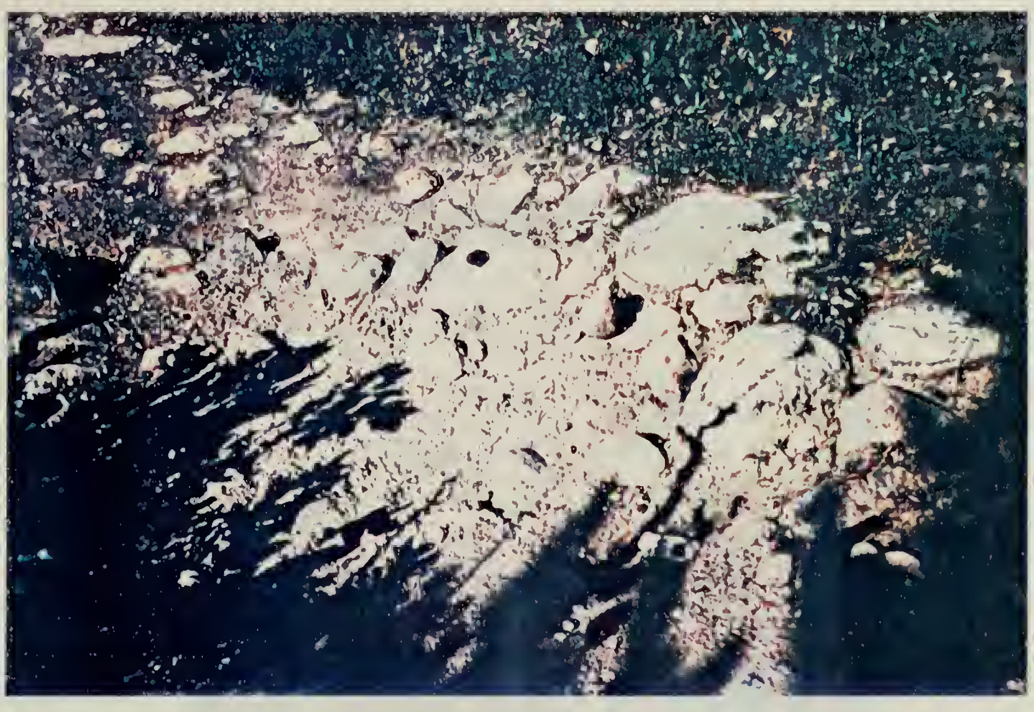


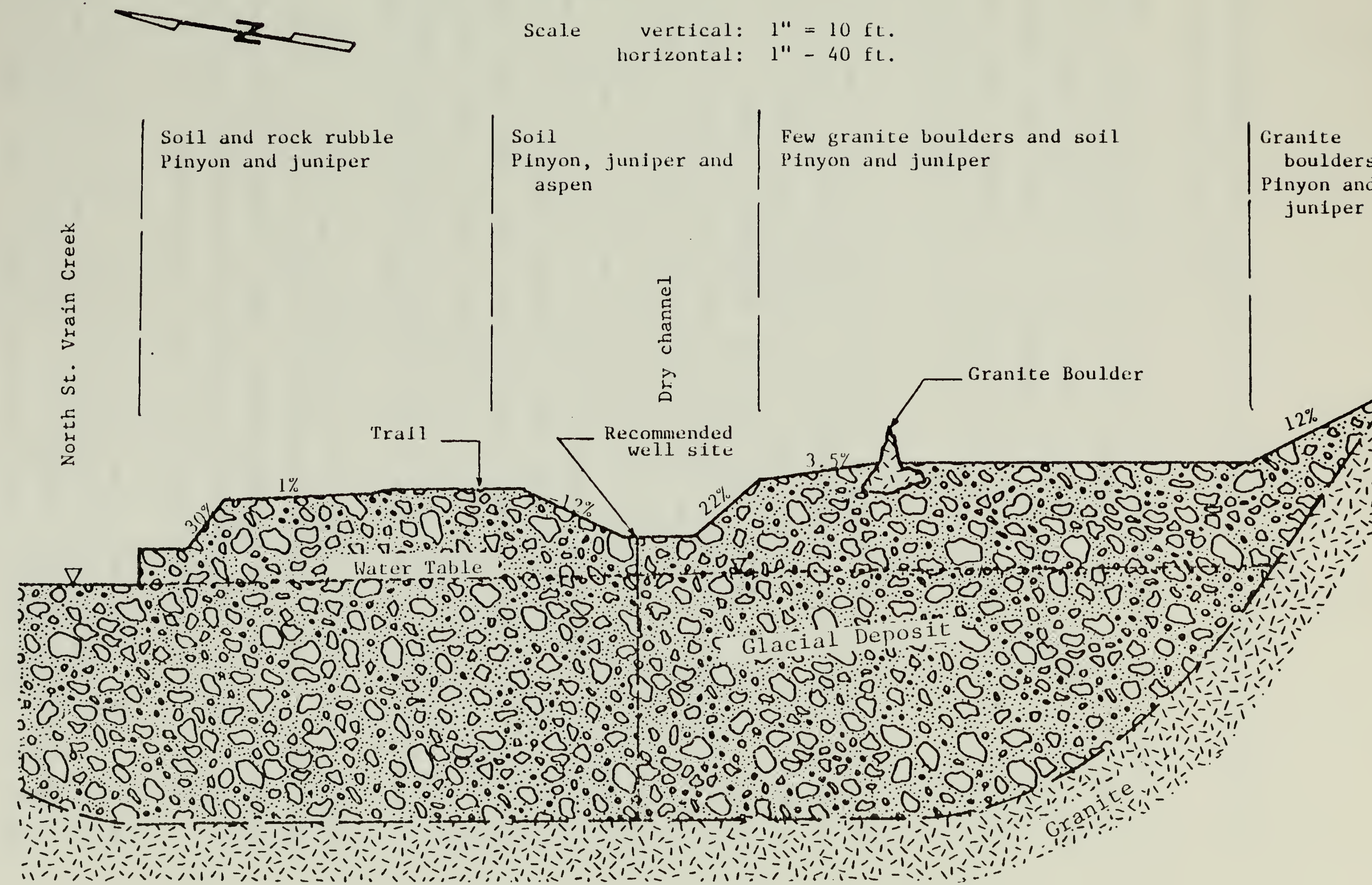
Photo No. 3 - Rounded boulders in the till deposit

Photo No. 4 - Rounded boulders in the till deposit

Photo No. 5 - Angular to sub-rounded boulders in the till deposit.

Figure 4. Section across southern half of North St. Vrain channel
Section D in Figure 2
(Looking downstream)

Scale vertical: 1" = 10 ft.
horizontal: 1" - 40 ft.



actually wedges out rapidly in the upstream direction because of the steep valley gradient.

The unconsolidated fluvio-glacial deposits are important sources of groundwater, mainly for domestic and livestock needs, where these deposits are thick enough to retain sufficient quantities of water. Recharge is mainly from streamflow, snowmelt and rainfall. Static water levels may reach depths of up to 30 feet below the surface with an average of 13 feet (Hall and others, 1980).

The Deer Haven well is the only known well close to Wild Basin picnic ground (Fig. 2). Unfortunately, no records of depth or water level are available for this well. The next closest well is 2 miles downstream at Wild Basin Lodge (Fig. 2). This well was drilled in 1975 and Mr. Randy Good, the present owner of the lodge, estimates the depth of the well at 25 feet, but Mr. Steve Ingrim, a driller, who has drilled many of the wells in the area, estimates it to be as deep as 100 feet. Water is reported to have been struck at 12 feet and static water level is said to be at 4 feet below surface. The well yields 60 gpm. It is located about 200 feet west of the lodge and about 600 feet from North St. Vrain Creek. Another well belonging to Mr. John Nex, is located north of the lodge and it is reported to have been drilled to 384 feet through the granite without striking water.

Well records are available for wells drilled at other recreation grounds north and northwest of Wild Basin. The area of the drainage basin above Endovalley picnic area is somewhat comparable to that at Wild Basin and information on the glacial and alluvial deposits there may be extrapolated to Wild Basin.

Total depth for the Endovalley well was 24.5 feet through unconsolidated deposits, but better yeild was obtained from 20 feet (Wright Water Engineers, Inc. 1979). The well was completed to 21.5 feet with a screen between 15 and 20 feet (Fig. 5). The

recommended safe pumping rate for the well was 10-12 gpm (Wright Water Engineers Inc., 1979).

At Longs Peak campground a test well drilled through boulders and alluvium reached a depth of 25 feet. The well was completed with a screen at 20 to 25 feet and a safe pumping rate was set at 5 gpm (Midwest/Rocky Mountain Team, DSC, 1979).

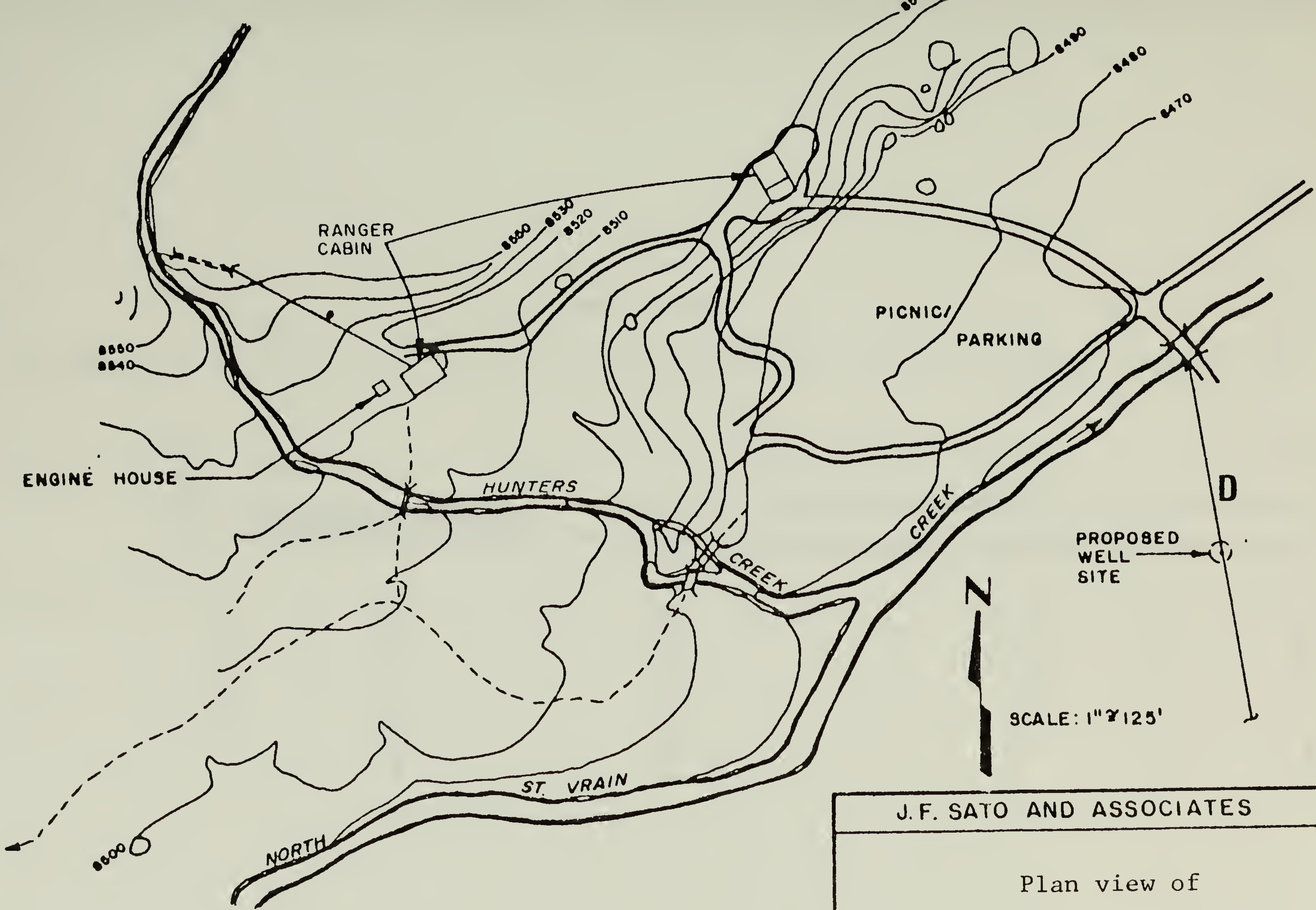
Water quality

All the wells drilled so far in the fluvio-glacial deposits appear to have adequate yields for domestic and recreation-ground use. However, high iron and manganese content is reported to be a persistent problem with the wells at Endovalley, Wild Basin Lodge and Deer Haven.

During field investigation it was observed that red coloration on the rocks in the North St. Vrain stream bed intensified progressively downstream. At Wild Basin picnic ground there is hardly any conspicuous iron staining of the rocks. It was also noticed that many of the granitic boulders in the glacial deposit have appreciable garnet mineralization. These boulders are highly weathered and the garnet crystals are mostly decomposed to brown spots. It is suspected that this decomposition of garnet, which is a complex silicate mineral high in iron and manganese among others, could be one of the sources for the high iron and manganese content in the ground water of the area. The longer the ground water travels through the glacial deposit the higher its concentration will be in these two constituents. Some bacteria are also known to concentrate iron, but these may act more as catalysts than sources of iron.

Recommendations for a well site near Wild Basin picnic ground

Figure 4 shows a profile and section of the valley floor south of the bridge crossing North St. Vrain Creek to Wild Basin Ranger Station and picnic ground. A possible site for a water well is shown on this section and in the plan view in Figure 5.



J.F. SATO AND ASSOCIATES

Plan view of

Wild Basin picnic ground

FIGURE NO. 5 | 10/83

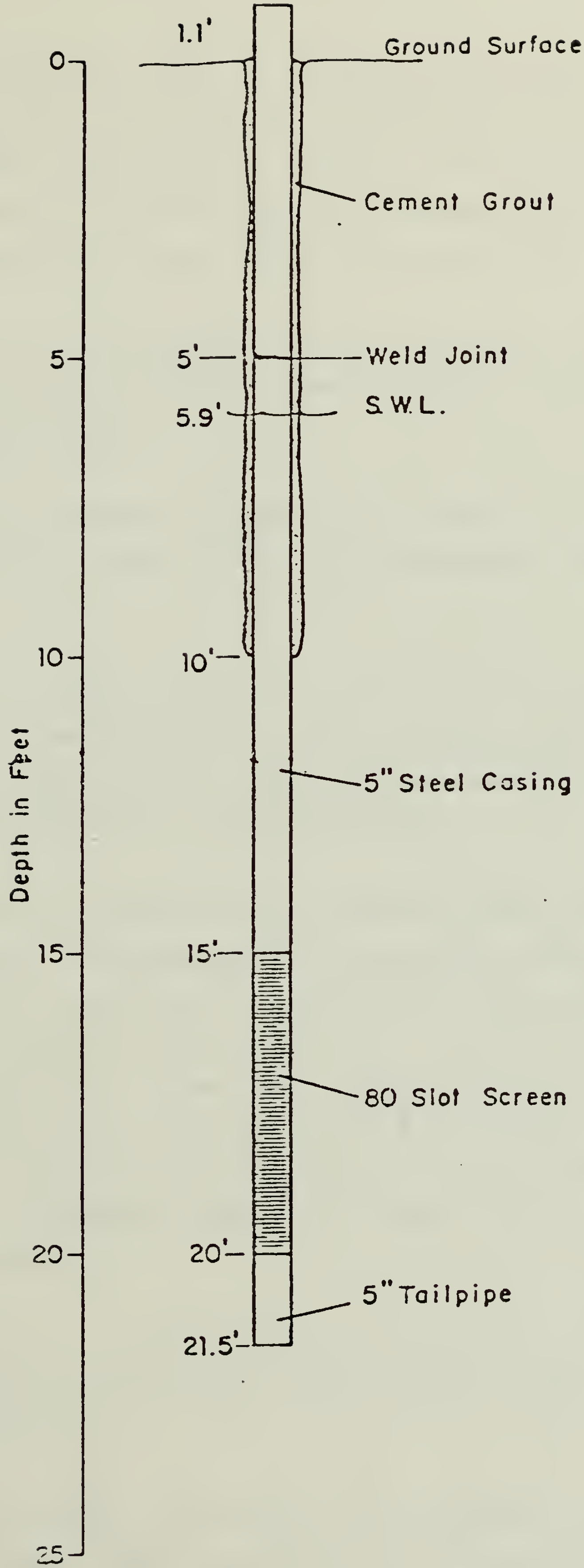


Figure 6. Construction Diagram
Endovalley Picnic Area Well
(from Wright Water Engineers, Inc., 1979)

The site is located 162 feet south from the eastern edge of the bridge and 228 feet in the easterly direction from the confluence of North St. Vrain and Hunters Creek. It is in a natural, dry channel that may have been an earlier course of North St. Vrain but now stands about 3.5 feet above the creek bed.

This location is considered favorable for an adequate supply and ground water and a quality close to that of the surface water for the following reasons:

1. The unconsolidated deposit is thought to be thickest on this side of the valley than elsewhere near the picnic-ground.

2. There is a good potential for direct recharge into the aquifer from North St. Vrain Creek without too long a passage distance for the ground water to pick up high iron and manganese concentrations.

3. The extent of the alluvial aquifer above the well site is small and is terminated at Copeland Falls. While this may limit the yield to the well, especially during the drier seasons when North St. Vrain Creek is low the contribution of iron and manganese from this pocket of sediments will be less than for a site further down-stream. Based on the records of the wells discussed earlier a minimum yield of 5 gpm can be anticipated at this location.

4. The site is removed from any possible contamination to the ground water from leaky septic tanks or other man made sources.

5. The distance to the center of the picnic ground along the road is less than 800 feet and is shorter in a straight line across North St. Vrain Creek.

The maximum depth anticipated is 20 feet and the static water level should be 3 to 5 feet below the surface. The usual problem of drilling through unconsolidated glacial deposits may be expected.

Conclusion

A ground water supply of 5 gpm or more for the Wild Basin picnic ground and Ranger Station is feasible within 800 feet of the picnic area. Water quality, particularly high iron content has been the main concern of ground water sources in the Wild Basin and other parts of the Rocky Mountain National Park. Two major factors that are suspected to contribute to the high iron values are the decomposition of the garnetiferous granite matrix of the glacial till aquifer and the residence time of the water in this aquifer. The proposed well site at Wild Basin picnic ground is close to the North St. Vrain Creek which is the principal recharge source and taps an aquifer which is not only limited in areal extent but is also disconnected from the glacial deposits further upstream. It is believed that these factors combined will cut down the iron concentration in the water from the proposed well to nearly that of the water in creek.

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APPENDIX C

PERFORMANCE CURVES

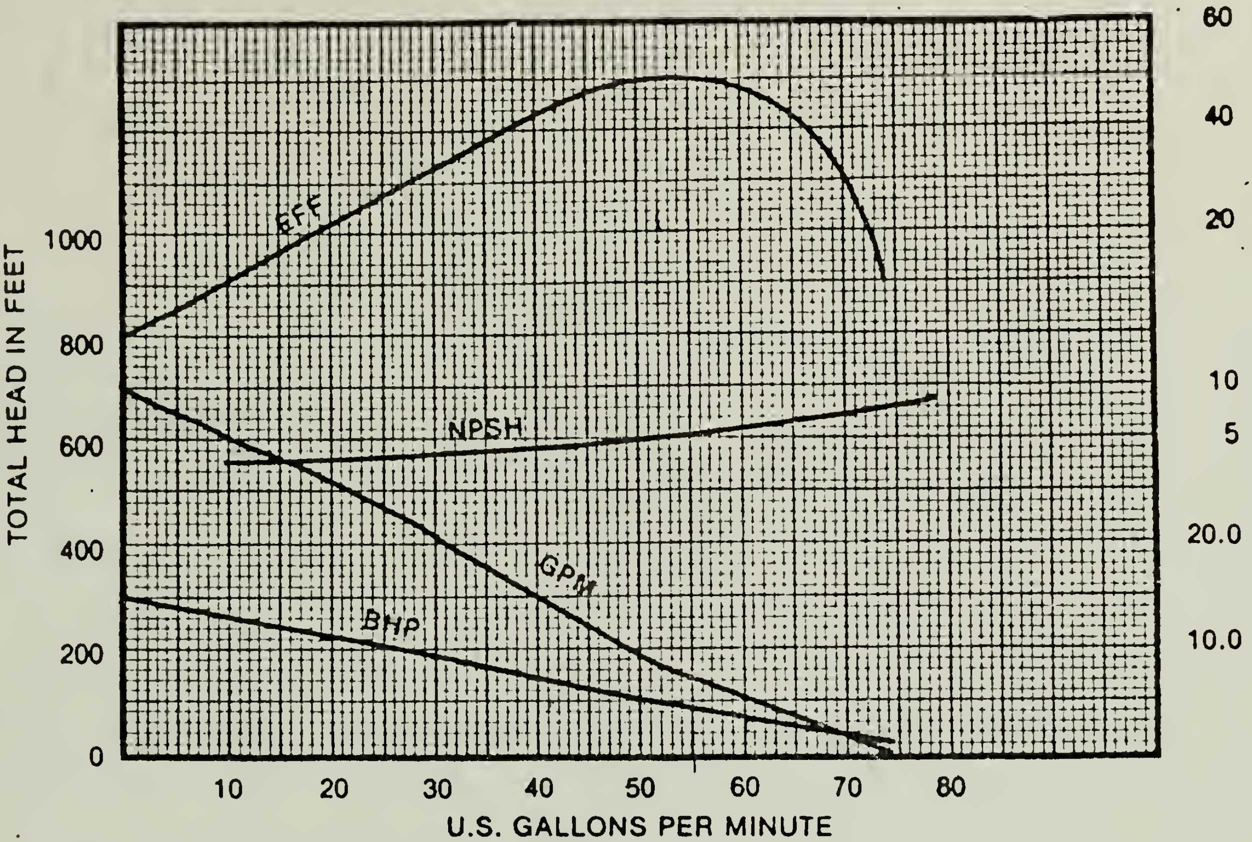
CURVE 46

FIGURE NO

6835

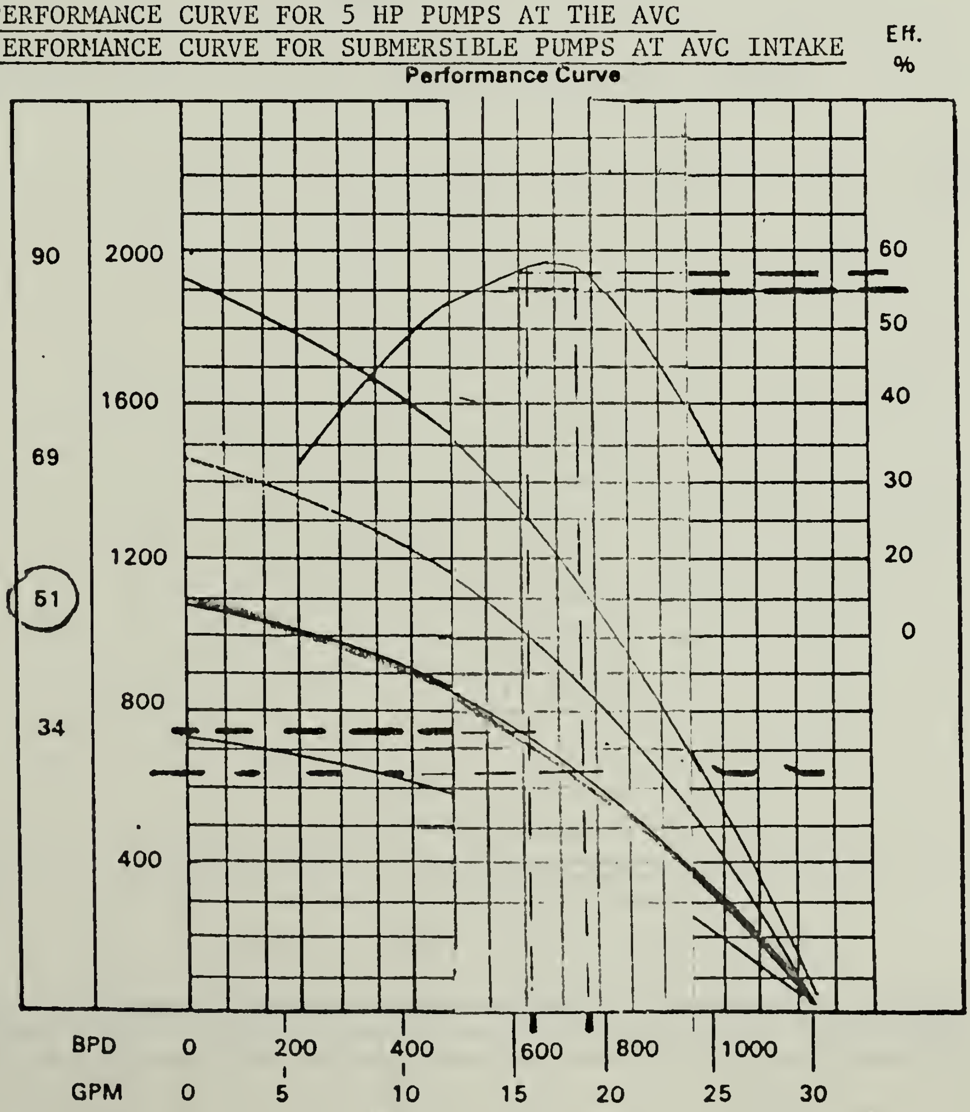
MODEL-BR702

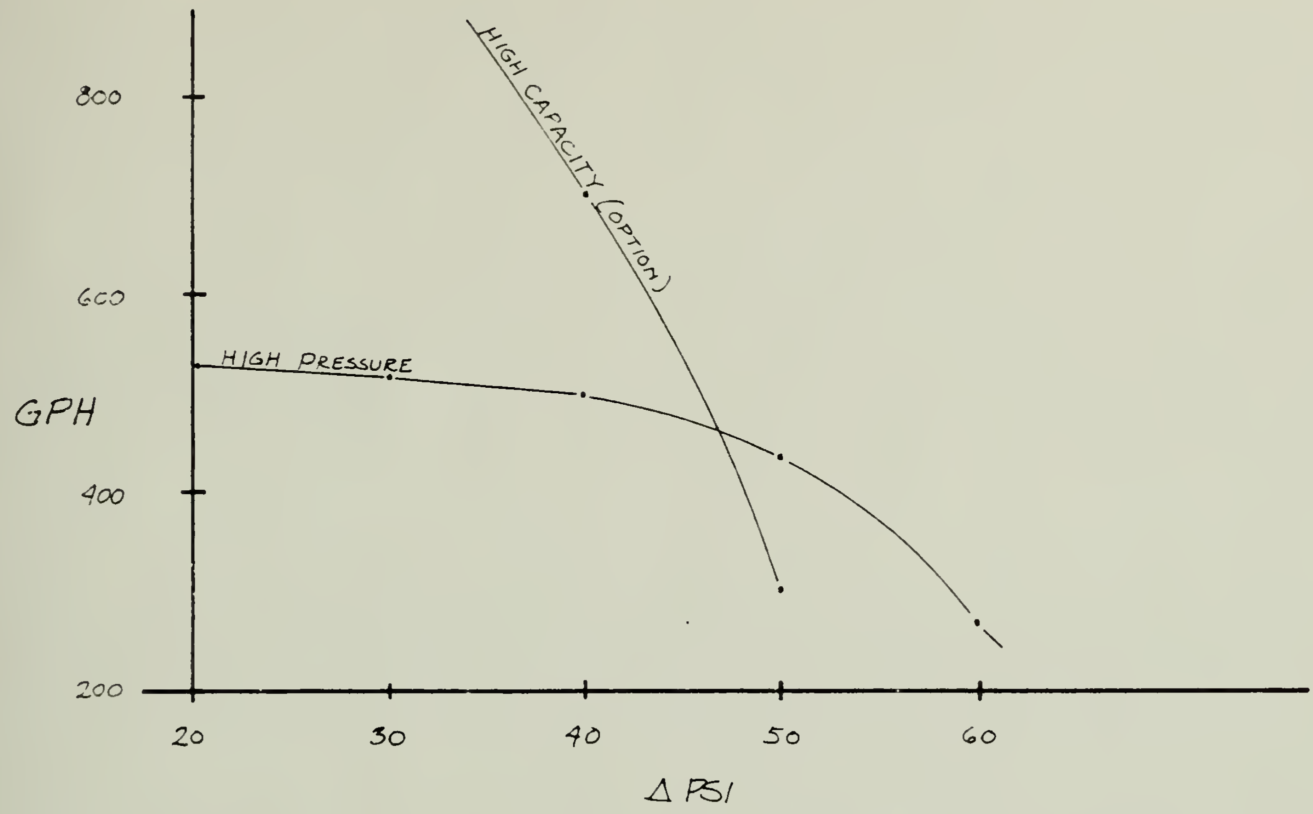
1750 RPM



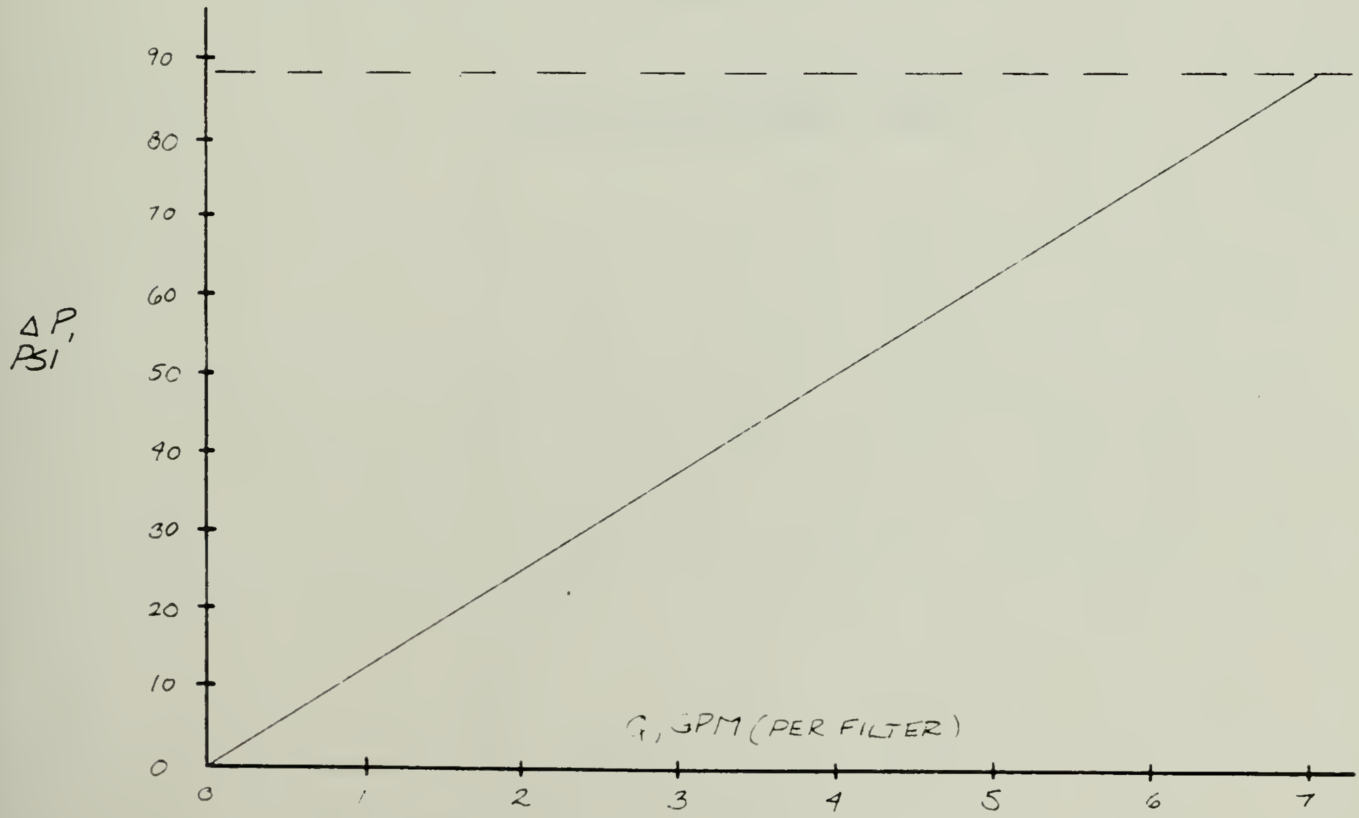
UPPER - PERFORMANCE CURVE FOR 5 HP PUMPS AT THE AVC

LOWER - PERFORMANCE CURVE FOR SUBMERSIBLE PUMPS AT AVC INTAKE





PUMP CURVE 1/2 HP QUICK SET PUMP 50 R.J.



FLOW DIAGRAM FOR 0.7μ MF-3 FILTER

FIGURE WILD BASIN-EQUIPMENT CHARACTERISTICS

APPENDIX D

ACOUSTICAL ENGINEER'S REPORT

engineering
dynamics

October 11, 1983

Steve Lowry, P.E.
J. F. Sato and Associates
5898 S. Rapp Street
Littleton, CO 80120

Dear Mr. Lowry:

Engineering Dynamics, Inc. has completed the analysis of the existing noise situation in the generator house located in the Rocky Mountain National Park. This letter report details the existing noise environment and presents possible methods to mitigate the situation.

The sound pressure level measurements taken in the interior of the generator house with one generator operational at three locations are given in Table 1 below and are plotted in Figure 1.

		Octave Band (Hz)								
Location #	"A"dB	31.5	63	125	250	500	1000	2000	4000	8000
1	103	88	84	90	96	95	101	97	88	84
2	100	86	82	94	92	93	98	92	86	83
3	100	89	82	90	93	93	96	93	86	83

Table 1 - Interior Sound Pressure Levels (dB), Generator House Rocky Mountain National Park

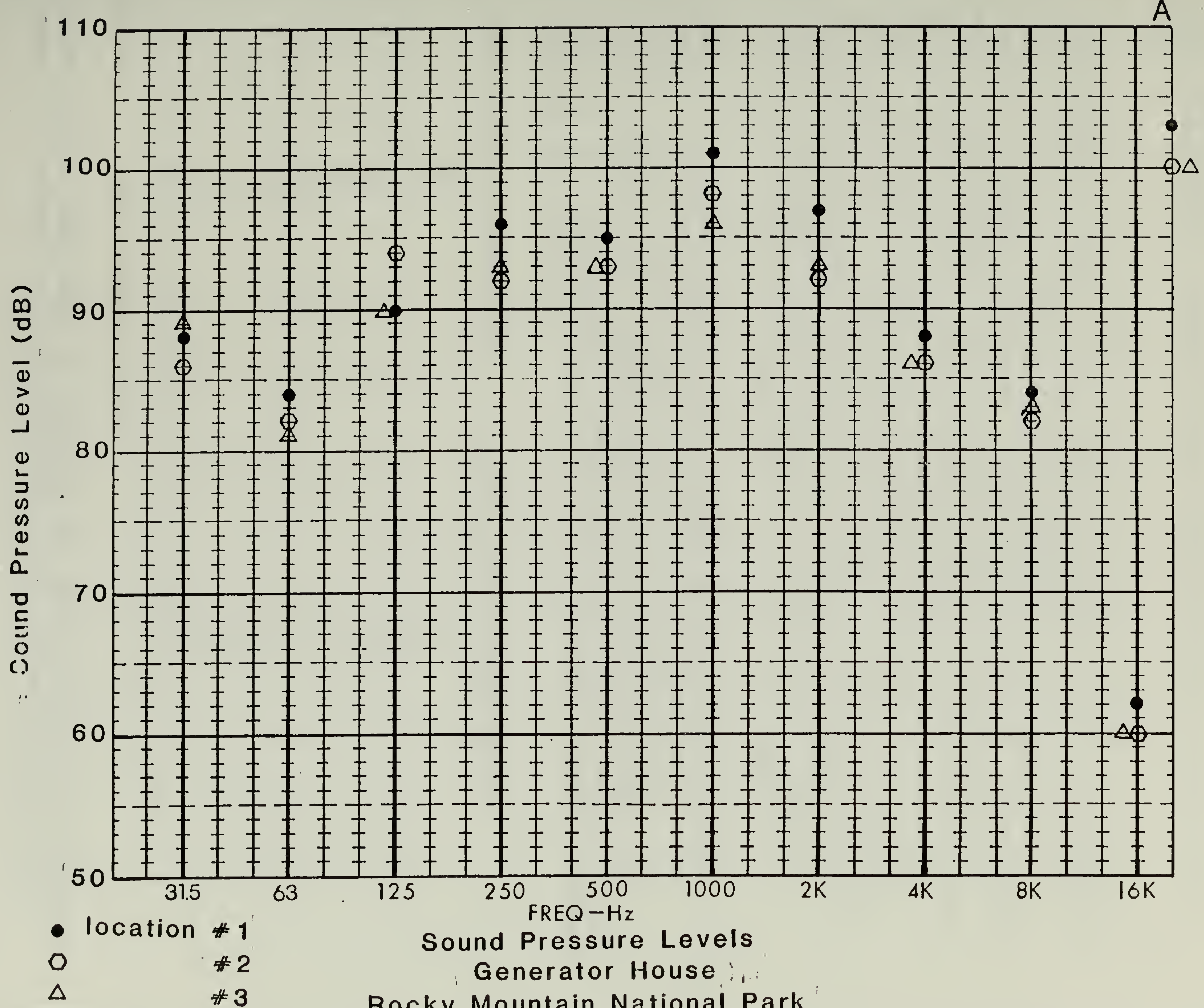
As can be seen from the data in Table 1, the internal sound field in the generator house is relatively constant. That is, the noise produced by the motor/generator is diffused evenly through out the building.

3925 south kalamath street
englewood, colorado 80110
(303) 761-4367

8420 delmar boulevard
st. louis, missouri 63124
(314) 991-1800

[illegible]

engineering dynamics, inc



Sound Pressure Levels
Generator House
Rocky Mountain National Park

Figure 1

The levels given in Table 1 under "A" are the measured A weighted sound pressure levels. The A weighted scale is used to approximate the response of the human ear and is therefore used as the basis for many criteria levels used in various laws and regulations enforced by government agencies. Since the interior of the generator house is periodically visited by park officials and maintenance workers, the maximum noise levels are governed by OSHA regulations. The OSHA regulation states that workers shall not be exposed to doses of noise of greater than 90 dB(A) for a period of 8 hours. This maximum dose is extrapolated for higher levels on a halving of exposure time for every 5 dB(A) increase in sound pressure level with an upper limit of 115 dB(A). For example, a worker has a 100% of the maximum allowed exposure, if he or she is exposed to a level of 95 dB(A) for 4 hours or 100 dB(A) for 2 hours.

Based on the sound pressure level measurements given in Table 1, a worker could be exposed for a period of approximately 2 hours without violating OSHA regulations in the generator hours. In order to increase the allowable time in the generator house for a worker, the sound pressure levels must be reduced. Table 2 below lists the allowable exposure times for sound pressure levels between 100 dB(A) and 90 dB(A).

Sound Pressure Level dB(A)	Exposure Time (OSHA)(hours)
100	2
99	2.3
98	2.6
97	3.0
96	3.5
95	4
94	4.6
93	5.3
92	6.0
91	6.9
90	8

Table 2 - OSHA Exposure Times

There are two approaches to reducing the noise level in the generator house. One method is to acoustically treat the reverberant sound

[illegible]

field in the room. This can accomplished by the addition of sound absorption materials to the walls and ceiling. The effectiveness of this type of treatment is somewhat limited. A 2 - 4 dB reduction would be the practical limit for the generator house with approximately 700 square feet of absorption material (1" fiberglass) added to the ceiling and wall areas. The other approach to reduce the noise levels in the generator house is to acoustically isolate the noise source. This could be accomplished by the building of an enclosure around the two motor generators. The enclosures could be fabricated with conventional 2 X 4 studs and gypsum board walls, extending from ceiling to floor. In order to minimize noise exposure during maintenance on one unit while the other unit is operation, a partition (2 X 4 stud and gypsum board) separating the units should be fabricated. By the addition of the partition around the motor/generators, the noise level in the other areas of the building should be reduced below the OSHA criteria of 90 dB(A).

Another approach to minimizing the noise exposure to workers in the generator house is to provide and require hearing protection to be worn during activity in the generator house. The noise reduction provided by hearing protection devices (ear muffs) will reduce the noise exposure to below the 90 dB(A) OSHA criteria. It is recommended that signs be posted at all entrances to the building and in the interior of the building stating the requirement of the use of hearing protection while in the generator house.

In order to determine which of the three noise control methods, given above, should be implemented, a study of past activity in the generator house should be reviewed. If activity is such that workers spend short periods of time (less than 2 hours) in the generator house, the first method (addition of absorption materials) would be the most cost effective method of reducing noise exposure. If, however, workers spend greater periods of time in the generator house than 2 hours, the second method (acoustical isolation) would provide the required noise reduction. Additionally, if activity on a monthly or weekly basis is infrequent, the third method (hearing protectors) would provide the most cost effective means for providing noise reduction.

Another point that should be addressed concerning noise exposure in the generator house is the most recent hearing conservation amendment to the OSHA regulation. This amendment states that whenever

employee noise exposures equal or exceed an 8 hour time weighted average of 85 dB(A), the employer shall administer a hearing conservation program for that employee. This in effect, reduces the times given in Table 2 by one half. In other words, an individual may be exposed to a level of 95 dB(A) for 2 hours before the hearing conservation program criteria is reached.

Once a determination has been made concerning the course of action to be taken, E.D.I. will provide details to your office concerning implementation of the noise control method.

If you should have any questions concerning this report, please contact me at our Englewood office at your convenience.

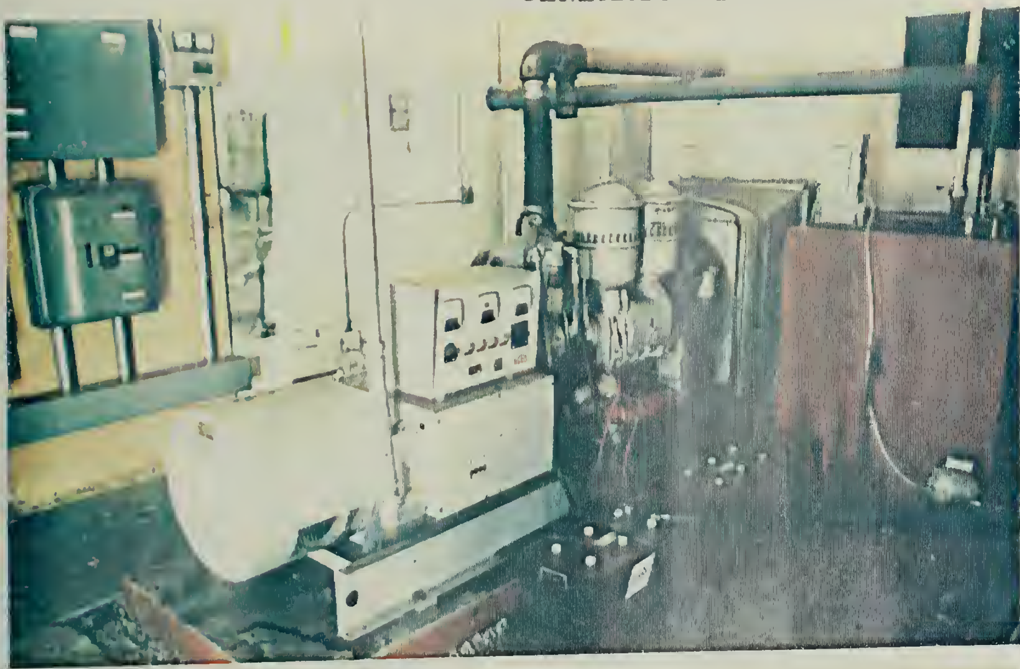
Very truly yours,
ENGINEERING DYNAMICS, INC.

Stephen M. Rossi

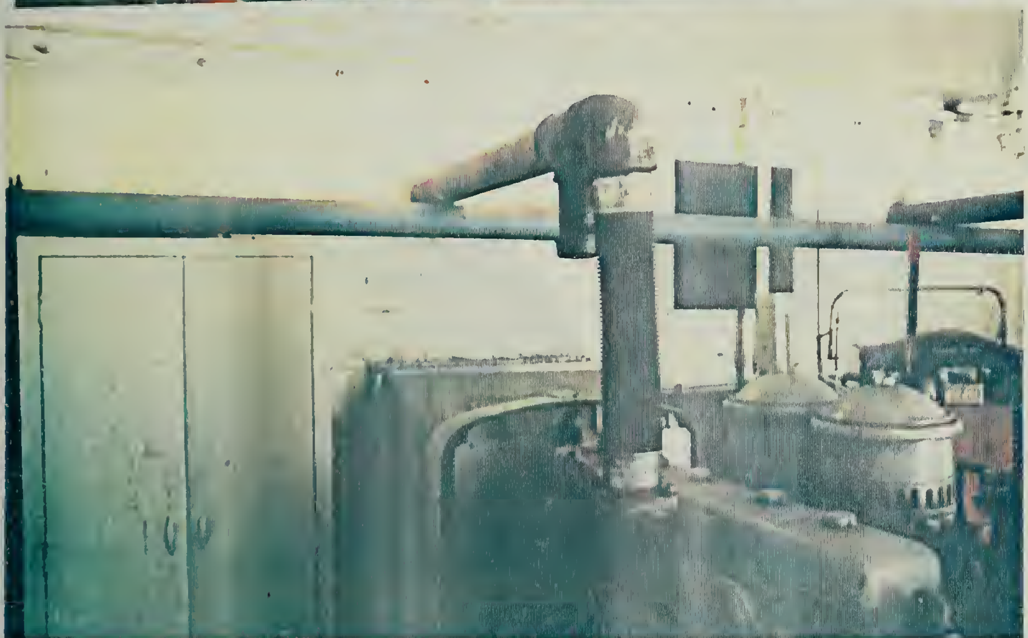
Stephen M. Rossi

ALPINE VISTIOR CENTER

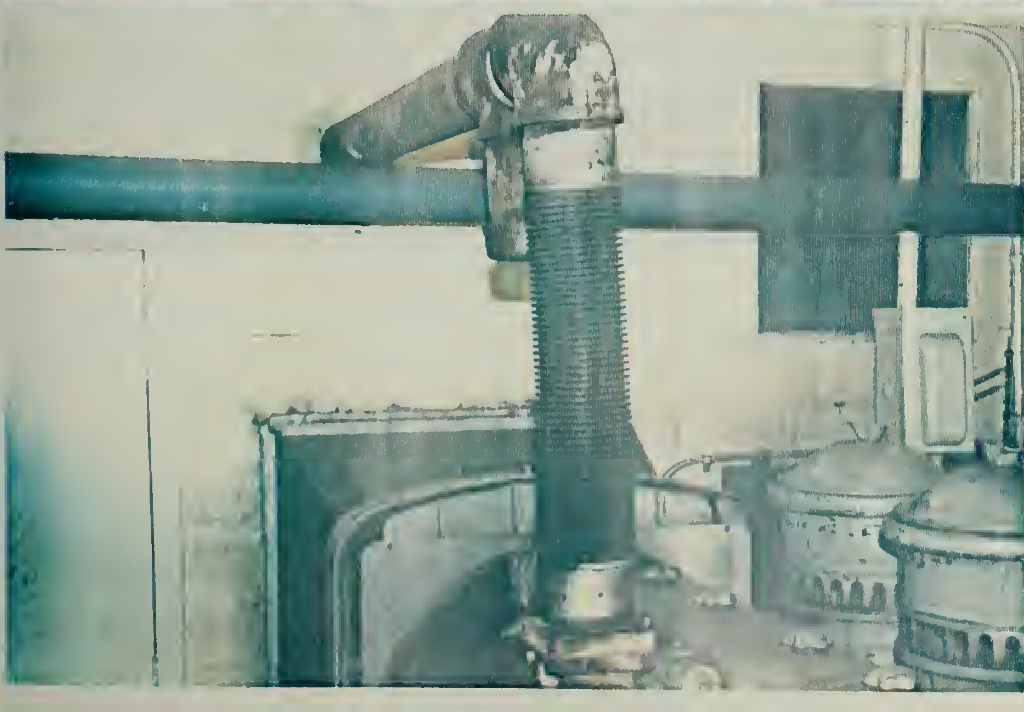
GENERATOR BUILDING



GENERATOR SET

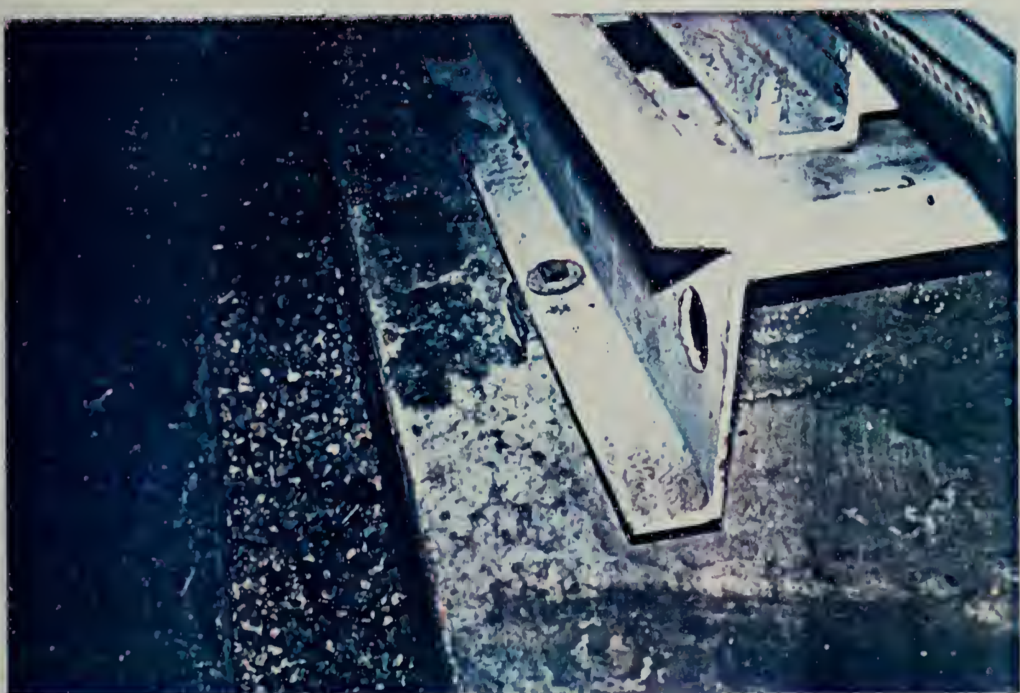


EXHAUST SYSTEM
NOTE RIGID CONNECTION
THRU WALL



CLOSE UP OF
EXHAUST SYSTEM

SAND BED FOR VIBRATION ISOLATION



RUBBER STEEL COMPOSITE FOR VIBRATION ISOLATION