ROBERT JACK SMITH & ASSOCIATES, INC.
CONSULTING ENGINEERS AND LAND SURVEYORS

P.O. BOX 1104 RAWLINS, WYOMING 82301 1015 HARSHMAN PHONE (307) 324-5262

JOB NO.____________

Town of Saratoga - Carbon County
Joint Powers Board

Saratoga, Wyoming 82331

Subject: Drainage and Street Improvement Study
Saratoga, Wyoming

Gentlemen:

We are transmitting at this time ten (10) copies of the report and maps for the above captioned project.

The conclusions and recommendations of our study and report are as follows:

Conclusions:

1. Most streets in the Town of Saratoga are not paved at the present time.

2. Existing storm drainage is inadequate.

3. Federal Grant monies are very scarce.

4. Proposed utility construction will delay street improvements in some areas.

5. Infiltration and sump pumps in basements that are tied to the existing sanitary sewer contribute to hydraulic overload of the sewage treatment plant.

General Recommendations:

1. Proposed utility construction should be completed prior to placing of permanent pavements.

2. Most storm drainage can be handled with surface drainage for a 10 year storm frequency. A small amount of storm sewer in Area 1, 2B and 2 will be required. Storm sewers for sump pumps in Area 2 and 2B can

be used to relieve the sanitary sewer system of the load of those sump pumps.

3. A drainage ditch starting at Bridge Street, just below the Hugus Ditch and going North to the river can be built to accommodate a large share of the drainage.

4. Stage construction of the streets can be used to defer costs and provide for corrective actions prior to the placement of the final surface.

5. Improvement districts should be formed to pay for the construction of basic street improvements.

6. Funding.

a. Special improvement districts should be formed to pay the cost of basic street pavement to a local street standard.

b. Grant applications should be submitted for the costs of storm drainage and the costs of collector and minor arterial streets.

c. The Town might want to pledge mineral royalties to the street project.

7. Cost reduction possibilities

a. Asphalt curb and gutter can be used on local streets with the understanding that durability is decreased and asphalt curbs are particularly vulnerable to damage caused by snowplows and other similar types of equipment.

b. Local streets, or indeed any streets, might be built with no curb and gutter at all. This will increase maintenance costs and shorten the life of the pavement.

c. The pavement can be narrowed so that only the travelled way is paved with full strength pavement and a chip seal is placed on the shoulders.

d. The pavement can be narrowed with only the travelled way paved with full strength pavement with gravel shoulders and ditches.

e. Existing streets could be surfaced with a chip seal coat and ditches graded for proper drainage.

f. Asphalt soils treatment can be substituted for more expensive material with a possible reduction in durability.

## Specific Recommendations

1. Start the formation of improvement districts as soon as possible and apply for grants for the cost of the drainage facilities and the full costs of arterial streets as a minimum. Include the costs of collector streets and a grant for bond interest above the average

interest during the life of the bonds if it appears practical and would not prevent the acquisition of the grants for the drainage and arterial streets.

2. Proceed with the construction of drainage facilities including modifications to the Hugus ditch as soon as possible to minimize flooding and erosion of streets until pavement projects can be undertaken.

3. Encourage the Town of Saratoga to exercise one or more of the possible means of generating revenue described in the Financial Report (Appendix D) and dedicate the Mineral Royalties income which could then be freed to the partial payment of bond issues.

4. Plan to pave all streets to the widths recommended in the Major Street Plan with a stage one pavement and concrete curb and gutter, i.e. Alternate 2 of this study.

We believe that if the residents of Saratoga are serious about wanting to improve their streets and drainage, they should do it in a fashion that will provide permanent facilities of a high quality. We also believe that the financial burden on the landowners need not be excessive if all funding sources are utilized as fully as possible.

We have appreciated the opportunity to serve you and are looking forward to working with you in implementing the recommended work.

Sincerely,
Robert Jack Smith & Associates, Inc.

Paul McCarthy

Paul McCarthy, P.E.
Vice-President

Richard R. Reusser

Richard R. Reusser, P.E.
Project Engineer

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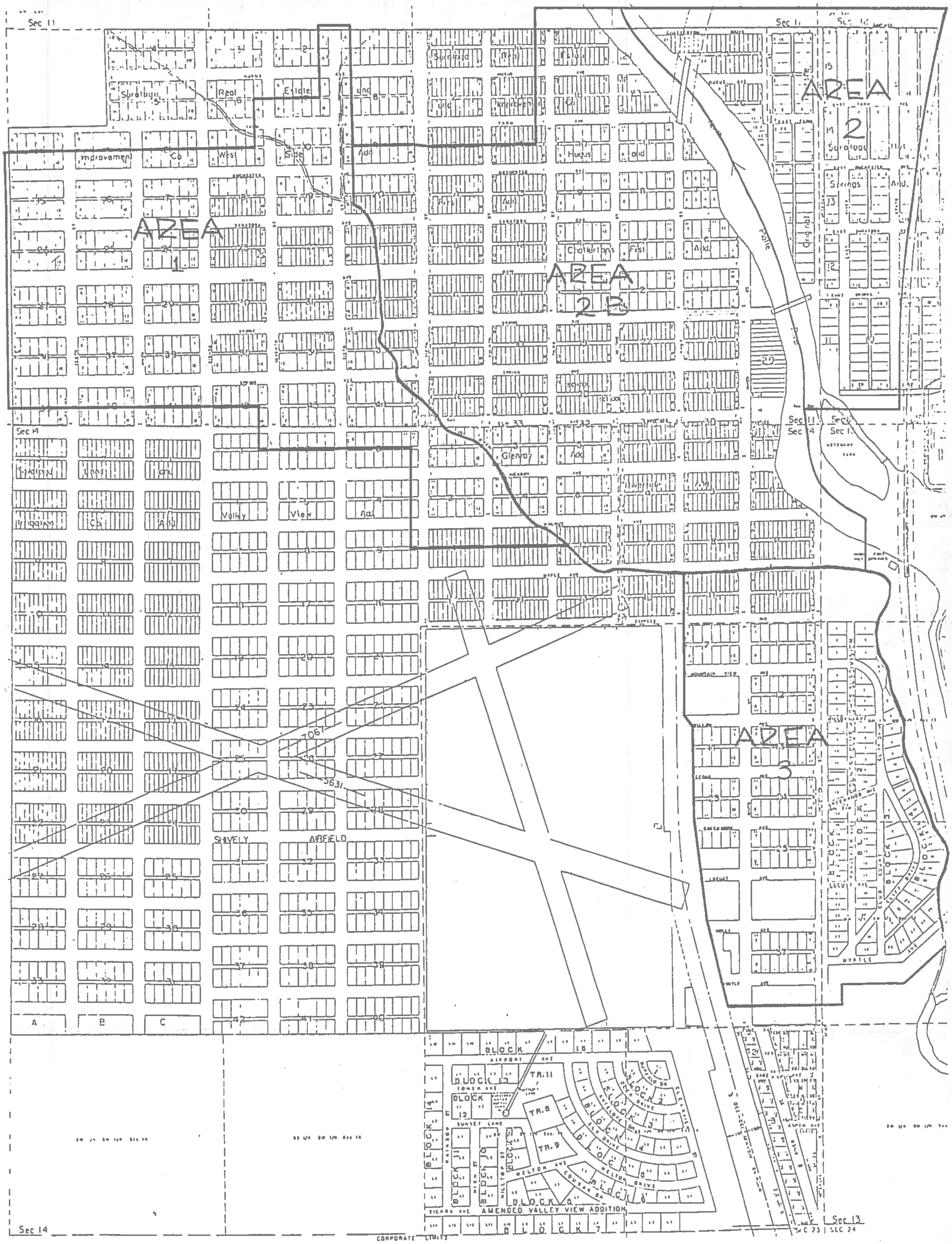
# SCOPE OF THE STUDY

The intent of this study is to develop a logical and economically feasible program of drainage and street improvements that can be undertaken by the Town of Saratoga and or by the Town and local residents through special improvement districts. The improvement study is also to be used as a basis for obtaining funding for the recommended improvements.

The street improvement program as proposed is not the final design of the street and drainage improvements. This report and drawings show the improvements in sufficient detail to ascertain that they are feasible and to determine a realistic project cost approximation.

By following the program outlined in this report, portions of the proposed work may be constructed with the assurance that all work undertaken will fit together when the total work is completed.

Page 1A shows the areas for which drainage and street improvements were studied. The Town was divided into four areas having similar requirements and related or similar problems.




STUDY AREA BOUNDARIES

DRAINAGE & STREET IMPROVEMENTS

SARATOGA, WYOMING

## DRAINAGE

Storm drainage is necessary to conveniently and safely route runoff from rainfall and snowmelt to areas for safe disposal. Storm drainage falls into several basic types: Surface drainage - allowing the water to simply ~~to~~ flow over the surface of the pavement or ground, Channelization - directing water through ditches and curb and gutter sections through specific routes, and third, Storm Sewers - taking water through inlet facilities into underground pipelines to points of disposal.

Drainage in Area 1 will be handled primarily through surface drainage via curb and gutter or ditch sections to the Hugus Ditch. A storm sewer will be placed from Seventh and Elm, north on Seventh to Bridge Street, then along Bridge Street under the Hugus Ditch to the beginning of the drainage channel. If the Hugus Ditch is abandoned as an irrigation facility, drainage from Area 1 should be carried past the Ditch to the drainage channel to be built in area 2B.

Drainage for Area 2 will be surface drainage flowing generally north to Chatterton Drive where it will be collected in a storm sewer which will run west to the river. A small diameter sewer system to collect water from basement sump pumps is recommended. Each small pipe in the north-south streets will connect to the storm sewer at Chatterton Drive.

Drainage in Area 2B will consist of surface drainage, storm sewer and a drainage channel. A drainage channel is recommended beginning at Bridge Street on the west side of Fifth Street, proceding northerly to the north edge of Town and then on to the river. Right-of-way will be needed for this drainage channel. Surface drainage in the southern portion will flow west and north to Bridge Street where it will be collected in a storm sewer and taken to the beginning of the drainage channel west of Fifth on Bridge Street. North of Bridge Street, drainage will be carried generally west until it reaches the channel at Fifth Street. In addition, a small diameter sewer system to collect water from basement sump pumps is recommended. The system south of Bridge Street can be tied into the storm sewer at Bridge Street. The system north of Bridge Street will have individual outlets to the drainage channel at each street.

A 12 inch underdrain begins at the corner of Third and Maple and proceeds north along Third Street to the alley between Elm Avenue and Spring Avenue. It proceeds west in this alley from Third Street to the approximate vicinity of Fifth Street, runs north-northwest across Fifth Street and Spring Avenue, then north to Bridge Avenue where it outlets into a culvert crossing Bridge Avenue into the slew. This underdrain is presently plugged. If Town maintenance forces can clear the drain at the Town's convenience, a portion of the proposed sump drain system can be tied into this underdrain, reducing the cost of the sump drain system by the amount of pipe that this would replace.

The Wyoming Department of Environmental Quality now has the option to require discharge permits for any water being discharged into a natural drainage. So far Wyoming has not required or issued a permit for storm water drainage. According to Mr. John Waggoner, of the Cheyenne office, they have no objections at this time to the use of storm sewers for the drainage of water pumped from basements with sump pumps even if this water contains some iron. They have no plans requiring such permits in the foreseeable future.

Drainage in Area 3 is to be surface drainage to the Hugus Ditch.

In the event the Hugus Ditch is abandoned, the Hugus Ditch should be maintained for storm water drainage from Area 3 to Bridge Street where it can be tied into the drainage channel.

The design storm used in estimating runoff amounts and designing surface runoff or drainage facilities is the ten year storm. For the channel west of Fifth Street, the 100 year storm is used and culverts under the various streets along this channel are sized on the basis of a 100 year storm.

Costs for drainage facilities in excess of drainage carried in street sections varies from nothing for Area 3 to as much as one hundred and eighty-three thousand dollars for Area 2B. Detailed costs for this drainage may be seen in Table 1.

Rainfall intensity curves and tables are shown in Appendix A. It may be seen from these tables that the longer a storm lasts, the less intense, or the lower the value of the rainfall for that storm. With the lengthening of the period for which a rainfall intensity is desired or with the lengthening of the design period, the intensity to be expected in a storm of a particular duration also increases. To determine the amount of water which will be flowing at a given point, (called the inlet) the area which contributes runoff to that point is determined. The difference in elevation and the distance between the inlet and the furthest point in the drainage are determined. From these values, the time of concentration or the time that it takes water from that furthest point to reach the inlet is determined. This time of concentration is used to select the storm duration equal to the time of concentration. The storm duration is used to enter the curves or tables for rainfall intensity to determine the average rainfall falling on the area contributing to the runoff at the chosen point. This is multiplied by a coefficient of runoff which is based upon the characteristics of the area and the size of the area to determine the volume of water. This volume of water then becomes the quantity used to size drainage facilities.

The Hugus Mullison Ditch is an irrigation facility which originates south of Saratoga. It flows along a low terrace which encircles and overlooks much of the Town.

New subdivisions and buildings are under construction west and south of the Hugus Mullison Ditch. In August of 1958, Robert Jack Smith & Associates, Inc. prepared a report on flow and seepage in the Ditch. This report is summarized as follows: The ditch is built on an alluvial flood plain and terraces of the North Platte River. It is constructed in sand and gravel. The normal flow is 21 cubic feet per

DRAINAGE COSTS - Table 1

| ITEM | UNIT | Area 1 | | | Area 2 | | | Area 2B | | | Area 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Price | Quan. | Cost | Price | Quan. | Cost | Price | Quan. | Cost | Price | Quan. | Cost |
| STORM SEWER | | | | | | | | | | | | | |
| 24" RCP | L.F. | | | | 21.00 | 400 | 8400 | 21.00 | 400 | 8400 | | | |
| 30" RCP | L.F. | | | | 30.00 | 400 | 12000 | 30.00 | 900 | 27000 | | | |
| 36" RCP | L.F. | 39.50 | 1400 | 55300 | 39.50 | 800 | 31600 | | | | | | |
| Manholes | Ea. | 440.00 | 4 | 1760 | 440.00 | 6 | 2640 | 440.00 | 4 | 1760 | | | |
| Drop Inlets & Castings | Ea. | 380.00 | 9 | 3420 | 380.00 | 8 | 3040 | 380.00 | 12 | 4560 | | | |
| Summation | L.S. | | | 60480 | | | 57680 | | | 41720 | | | |
| DRAINAGE CHANNEL | | | | | | | | | | | | | |
| Right-of-Way | L.S. | | | | | | | | L.S. | 17450 | | | |
| Channel Excavation | C.Y. | | | | | | | 3.00 | 13500 | 40500 | | | |
| 60" CMP | L.F. | | | | | | | 80.00 | 400 | 32000 | | | |
| 65"x40" CMP Arch | L.F. | 80.00 | 420 | 33600 | | | | | | | | | |
| Summation | L.S. | | | 33600 | | | | | | 89950 | | | |
| SUMP DRAINAGE | | | | | | | | | | | | | |
| 4" PVC | L.F. | | | | 4.50 | 3150 | 14175 | 4.50 | 2940 | 13230 | | | |
| 6" PVC | L.F. | | | | 5.20 | 2550 | 13260 | 5.20 | 5580 | 29016 | | | |
| 8" PVC | L.F. | | | | --- | --- | --- | 6.20 | 1370 | 8494 | | | |
| 10" PVC | L.F. | | | | --- | --- | --- | 7.40 | 1100 | 8140 | | | |
| Manholes | Ea. | | | | 440.00 | 14 | 6160 | 440.00 | 29 | 12760 | | | |
| Summation | L.S. | | | | --- | --- | 33595 | --- | --- | 71640 | | | |

NOTE: PVC Sewer Pipe Costs based on 1979 Dodge Guide Non-Reinforced Concrete Pipe p. 133.

second with flood rights to 42 cubic feet per second. In the event users elect to take advantage of the flood rights provision, the ditch would have to be enlarged. Major leaks and seepage were verified and improvement methods were described and costs were given. The methods considered were concrete lining, asphalt membrane lining and bentonite sealing. A bentonite seal was applied. However this had a short life.

In May, 1975, the Soil Conservation Service developed an economic analysis of solutions to the Hugus Mullison Ditch problem. Their solutions follow:

1. Change the point of diversion. That is the point at which the water is taken from the North Platte River and put into the ditch. Two methods were analyzed. (a) Build an inlet channel from the river to a pump which would then raise the water to the elevation of the existing ditch north of Town. (b) Pump from the river through a 42 inch corrugated metal pipe to the existing ditch at a point north of Town.

2. Treat the present ditch. (a) Provide 5800 feet of concrete ditch lining. (b) Provide 5800 feet of 66 inch 12 gage corrugated metal pipe arch. (c) Bentonite seal 5800 feet of the ditch after cleaning and reshaping the ditch.

In December, 1976, the Soil Conservation Service updated the former study. The update includes the following comments. Near its upper end the ditch received effluent from a septic tank overflow system (This has been eliminated). The overflow contained dangerous levels of coliform bacteria. Little fall in the ditch is apparent through Town. Acute problems identified include: (1) Lack of fall or grade which inhibits drainage. The ditch holds polluted water in inpermeable areas which facilitates the breeding of aquatic insects. (2) Most of the ditch is built in sandy alluvium which allows large quantities of seepage to the ground below the ditch. (3) Seepage from the ditch infiltrates the Town's sewer system which is at capacity during the irrigation season. Town growth and the attendant increase in the number of home connections to the sewer will soon overload the sewer system. (4) The ditch is an attractive health and safety hazard to children. (5) Seepage from the ditch causes a large boggy area immediately below the ditch in some parts of Town which is of little use during the irrigation seasons.

Solutions to these problems are: (1) Line the ditch. (2) Put the ditch in a pipe through Town. (3) Change the point of diversion. The Soil Conservation Service recommended item 3, changing the point of diversion.

We took the costs from the various reports and updated them to 1979 costs. We did this by using the Engineering News Record construction costs index from the year the previous estimate to December, 1978, plus 4% to raise the cost estimate to mid 1979. For a 4 inch concrete lining through Town the estimated 1979 cost would be $327,000. The lining could be expected to last 25 years. For a one-half inch asphalt-asbestos membrane lining the cost would be $260,000 with an expected life of 15 years. For a light asphalt-asbestos membrane lining, the cost would be $211,200 with a life expectancy of 12 years. Asphalt-asbestos linings probably are no longer allowed by EPA. The three previous estimates include fencing both sides of the ditch for approximately a mile to prevent children and pets from getting into the ditch. A low cost alternative would be to simply bentonite seal the ditch after shaping and grading and don't fence it. The cost for this alternative would be $10,500 with a potential life of a maximum of five years. To build a pipe through town would cost $440,000 and would provide a design life of approximately 20 years. Changing the point of diversin would cost approximately $107,000 and a design life of approximately 25 years could be expected. Changing the point of diversion requires the operation of a pump which means that operating costs with the change of point of divsersion would be the highest of any of the methods. However, the bentonite lining which has a short life, and is relatively inefficient at that, is the only method which is cheaper in initial cost than the alternate of changing the point of diversion.

## GEOTECHNICAL

Seventy-one exploratory holes were drilled throughout the street system during July, 18, 19 and 20, 1978. Both undisturbed and disturbed soil samples were obtained. Observations were made of the free water at the time the test holes were drilled. The soils were classified on the site by a field engineer, with representative samples of the soils being returned to the soils laboratory for testing. In addition to the sample holes, five ground water observation holes were drilled and slotted PVC pipe was installed in these holes to allow monitoring of the water table. A fact finding investigation was conducted consisting of talking with the street department for the Town of Saratoga and local residents. Information gathered from this investigation identified an old stream channel and localized soft spots. Laboratory tests were performed to obtain the natural moisture content of the soil, the natural dry density of the soil, and gradation to be used in classifying the soil for design calculations. For more complete details, see the Soils Report included as Appendix B.

## PUBLIC HEARINGS

The first public meeting was held November 14, 1978, at the Fireman's Hall. Those present representing the engineering firm were Paul McCarthy from Robert Jack Smith & Associates, Inc. and Mr. Ken Temme from Chen & Associates. Approximately 20 people, mostly members of different Town boards were also in attendance. The purpose of this meeting was to explain the project to those present. It was stated at that time that approximately three and one-half million would be the total project cost, which was later found to be incorrect. Mr. Temme explained the stage construction of street projects. The biggest concern of those present was the ability to construct streets that will last in Area 2B. Mr. Temme explained the fabric reinforcment principle and stated that the occurence of frost heave would be reduced but that it would not necessarily be totally eliminated. A test section using Mirafi 500 fabric with 18 inches of gravel was installed on Rochester Avenue between First and Second Streets. This test section is being monitored through the 1979 Spring season to determine its total reactions.

A second public meeting was held January 11, 1979, again at the Fireman's Hall. Paul McCarthy and Richard Reusser were in attendance from Robert Jack Smith & Associates, Inc. Approximately a dozen people were present for the meeting. Mr. McCarthy explained the proposed street improvement program. The widths and thicknesses for the proposed improvements are based on the master street plan and the soils investigation. The recommended pavements utilize stage construction which is building a portion of the pavement thickness at one time followed by the remainder of the pavement at another time, as much as ten years later. We are recommending stage construction with concrete curb and gutter if grant monies can be found. This stage construction will consist of a full-depth asphalt section of which the first stage would be the plant mix base.

We would anticipate cost savings if the following changes are made: (1) asphalt curb and gutter can be substituted for concrete curb and gutter, although we would recommend that concrete curb and gutter be used on arterial and collector streets due to the increased maintenance required for asphalt curb and gutter and its susceptiblity to damage from snowplows, (2) asphalt crosspans are cheaper than concrete crosspans, but again require a little bit more maintenance, (3) No curb and gutter at all would further reduce the cost but again, it increases maintenance costs, (4) paving only the travelled way with full strength pavement and using gravelled parking and ditch areas would further reduce the cost as the width of the full strength asphalt pavement would be considerably reduced,(5) still cheaper and of course less durable would be to simply grade and gravel the streets. This would be done with a section somewhat similar to a rural road section except that ditchs should be built with flat enough slopes that driveways would not have to be built up across them thus forming dikes or dams hindering

the drainage. A slightly improved version of this would be to gravel the street and then place a chip seal. If either of the last two options were followed, we would recommend that a full pavement be placed on Bridge Street as this is a county road and one of the designated minor arterials. It was also noted that many of the street improvements should be scheduled to follow sewer and water construction to prevent the damaging of the street pavement by subsequent utility construction. It is impossible to anticipate the location of repair work so there will always be a certain amount of tearing up of pavement and rebuilding done, but by placing all new water and sewer lines prior to constructing pavement, this can be minimized.

## PAVEMENT SECTIONS STUDIED

The basic materials used in pavements considered for the this project include: In place materials existing subgrade and materials overlaying the subgrade which can possibly be used in the construcion of the pavement, Granular base - either a natural gravel or crushed rock or gravel of controlled gradation and hardness used for a base material, Plant mix base - an asphalt cement blended base material normally having a greater strength than granular base but less strength than a plant mix pavement, Plant mix pavement - an asphalt cement blended material used for the final structural course in a pavement, Plant mix wearing course - a plant mixed asphaltic material placed over the plant mixed pavement to provide a surface that will seal the underlying pavement layers against the intrusion of water and provide a surface which may be worn away without detrimentally affecting the structural strength ofthe pavement, Seal coat - a seal coat is a non-structural element of the pavement with the sole purpose of sealing the pavement against the intrusion of water and minimize wear of the plant mix pavement, Soil treatment - a process whereby in-place materials are mixed with a minimal amount of asphalt to increase the strength of the materials and thereby reduce the amount of material of higher quality that has to be placed above the treated material.

Traditional pavement sections include either a seal coat or a plant mix wearing course, a plant mix pavement and a granular base placed on the subgrade. An alternate pavement which is coming into favor, particularly where ground water is a problem, is the so-called full-depth pavement, which is a seal coat or plant mix wearing course placed on a plant mix pavement which is placed on a plant mix base which lies directly on the existing subgrade. No granular materials are used in the full-depth pavement to prevent or minimize the intrusion of water into the pavement structure. Soil treatments are not used very often. However in this instance, due to the thick pavement sections that are needed, particularly in the areas having water problems and poor subgrade materials, it appears that soil treatment might be used profitably by the Town of Saratoga to reduce costs. However, soil treatment is highly susceptable to certain conditions in the soil and because soils vary widely, very little can be done to predict the performance of the soil treatment without laboratory tests of the specific soils and the proposed asphalt blend. Therefore before soil treatment would be used it should be tested in a laboratory to determine if the soil treatment would indeed increase the strength of the existing soils such that the resulting pavement structure above the soil treatment would be reduced enough to offset the cost of the soil treatment. Research and conversations with an engineer from the Ashpalt Institute indicate that the potential for cost saving using soil treatment in place of granular base and to reduce the thickness of plant mix base is well worth pursuing.

The following pavement sections were evaluated for approximate construction cost for the purpose of comparing these sections to determine practical alternates and costs for the Town to use in deciding on the option or plan they desire to follow in upgrading the streets.

1. A full-depth pavement consisting of plant mix base, plant mix pavement and plant mix wearing course. In areas of poor subgrade in Area 2B, additional material, filter fabric and granular base would be used. Concrete curb and gutter would be placed on all streets. The full-depth pavement was selected over the equivalent granular structure pavement because it is cheaper to achieve the same strength.

2. A stage one pavement consisting of plant mix base, and plant mix wearing course. The full-depth pavement would be achieved with a second stage at a later date which would include a layer of plant mix pavement and a new plant mix wearing course. Again in areas of poor subgrade, filter fabric and granular base are used to increase the depth. Concrete curb and gutter are provided on all streets.

3. A stage one pavement utilizing a plant mix base and plant mix wearing course. Filter fabric and granular base are used on poor subgrades. Concrete curb and gutter would be used only on arterial and collector streets with asphalt curbs on local streets.

4. A stage one pavement similar to alternate 3. However a soil treatment would be used to substitute for a portion of the plant mix base and soil treatment would be used instead of the filter fabric and granular base on poor subgrade. Above the soil treatment would be a thinner section of plant mix base and plant mix wearing course. Concrete curb and gutter would be used on arterials and collector streets with asphalt curbs on local streets.

5. A stage one pavement built for the travelled way only, 24 feet for local streets, 32 feet for arterials and collectors. This would be a plant mix base and plant mix wearing course. Filter fabric and granular base would be used on poor subgrade. No curb would be provided. This section would include grading the ditches as an extension of the pavement using very flat slopes so that no driveways would have to be built up. This would allow the flow of water in the same fashion as curb and gutter. An Alternate 5A includes a penetration seal of the ditch section to minimize erosion.

6. A stage one pavement similar to alternate 5 using soil treatment to substitute for a portion of the plant mix base. This pavement would be a plant mix base and a plant mix wearing course for just the travelled ways only, 24 feet on the local streets, 32 feet on the arterials and collectors. There would no curb and the ditches would be graded simply to provide a flat shallow ditch that could be crossed by driveways without building a dike to inhibit the flow of the water.

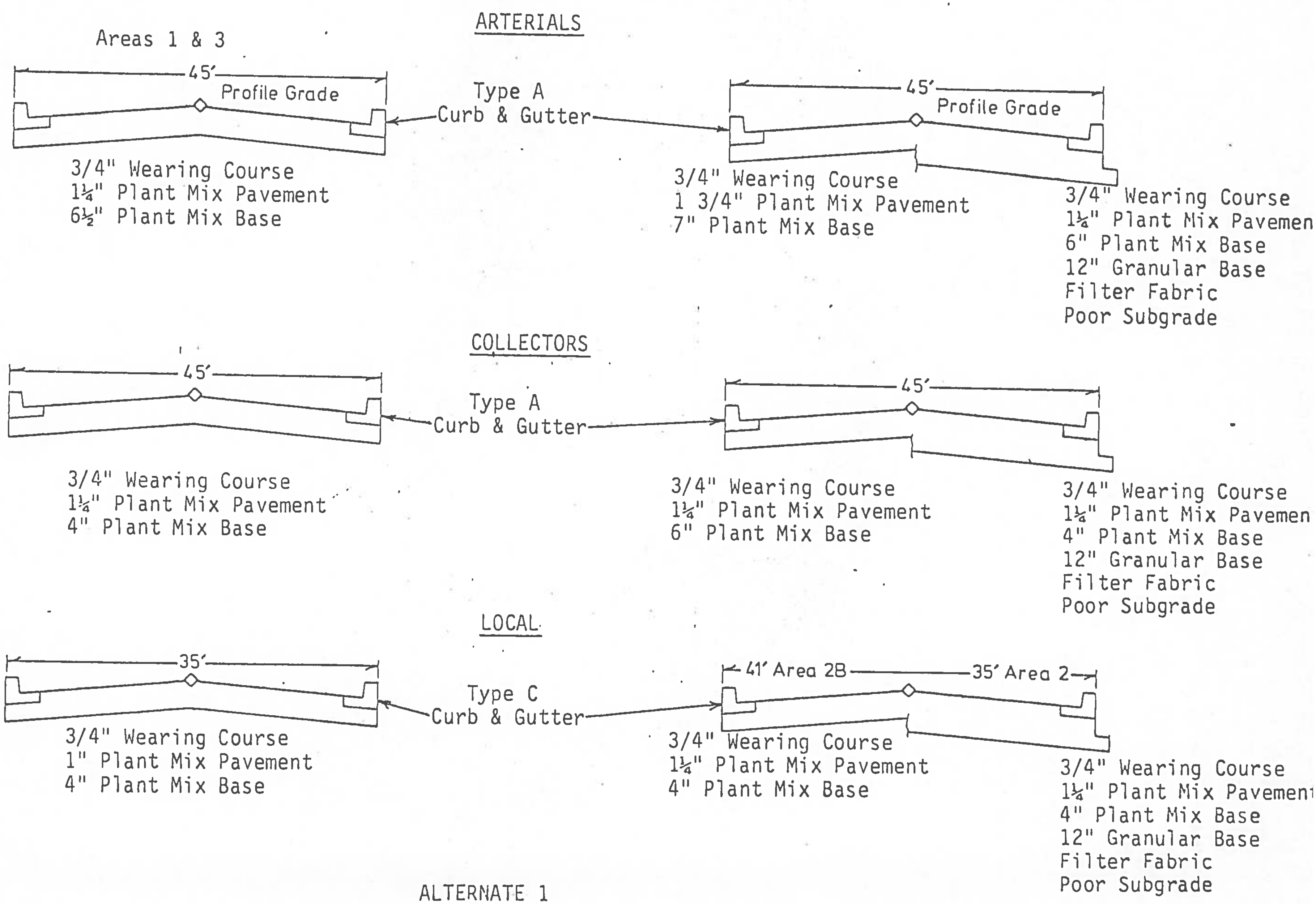
Widths for Alternates 1 through 4 would be 45 feet from the back of the curb to back of curb for arterial and collector streets. Local streets in Areas 1, 2 and 3 would be 35 feet from back of curb to back of curb. Because Area 2B consists of the older part of Town which is more built up, local streets in Area 2B would have a width of 41 feet from back of curb to back of curb to provide for practical on street parking. Alternates 5 and 6 have a pavement width of 32 feet for arterial and collectors, 24 feet for local streets. Alternates 5 and 6, because they have less than a full-width pavement, run the potential of having more problem in the weaker ditch section at driveways. Without the penetration seal some erosion will occur, which will require grading at a regular and frequent intervals. Alternatives 3 & 4 with the asphalt curb on local streets also will probably require a little bit more maintenance because the asphalt curb is not as durable under impact such as larger vehicles or snowplows hitting it. Typical sections illustrating each of the alternates are shown on the following pages.

The large scale maps which accompany this report show the edge of the street for the full width pavements and proposed final street elevations at the center of each intersection which will maintain proper grades for drainage.

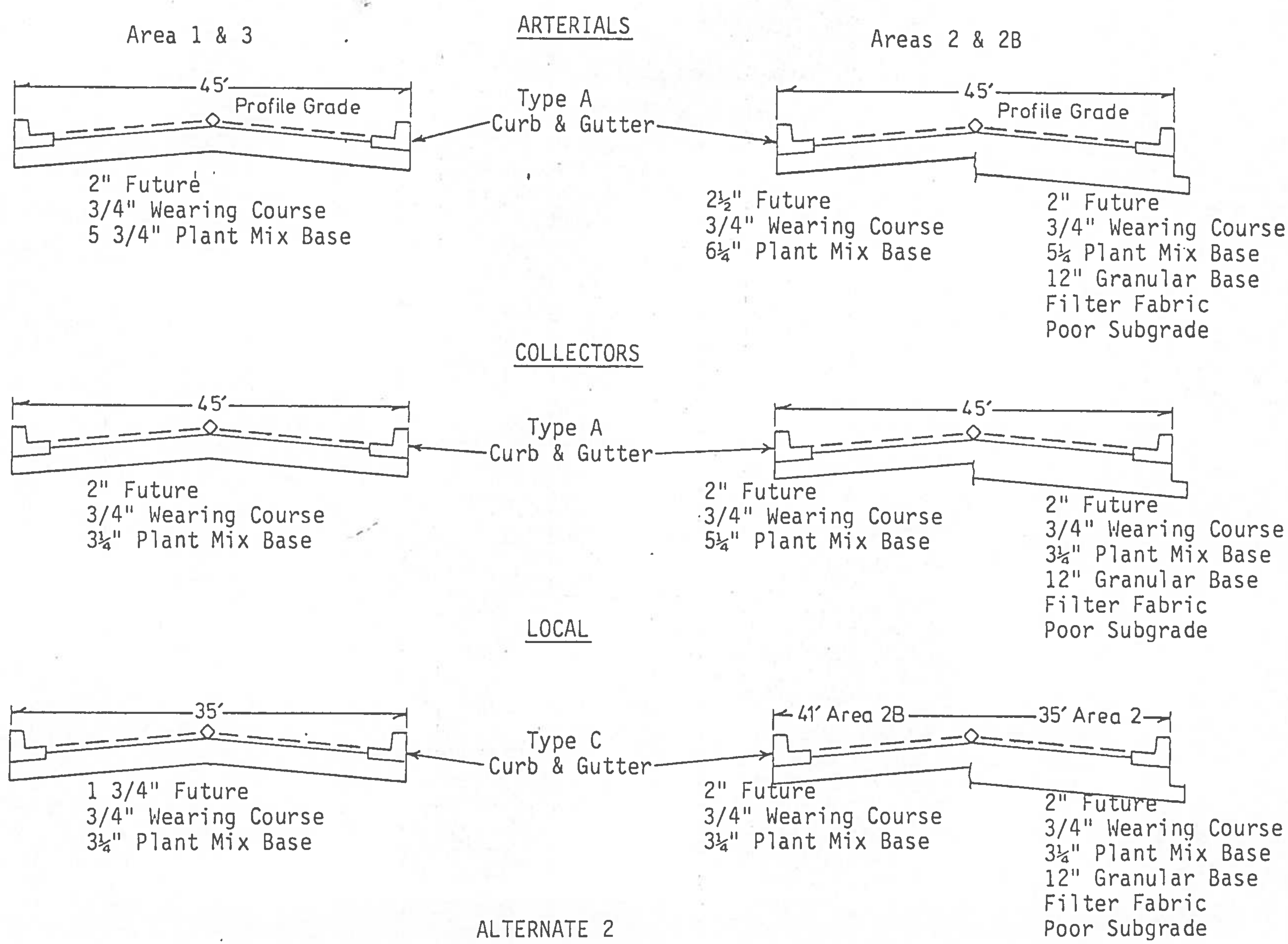
# COST APPROXIMATIONS

Construction costs have been approximated for the construction of streets and drainage. Preliminary project approximations are made before all of the details are known, and before the project is designed. Consequently, these approximations should be used for planning or feasibility studies only. It must be understood that in the light of a highly variable construction market, continually changing material prices and labor costs, that any such approximation of construction cost cannot be guaranteed nor will it be realistic after any appreciable time has lapsed. If actual construction of the proposed work is delayed beyond the 1979 construction season, it will be necessary to reappraise the construction cost approximations.

Table 2 shows approximations of construction costs including an approximation of engineering fees, legal fees and a small amount for contingencies for the construction of all streets in each area to a local street width and strength and an added cost to widen designated streets to arterial or collector width and provide the strength is also included. Storm sewer, drainage channel and sump drain system costs are also tabulated. Each cost is related to the total assessable footage within each area to arrive at a cost per assessable square foot of property for each of the improvements in the area. Six alternates are tabulated ranging from the full asphalt pavement with concrete curb and gutter on all streets with appropriate drainage downward through stage construction, substituting asphalt curbs, removing curbs, substituting an asphalt soil treatment for some of the plant mix materials, narrowing pavement so that only the travelled way is paved using only a soil treatment for the base with a wearing course. The highest costs range from 63 cents a square foot to 80 cents a square foot of cost per assessable square foot downward to costs ranging from 21 cents to 39 cents per assessable square foot. Detailed cost tabulations are shown in Appendix C.


ARTERIALS
Areas 1 & 3
45'
Profile Grade
Type A
Curb & Gutter
3/4" Wearing Course
1¼" Plant Mix Pavement
6½" Plant Mix Base
45'
Profile Grade
3/4" Wearing Course
1 3/4" Plant Mix Pavement
7" Plant Mix Base
3/4" Wearing Course
1¼" Plant Mix Pavemen
6" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade
COLLECTORS
45'
Type A
Curb & Gutter
3/4" Wearing Course
1¼" Plant Mix Pavement
4" Plant Mix Base
45'
3/4" Wearing Course
1¼" Plant Mix Pavement
6" Plant Mix Base
3/4" Wearing Course
1¼" Plant Mix Pavemen
4" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade
LOCAL
35'
Type C
Curb & Gutter
3/4" Wearing Course
1" Plant Mix Pavement
4" Plant Mix Base
41' Area 2B
35' Area 2
3/4" Wearing Course
1¼" Plant Mix Pavement
4" Plant Mix Base
3/4" Wearing Course
1¼" Plant Mix Pavement
4" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade

ALTERNATE 1

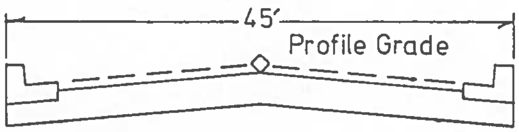

ARTERIALS
Area 1 & 3
45′
Profile Grade
2" Future
3/4" Wearing Course
5 3/4" Plant Mix Base
Type A
Curb & Gutter
Areas 2 & 2B
45′
Profile Grade
2½" Future
3/4" Wearing Course
6¼" Plant Mix Base
2" Future
3/4" Wearing Course
5¼ Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade
COLLECTORS
45′
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
Type A
Curb & Gutter
45′
2" Future
3/4" Wearing Course
5¼" Plant Mix Base
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade
LOCAL
35′
1 3/4" Future
3/4" Wearing Course
3¼" Plant Mix Base
Type C
Curb & Gutter
41′ Area 2B
35′ Area 2
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade

ALTERNATE 2

## ARTERIALS

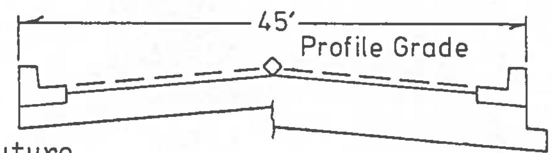
Type A
Curb & Gutter

Areas 1 & 3




2" Future
3/4" Wearing Course
5 3/4" Plant Mix Base

Areas 2 & 2B

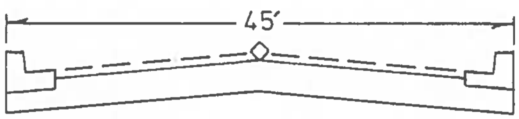



2½" Future
3/4" Wearing Course
6¼" Plant Mix Base

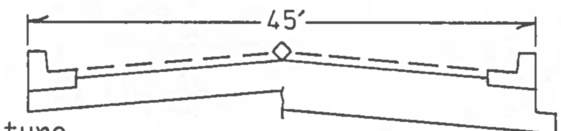
2" Future
3/4" Wearing Course
5¼" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade

## COLLECTORS

Type A
Curb & Gutter




2" Future
3/4" Wearing Course
3¼" Plant Mix Base

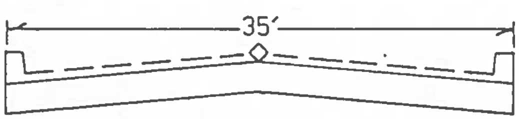



2" Future
3/4" Wearing Course
5¼" Plant Mix Base

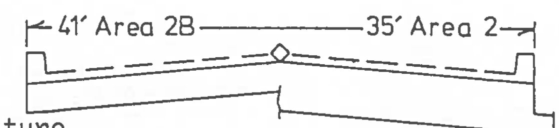
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade

## LOCAL

Asphalt. Curb



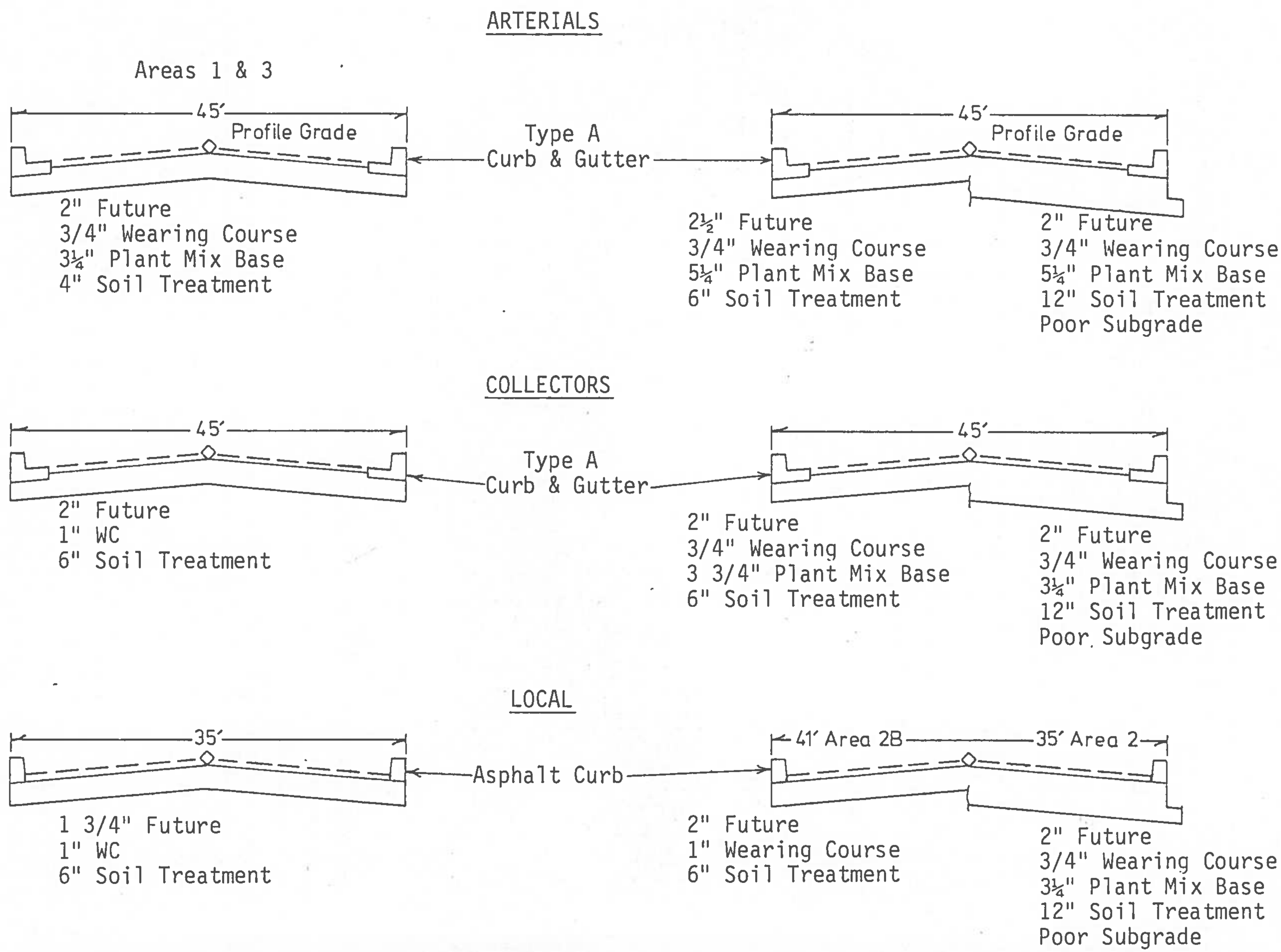

1 3/4" Future
3/4" Wearing Course
3¼" Plant Mix Base




2" Future
3/4" Wearing Course
3¼ Plant Mix Base

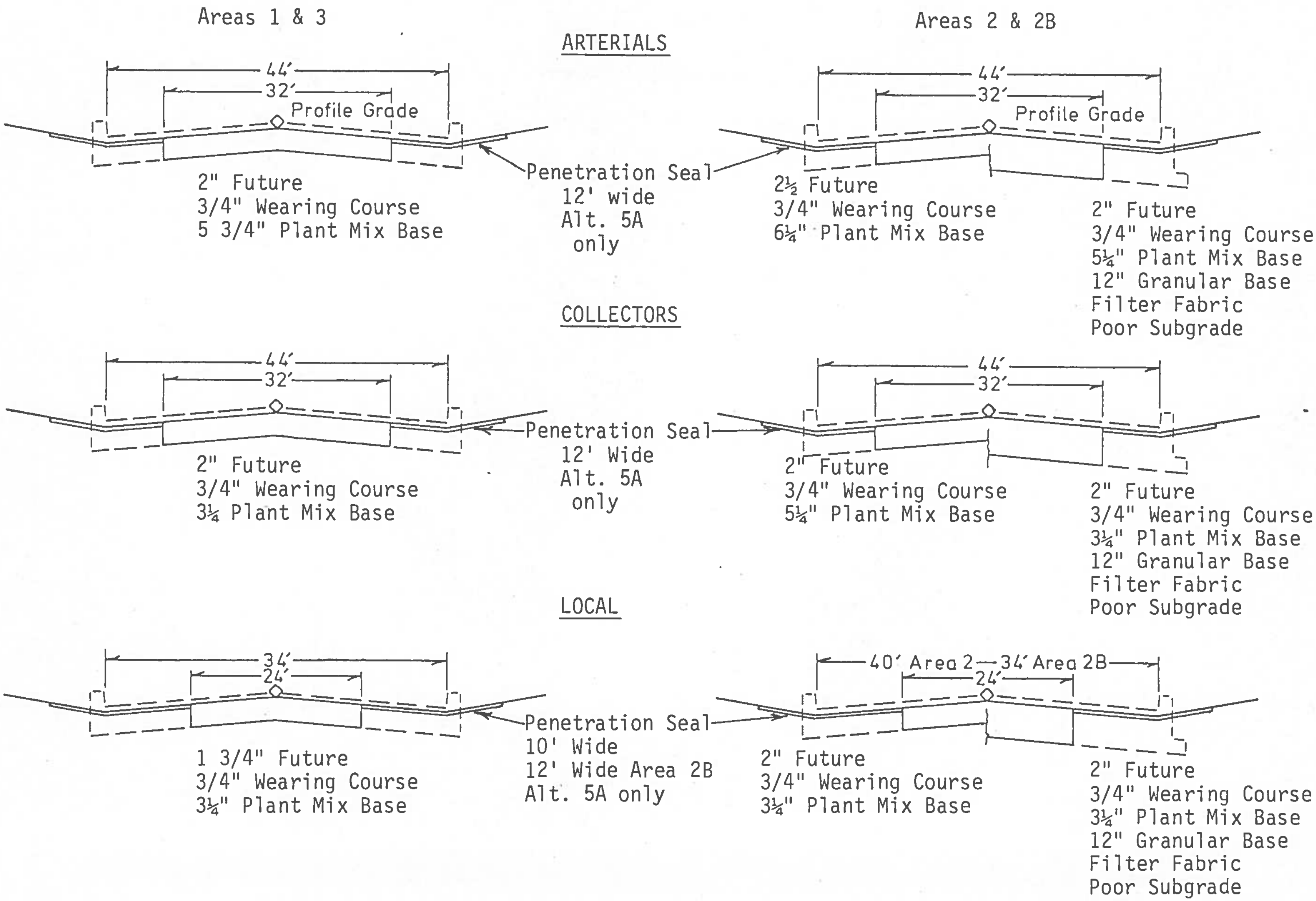
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Granular Base
Filter Fabric
Poor Subgrade

## ALTERNATE 3

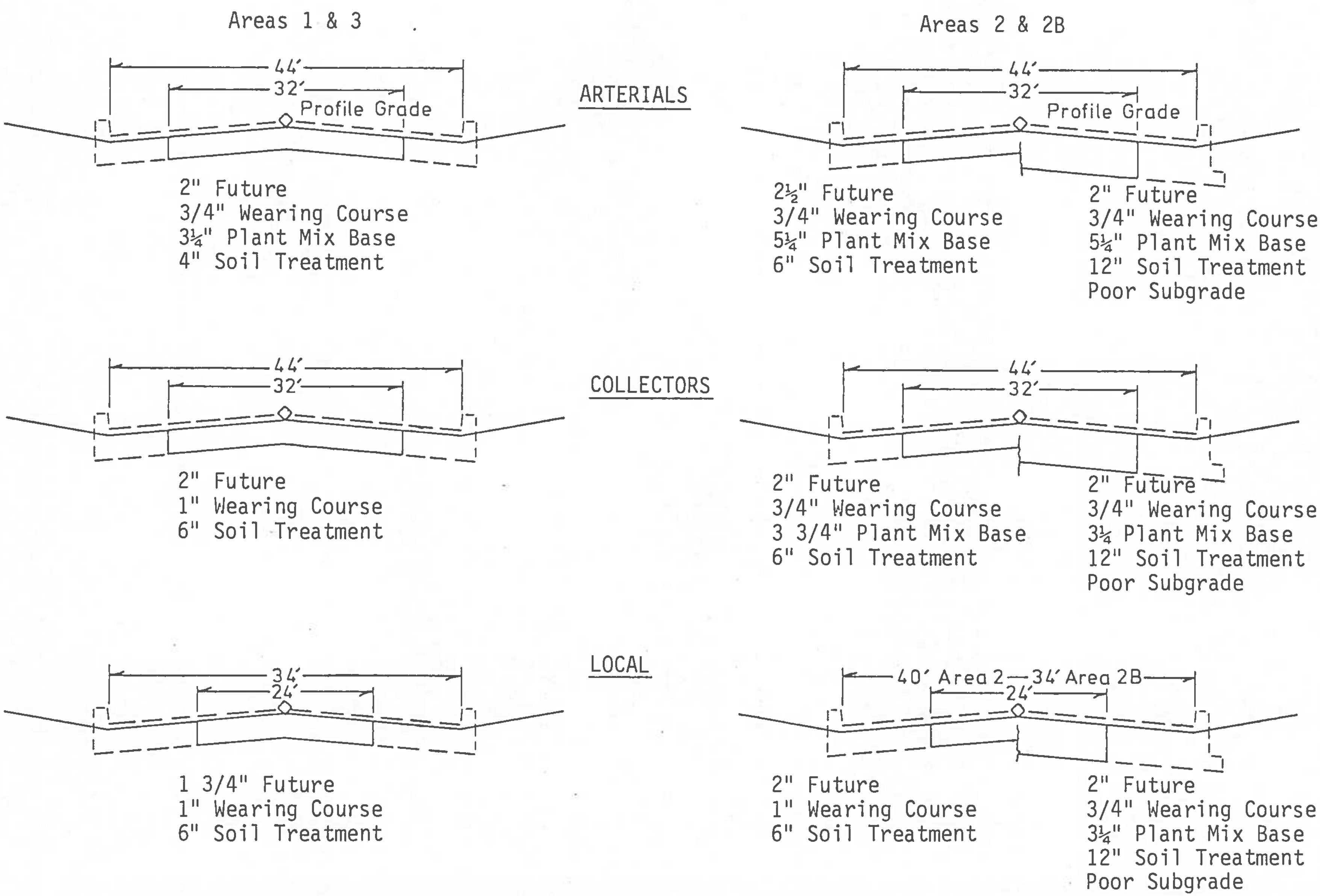

ARTERIALS
Areas 1 & 3
45′
Profile Grade
Type A
Curb & Gutter
45′
Profile Grade
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
4" Soil Treatment
2½" Future
3/4" Wearing Course
5¼" Plant Mix Base
6" Soil Treatment
2" Future
3/4" Wearing Course
5¼" Plant Mix Base
12" Soil Treatment
Poor Subgrade
COLLECTORS
45′
Type A
Curb & Gutter
45′
2" Future
1" WC
6" Soil Treatment
2" Future
3/4" Wearing Course
3 3/4" Plant Mix Base
6" Soil Treatment
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Soil Treatment
Poor Subgrade
LOCAL
35′
Asphalt Curb
41′ Area 2B
35′ Area 2
1 3/4" Future
1" WC
6" Soil Treatment
2" Future
1" Wearing Course
6" Soil Treatment
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Soil Treatment
Poor Subgrade

ALTERNATE 4

ALTERNATE 5 & 5A



ALTERNATE 6


Areas 1 & 3
Areas 2 & 2B
ARTERIALS
44'
32'
Profile Grade
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
4" Soil Treatment
2½" Future
3/4" Wearing Course
5¼" Plant Mix Base
6" Soil Treatment
2" Future
3/4" Wearing Course
5¼" Plant Mix Base
12" Soil Treatment
Poor Subgrade
COLLECTORS
44'
32'
2" Future
1" Wearing Course
6" Soil Treatment
2" Future
3/4" Wearing Course
3 3/4" Plant Mix Base
6" Soil Treatment
2" Future
3/4" Wearing Course
3¼ Plant Mix Base
12" Soil Treatment
Poor Subgrade
LOCAL
34'
24'
1 3/4" Future
1" Wearing Course
6" Soil Treatment
40' Area 2 — 34' Area 2B
24'
2" Future
1" Wearing Course
6" Soil Treatment
2" Future
3/4" Wearing Course
3¼" Plant Mix Base
12" Soil Treatment
Poor Subgrade

APPROXIMATION OF CONSTRUCTION COST - Table 2

| Area | 1 | | 2 | | 2B | | 3 | |
|---|---|---|---|---|---|---|---|---|
| Assessable Footage | 3,066,840S.F. | | 1,401,402S.F. | | 4,292,650S.F. | | 2,363,200S.F. | |
| ITEM | Cost | Per S.F. | Cost | Per S.F. | Cost | Per S.F. | Cost | Per S.F. |
| Alternate 1 - Full Depth Asphalt Pavement w/Concrete Curb & Gutter | | | | | | | | |
| All streets local | 1664036 | 0.54 | 824506 | 0.59 | 2480747 | 0.58 | 1423920 | 0.60 |
| Added Cost for Arterial/ Collector | 203059 | 0.07 | 216627 | 0.15 | 281416 | 0.07 | 58804 | 0.02 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46738 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 1997961 | 0.65 | 1168097 | 0.83 | 3044968 | 0.71 | 1482724 | 0.63 |
| Alternate 2 - Stage One Asphalt Pavement w/Concrete Curb & Gutter | | | | | | | | |
| All streets local | 1395284 | 0.45 | 677871 | 0.48 | 2043729 | 0.48 | 1196289 | 0.51 |
| Added Cost for Arterial/ Collector | 153390 | 0.05 | 183067 | 0.13 | 252803 | 0.06 | 39127 | 0.02 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46738 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 1679540 | 0.55 | 987902 | 0.70 | 2579337 | 0.60 | 1235416 | 0.52 |
| Alternate 3 - Stage One Asphalt Pavement w/Concrete & Asphalt Curbs | | | | | | | | |
| All streets local | 1193997 | 0.39 | 581238 | 0.41 | 1823397 | 0.42 | 1016124 | 0.43 |
| Added Cost for Arterial/ Collector | 217329 | 0.07 | 227079 | 0.16 | 336216 | 0.08 | 62200 | 0.03 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46738 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 1542192 | 0.50 | 935281 | 0.67 | 2442418 | 0.57 | 1078324 | 0.46 |

APPROXIMATION OF CONSTRUCTION COST - Table 2 Cont.

| Area | 1 | | 2 | | 2B | | 3 | |
|---|---|---|---|---|---|---|---|---|
| Assessable Footage | 3,066,840S.F. | | 1,401,402S.F. | | 4,292,650S.F. | | 2,363,200S.F. | |
| ITEM | Cost | Per S.F. | Cost | Per S.F. | Cost | Per S.F. | Cost | Per S.F. |
| Alternate 4 - Asphalt Pavement using Soil Treatment - Curb & Gutter | | | | | | | | |
| All Streets local | 1091592 | 0.36 | 555345 | 0.40 | 1648 | 0.38 | 881438 | 0.37 |
| Added Cost Arterial/ Collector | 107500 | 0.04 | 206791 | 0.15 | 280761 | 0.07 | 25176 | 0.01 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46738 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 1329958 | 0.43 | 889100 | 0.63 | 2212513 | 0.52 | 906614 | 0.38 |
| Alternate 5 - Asphalt Pavement Travelled Way only | | | | | | | | |
| All Streets local | 693792 | 0.23 | 346808 | 0.25 | 958094 | 0.22 | 600257 | 0.25 |
| Added Cost for Arterial/ Collector | 118602 | 0.04 | 136262 | 0.10 | 256676 | 0.06 | 31478 | 0.01 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46736 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 943260 | 0.31 | 610034 | 0.4 | 1497575 | 0.35 | 631735 | 0.27 |
| Alternate 6 - Asphalt Pavement Travelled Way only using soil treatment | | | | | | | | |
| All streets local | 553339 | 0.18 | 281685 | 0.20 | 781980 | 0.18 | 479384 | 0.20 |
| Added Cost for Arterial/ Collector | 101839 | 0.03 | 177970 | 0.13 | 316512 | 0.07 | 26559 | 0.01 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46738 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 786044 | 0.26 | 586619 | 0.42 | 1381297 | 0.32 | 505943 | 0.21 |

APPROXIMATION OF CONSTRUCTION COST - Table 2 (Cont.)

| Area | 1 | | 2 | | 2B | | 3 | |
|---|---|---|---|---|---|---|---|---|
| Assessable Footage | 3,066,840S.F. | | 1,401,402S.F. | | 4,292,650S.F. | | 2,363,200S.F. | |
| ITEM | Cost | Per S.F. | Cost | Per S.F. | Cost | Per S.F. | Cost | Per S.F. |
| Alternate 5A - Asphalt Pavement Travelled Way only, Oiled Ditches | | | | | | | | |
| All streets local | 737954 | 0.24 | 367916 | 0.26 | 1011001 | 0.24 | 638264 | 0.27 |
| Added Cost for Arterial/ Collector | 121719 | 0.04 | 138325 | 0.10 | 260779 | 0.06 | 32709 | 0.01 |
| Storm Sewer | 84128 | 0.03 | 80233 | 0.06 | 58032 | 0.01 | --- | -- |
| Drainage Channels | 46738 | 0.02 | --- | -- | 125121 | 0.03 | --- | -- |
| Sump Drain System | --- | -- | 46731 | 0.03 | 99652 | 0.02 | --- | -- |
| TOTAL | 990539 | 0.32 | 633205 | 0.45 | 1554585 | 0.36 | 670973 | 0.28 |

## FUNDING POSSIBILITIES

Grants for the funding of all or a portion of this proposed work are thought to be an extremely unlikely possibility. Some loan assistance may be available from the Farmers Home Administration or the State Farm Loan Board Joint Powers Loan program. However the State Farm Loan Board does not at this time want to make any type of long term loans. It does not appear that the Town has a very good possibility of contributing a significantly large portion of the cost of this project without in some way increasing the Town's revenue. Most options for such an increase are not very viable at this point. A third possibility is that of a grant to pay off the high early or first years' costs of the project. For this to be most practical, the actual cost of construction should be reduced as much as can possibly be done. A tabulation of costs for Alternates 1, 2, 5 and 5A showing the assessments with and without grants and Town contributions follows. Assessments for other alternatives may be quickly calculated using the previously shown tabulations of construction costs in the section on construction costs. For more details, see the Financial Recommendations Report included as Appendix D. Table 4, a complete scenario based on Alternate 2 detailing the costs for typical lots of 7200 S.F. in areas 1 and 3 or 9600 S.F. in areas 2 and 2D throughout a year payback period follows TAble 3.

Table 3
TYPICAL ASSESSMENTS

| Alternate / Area | Assessment for Full Cost | | Assessment with Grant for Drainage | | Assessment with Grant for Arterial/Collector Costs | | Assessment with Grants for all except local street costs | |
|---|---|---|---|---|---|---|---|---|
| | Per S.F. | Per 60' x120' Lot | Per S.F. | Per 60' x120' Lot | Per S.F. | Per 60' x120' Lot | Per S.F. | Per 60' x120' Lot |
| Alternate 1 | | | | | | | | |
| Area 1 | 0.65 | 4680.00 | 0.61 | 4392.00 | 0.58 | 4176.00 | 0.54 | 3880.00 |
| Area 2 | 0.83 | 5976.00 | 0.74 | 5328.00 | 0.68 | 4896.00 | 0.59 | 4248.00 |
| Area 2B | 0.71 | 5112.00 | 0.65 | 4680.00 | 0.64 | 4608.00 | 0.58 | 4176.00 |
| Area 3 | 0.63 | 4536.00 | 0.63 | 4536.00 | 0.60 | 4320.00 | 0.60 | 4320.00 |
| Alternate 2 | | | | | | | | |
| Area 1 | 0.55 | 3960.00 | 0.50 | 3600.00 | 0.50 | 3600.00 | 0.45 | 3240.00 |
| Area 2 | 0.70 | 5040.00 | 0.61 | 4392.00 | 0.57 | 4104.00 | 0.48 | 3456.00 |
| Area 2B | 0.60 | 4320.00 | 0.54 | 3888.0 | 0.54 | 3888.00 | 0.48 | 3456.00 |
| Area 3 | 0.52 | 3744.00 | 0.52 | 3744.00 | 0.51 | 3672.00 | 0.51 | 3672.00 |
| Alternate 5 | | | | | | | | |
| Area 1 | 0.31 | 2232.00 | 0.27 | 1944.00 | 0.27 | 1944.00 | 0.23 | 1656.00 |
| Area 2 | 0.43 | 3096.00 | 0.35 | 2520.00 | 0.33 | 2376.00 | 0.25 | 1800.00 |
| Area 2B | 0.35 | 2520.00 | 0.28 | 2016.00 | 0.29 | 2088.00 | 0.22 | 1584.00 |
| Area 3 | 0.27 | 1944.00 | 0.27 | 1944.00 | 0.25 | 1800.00 | 0.25 | 1800.00 |
| Alternate 5A | | | | | | | | |
| Area 1 | 0.32 | 2304.00 | 0.28 | 2016.00 | 0.28 | 2016.00 | 0.24 | 1728.00 |
| Area 2 | 0.45 | 3240.00 | 0.36 | 2592.00 | 0.35 | 2520.00 | 0.26 | 1872.00 |
| Area 2B | 0.36 | 2592.00 | 0.30 | 2160.00 | 0.30 | 2160.00 | 0.24 | 1728.00 |
| Area 3 | 0.28 | 2016.00 | 0.28 | 2016.00 | 0.27 | 1944.00 | 0.27 | 1944.00 |

## MAINTENANCE REQUIREMENTS

With the construction of higher quality streets, additional maintenance requirements will be added to the Town's operating expenses.

1. The streets should be swept with a power broom at least once a year, normally in the late spring or early summer to remove mud, sand and other debris which has accumulated during the winter.

2. Plowing of snow, especially from arterial and collector streets, will become more important with the higher pavement type to provide safety and minimize water-freezing damage to the pavement.

3. Maintenance will no longer simply be a matter of grading the area smooth and driving away. It will involve crack sealing, patching and, in some cases, possibly outright replacement of small sections of pavement. The Town will have to provide a different means of repairing trenches which are cut for various utilities.

4. Maintenance of unobstructed drainage facilities, including curb and gutter, will be necessary to prevent flooding. Packed snow, ice, leaves, cardboard and other debris will have to be kept out of storm sewers and their inlets. Packed snow and ice in gutters or ditches can cause flooding by backing up water or diverting it into drainages not sized to handle it. These problems will be most critical in areas 2 and 2B because of the very flat grades in the drainage facilities.

5. It may be necessary for the Town to enact an ordinance restricting heavy truck traffic on local streets if such an ordinance does not already exist to protect the light duty pavements from unnecessary damage and resulting maintenance costs.

Additional personnel, equipment, and training will be needed to meet these requirements.

## RECOMMENDED CONSTRUCTION

An off systems street improvement project funded by the Wyoming Highway Department has been let for construction during the summer of 1979. This project involves reshaping and gravelling selected streets in the Town of Saratoga. The gravel will be applied 3 inches thick for a 30 foot width to the following streets: Sixth Street from Spring Avenue to Rochester Avenue; Seventh Street from Spring Avenue to Rochester Avenue; Rochester Avenue from Sixth Street to Eighth Street; Saratoga Avenue from First Street to Fifth Street and Sixth Street to Eighth Street; Main Avenue from First Street to Fifth Street and Sixth Street to Eighth Street; and Bridge Avenue from First Street to Eighth Street.

The off systems street project will allow deferral of work in Area 2B by two to three years on streets concerned. This will have the advantage of providing more time for utilities to be constructed prior to the recommended street construction.

We would recommend the following construction: The first choice would be stage 1 full-depth pavement which would include plant mix base with a plant mix wearing course and concrete curb and gutters on all streets to the full designed width. THis has been previously shown as Alternate 2. Costs may be found in the section under costs. Assessments with and without various grant possibilities may be seen on Table 3, Page 24 . Second choice would be stage 1 full-depth pavement using plant mix base, plant mix wearing course for the full width of the streets with concrete curb and gutter on arterials and collector streets, substituting an asphalt curb on local streets. Again assessments may be seen on TAble 3. Third choice and one we would recommend as a last resort if it is the only way to achieve paved streets, would be stage 1 full-depth pavement for the travelled way only. This would involve plant-mix base and plant-mix wearing course for the width of the travelled way, 24 feet for local streets, 32 feet for arterials and collectors. There would be no curb and gutter and we would recommend that the option of protecting the ditches with a double penetration seal be exercised. The option with the penetration seal is shown as Alternate 5A. Assessments for this choice are shown on TAble 3.

During design of the chosen alternate, we would recommend investigating the use of soil treatment as a means of reducing costs by substituting soil treatment for more expensive materials. We do not recommend using any of the schedules including soil treatment as a cost basis for improvement district budgeting without a full design analysis. Schedules showing soil treatment are included only to illustrate the potential cost savings if soil treatment will indeed serve the purpose in Saratoga.

We would further recommend that the Town of Saratoga pursue the subject of a change of point of diversion of the Hugus Mullison Ditch with Pacific Power & Light and the Saratoga Land and Cattle Company. We would recommend that the Town try to get a grant to defray all or part of the cost of making the change in the point of diversion if an agreement can be reached.

TABLE 4

Total Project: $6,482,184
Grant Portion: $1,279,766
Amount to Finance: $5,202,418 (3)

Terms: 10 years
Interest Rate: 5%
Bond Purchaser: Farmers Home Administration

| | Area 1 | | Area 2 | | Area 2B | | Area 3 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Amount Financed | $1,315,086 | | $642,916 | | $2,009,000 | | $1,235,416 | | $5,202,418 | |
| Assessable Footage | 3,066,840 S.F. | | 1,401,402 S.F. | | 4,292,650 S.F. | | 2,363,200 S.F. | | 11,124,092 S.F. | |
| Percentage of Total Cost | 25.28% | | 12.36% | | 38.61% | | 23.75% | | 100.00% | |
| Yearly Town Payment | $11,376.00 | | $5,562.00 | | $17,374.50 | | $10,687.50 | | $45,000.00 | |
| Average Lot Size | 9,600 S.F. | | 7,200 S.F. | | 7,200 S.F. | | 9,600 S.F. | | 8,200 S.F. | |
| | Annual Payments | | | | | | | | | |
| Year | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| 1 | 489.25 | 581.87 | 392.57 | 466.89 | 400.49 | 476.31 | 596.46 | 709.38 | 455.78 | 542.06 |
| 2 | 489.25 | 561.29 | 392.57 | 450.38 | 400.49 | 459.46 | 596.46 | 684.28 | 455.78 | 522.89 |
| 3 | 489.25 | 540.71 | 392.57 | 433.86 | 400.49 | 442.61 | 596.46 | 659.19 | 455.78 | 503.72 |
| 4 | 489.25 | 520.13 | 392.57 | 417.34 | 400.49 | 425.76 | 596.46 | 634.10 | 455.78 | 484.54 |
| 5 | 489.25 | 499.54 | 392.57 | 400.83 | 400.49 | 408.91 | 596.46 | 609.00 | 455.78 | 465.37 |
| 6 | 478.96 | 478.96 | 384.31 | 384.31 | 392.07 | 392.07 | 583.91 | 583.91 | 446.19 | 446.19 |
| 7 | 458.38 | 458.38 | 367.80 | 367.80 | 375.22 | 375.22 | 558.82 | 558.82 | 427.02 | 427.02 |
| 8 | 437.79 | 437.79 | 351.28 | 351.28 | 358.37 | 358.37 | 533.72 | 533.72 | 407.84 | 407.84 |
| 9 | 417.21 | 417.21 | 334.77 | 334.77 | 341.52 | 341.52 | 508.63 | 508.63 | 388.67 | 388.67 |
| 10 | 396.63 | 396.63 | 318.25 | 318.25 | 324.67 | 324.67 | 483.54 | 483.54 | 369.49 | 369.49 |

(1) With grant for yearly interest exceeding average interest

(2) Without grant for "excess" interest

(3) Includes Drainage and Arterial Street Costs

TABLE 4

Total Project: $6,482,184
Grant Portion: $2,980.089
Amount to Finance: $3,502,095 (3)

Terms: 10 years
Interest Rate: 5%
Bond Purchaser: Farmers Home Administration

| | Area 1 | | Area 2 | | Area 2B | | Area 3 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Amount Financed | $904,038 | | $357,201 | | $1,244,023 | | $996,733 | | $3,502,095 | |
| Assessable Footage | 3,066,840 S.F. | | 1,401,402 S.F. | | 4,292,640 S.F. | | 2,363,200 S.F. | | 11,124,092 S.F. | |
| Percentage of Total Cost | 25.81% | | 10.20% | | 35.53% | | 28.46% | | 100.00% | |
| Yearly Town Payment | $11,614.50 | | $4590.00 | | $15,988.50 | | $12,807.00 | | $45,000.00 | |
| Average Lot Size | 9600 S.F. | | 7200 S.F. | | 7200 S.F. | | 9600 S.F. | | 8200 S.F. | |
| | Annual Payments | | | | | | | | | |
| Year | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| 1 | 324.46 | 388.12 | 210.41 | 251.70 | 239.25 | 286.20 | 464.23 | 555.33 | 295.98 | 354.06 |
| 2 | 324.46 | 373.98 | 210.41 | 242.52 | 239.25 | 275.76 | 464.23 | 535.08 | 295.98 | 341.15 |
| 3 | 324.46 | 359.83 | 310.41 | 233.35 | 239.25 | 265.33 | 464.23 | 514.84 | 295.98 | 328.24 |
| 4 | 324.46 | 345.68 | 210.41 | 224.17 | 239.25 | 254.89 | 464.23 | 494.59 | 295.98 | 315.34 |
| 5 | 324.46 | 331.53 | 210.41 | 214.99 | 239.25 | 244.46 | 464.23 | 474.35 | 295.98 | 302.43 |
| 6 | 317.38 | 317.38 | 205.82 | 205.82 | 234.03 | 234.03 | 454.10 | 454.10 | 289.52 | 289.52 |
| 7 | 303.23 | 303.23 | 196.64 | 196.64 | 223.59 | 223.59 | 433.86 | 433.86 | 276.61 | 276.61 |
| 8 | 289.08 | 289.08 | 187.47 | 187.47 | 213.16 | 213.16 | 413.61 | 413.61 | 263.70 | 263.70 |
| 9 | 274.93 | 274.93 | 178.29 | 178.29 | 202.73 | 202.73 | 393.37 | 393.37 | 250.80 | 250.80 |
| 10 | 260.78 | 260.78 | 169.11 | 169.11 | 192.29 | 192.29 | 373.12 | 373.12 | 237.89 | 237.89 |

(1) With grant for yearly interest exceeding average interest

(2) Without grant for "excess" interest

(3) Includes Drainage and Arterial and Collector Street Costs

APPENDIX A

RAINFALL AT SARATOGA, WYOMING

FREQUENCY - PRECIPITATION / DURATION DEPTH TABULATION

Depth - Inches

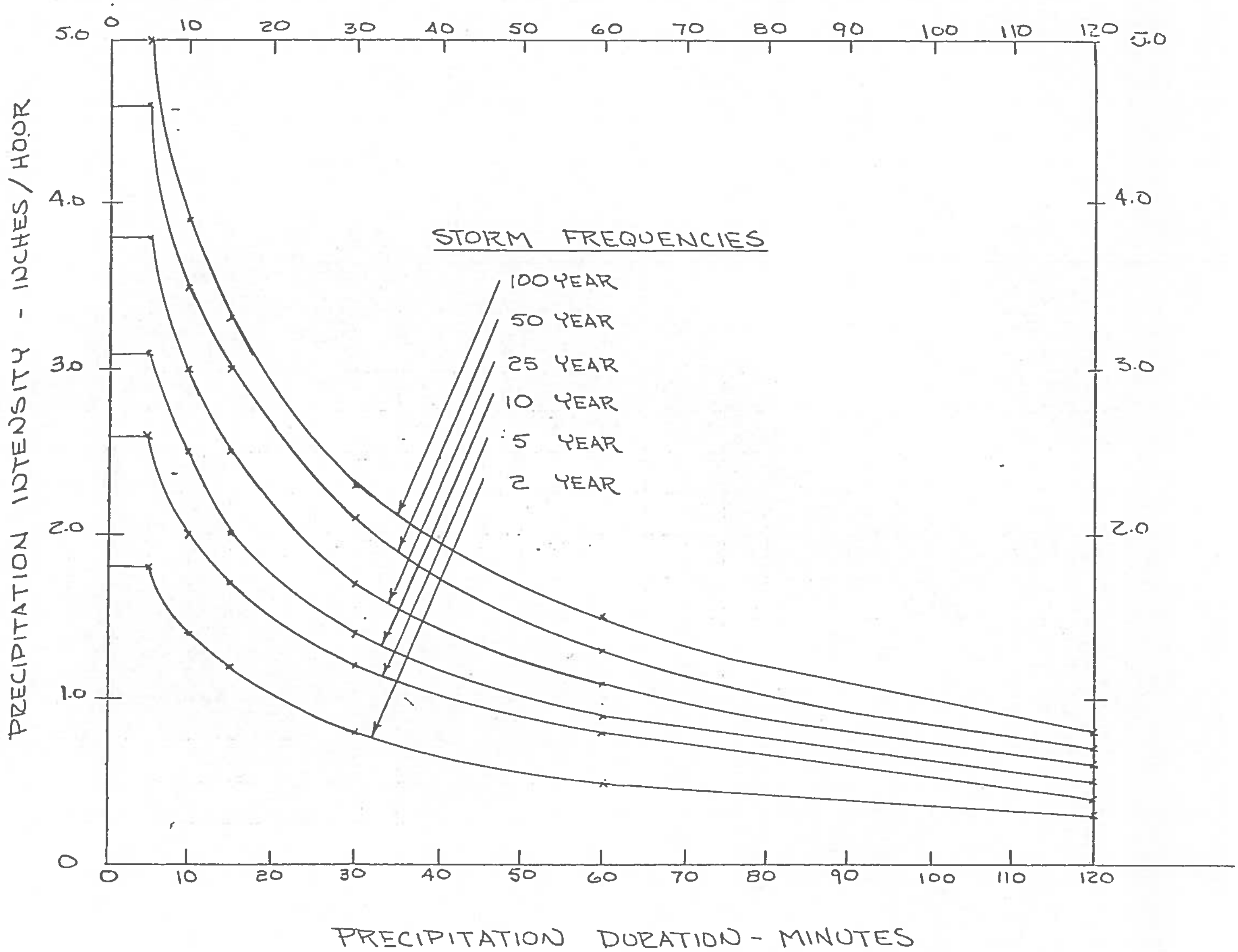
| | 5 min. | 10 min. | 15 min. | 30 min. | 1 hr. | 2 hr. | 3 hr. | 6 hr. | 12 hr. | 24 hr. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 yr | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 |
| 5 yr. | 0.2 | 0.3 | 0.4 | 0.6 | 0.8 | 0.8 | 0.8 | 1.0 | 1.1 | 1.3 |
| 10 yr. | 0.3 | 0.4 | 0.5 | 0.7 | 0.9 | 1.0 | 1.0 | 1.2 | 1.4 | 1.6 |
| 25 yr | 0.3 | 0.5 | 0.6 | 0.9 | 1.1 | 1.2 | 1.2 | 1.4 | 1.7 | 1.9 |
| 50 yr. | 0.4 | 0.6 | 0.7 | 1.0 | 1.3 | 1.4 | 1.4 | 1.6 | 1.9 | 2.2 |
| 100 yr | 0.4 | 0.7 | 0.8 | 1.2 | 1.5 | 1.5 | 1.6 | 1.8 | 2.2 | 2.5 |

FREQUENCY - PRECIPITATION / DURATION INTENSITY TABULATION

INTENSITY - INCHES / HR.

| | 5 min. | 10 min. | 15 min. | 30 min. | 1 hr. | 2 hr. | 3 hr. | 6 hr. | 12 hr. | 24 hr. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 yr. | 1.8 | 1.4 | 1.2 | 0.8 | 0.5 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 |
| 5 yr | 2.6 | 2.0 | 1.7 | 1.2 | 0.8 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 |
| 10 yr | 3.1 | 2.5 | 2.0 | 1.4 | 0.9 | 0.5 | 0.3 | 0.2 | 0.1 | 0.1 |
| 25 yr | 3.8 | 3.0 | 2.5 | 1.7 | 1.1 | 0.6 | 0.4 | 0.2 | 0.1 | 0.1 |
| 50 yr. | 4.6 | 3.5 | 3.0 | 2.1 | 1.3 | 0.7 | 0.5 | 0.3 | 0.2 | 0.1 |
| 100 yr | 5.0 | 3.9 | 3.3 | 2.3 | 1.5 | 0.8 | 0.5 | 0.3 | 0.2 | 0.1 |

RAINFALL AT SARATOGA, WYOMING




STORM INTENSITY - DURATION

APPENDIX B

chen and associates, inc.
CONSULTING ENGINEERS

SOIL & FOUNDATION ENGINEERING

900 EAST F STREET • CASPER, WYOMING 82601 • 307/234-2126
96 S. ZUNI • DENVER, COLORADO 80223 • 303/744-7105

# GEOTECHNICAL INVESTIGATION FOR THE STREET IMPROVEMENT PROJECT FOR THE TOWN OF SARATOGA, WYOMING

Prepared For:

ROBERT JACK SMITH & ASSOCIATES
1015 HARSHMAN STREET
RAWLINS, WYOMING 82301

Job No. 5615W

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## CONCLUSIONS

(1) Pavement designs for the street system for the Town of Saratoga have been prepared using the the recommended street plan as presented in the "Saratoga Major Street Plan" prepared by BRW/Noblitt and the ASSHTO Design of Pavement Structures in conjuction with the Wyoming Thickness Design for Flexible Pavement.

(2) The street system pavement should be a flexible pavement structure consisting of either a full depth asphalt section placed on a prepared subgrade or an asphalt and granular base course section placed on a prepared subgrade. Depths of the pavement structures will depend on the street type and soils exposed at subgrade elevation.

(3) Recommendations for stage construction are presented.

(4) Other design and construction details are discussed in the body of the report.

SCOPE

This report presents the results of a geotechnical investigation for the street improvement project for the Town of Saratoga, Wyoming. The report presents the soil, bedrock, and groundwater conditions throughout the street system. Recommended pavement sections are given for the streets. Type of concrete for curb and gutters is also discussed.

PROPOSED CONSTRUCTION

It is proposed to pave the street system in the Town of Saratoga. At the present time, the majority of the streets are unimproved or covered with a gravel surfacing. Pavement structures for the streets have been prepared using the Recommended Plan as presented in the "Saratoga Major Street Plan" prepared by BRW/Noblitt. Other pertinent information provided in the report such as traffic volume data has also been utilized. Pavement structures have been designed using the ASSHTO Guide for Design of Pavement Structures in conjuction with the Wyoming Thickness Design for Flexible Pavements and using a 20 year design period.

FIELD INVESTIGATION

A total of 71 exploratory holes were drilled throughout the street system. Drilling was started on July 18 and completed on July 20, 1978. The locations of the exploratory holes are presented in Fig. 1. The exploratory holes were drilled with a CME-55 truck mounted drill rig using 4-inch diameter continuous flight power auger. Undisturbed soil samples were obtained using a California sampler. Disturbed soil samples were obtained using a 2-inch O.D. split spoon sampler and from auger cuttings. Observations of free water were made at the time the test holes were drilled. The soils for the full depth of the exploratory holes were classified in the field by a field engineer. Representative samples of the typical soils encountered were returned to the laboratory for testing.

Five groundwater observation holes were drilled at the locations shown in Fig. 1. Slotted PVC pipe was installed in these holes to allow monitoring the water table.

Also a fact-finding investigation was conducted consisting of talking with the street department for the Town of Saratoga and local residents. Information gathered from this investigation consisted of identifying an old stream channel which meandered through the downtown section of the city and identifying localized soft spots which occured in the street system during the spring of 1977. This information is presented in Fig. 2.

LABORATORY TESTING

The natural moisture content, natural dry density, liquid limit, plasticity index, and gradation were determined for representative samples of the typical soils and bedrock encountered in the field investigation. The materials were classified in accordance with the Highway Research Board Classification System and the Unified Soil Classification System. These test results are presented in Figs. 13 through 45 and summarized in Table I. Consolidation characteristics for typical samples of the soils encountered are presented in Figs. 8 through 12. The water soluble sulfate content was determined for representative samples; these results are presented in Figs. 3 through 6 and summarized in Table I.

Six samples typical of the materials in the street system subgrade were selected for additional testing. The moisture-density relationship for these six representative samples was determined in accordance with ASTM D698-70. The test results are presented in Figs. 46 through 51. The California Bearing Ratio was determined for remolded specimens of the typical samples. The materials were remolded at their optimum moisture content and compacted in the test cylinder to approximately 95% standard Proctor density. The specimens were tested after soaking for 96 hours. The load-penetration curves for the CBR tests are presented in Figs. 52 through 57 and summarized in Table II. Three of these six samples were also tested for the Hveem Stabilometer test. Test results for this test are presented in Figs. 58 through 60 and summarized in Table IV. All laboratory testing was done in accordance with ASTM and ASSHTO test procedures.

SUBSOIL CONDITIONS

Subsoil conditions throughout the street system were highly erratic. In general, subsoils ranged from a medium stiff to stiff clay fill containing numerous claystone fragments and gravel; loose to medium dense, silty to very silty sand and gravel fill; soft to stiff, sandy to very sandy clay; soft to very stiff, sandy to very sandy silt which occasionally grades into a very sandy clay-silt; a medium stiff to stiff, sandy to very sandy clay-silt containing numerous sandy clay or sandy silt layers; a medium dense, clean to slightly silty sand; a loose to medium dense, clayey to very clayey sand occasionally intergrading into a very sandy clay; a loose to medium dense, silty to very silty sand which occasionally intergrades into a very sandy silt; medium dense silty sand to sandy silt; very loose to medium dense, slightly organic to highly organic silty sand to sandy silt; a loose to very dense, slightly silty to silty sand and gravel containing numerous cobble; hard to very hard sandstone bedrock; and a hard to very hard claystone bedrock with occasional thin interbedded siltstone or sandstone layers.

In general, the area investigated can be divided into three areas having somewhat similar soil conditions for the proposed roadway system. Area I consisted of that area west of the Hugus Irrigation Ditch located between Farm Avenue and Elm Street. In general, these soils consisted of the finer-grained clays, silts, clay-silts with occasional deposits of surface fill, coarser-grained sands and coarse-grained sand and gravels. For design purposes, the soils in Area I were considered to be the finer-grained clays, silts, or clay-silts and in general classify as A-4 soils under the Highway Research Board Classification System. These soils have a moderate strength as indicated by the CBR value of 6 and the respective R value of 35. Water soluble sulfate contents of the soil in this area are less than 0.01 percent.

Area II consisted of the area located east and north of the Hugus Irrigation Ditch and included the area east of the North Platte River and north of Bridge Avenue. In general, the subsoils in this area consisted of two types of soil; slightly silty to silty sand and gravel soils or slightly organic to highly organic sandy silt to silty sand. Isolated areas of the finer-grained clays, silts, clay-silts, and clayey to silty sands were encountered. As indicated on Fig. 2, an old river channel meandered through this portion of the town. Also, the street system has experienced localized soft spots as indicated on Fig. 2. We believe the slightly to highly organic silty sand to sandy silt deposits are associated with the old river channel or channels and the localized soft spots related to the finer-grained soils and/or old river channel deposits. In general, the finer grained soils classified under the Highway Research Board Classification System as A-4 to A-7-6 soils depending on the amount of -#200 material and organic content. These soils, when tested by the Hveem Stabilometer Test, indicate a moderate strength. However, when subjected to saturation conditions as indicated by the CBR test results, these soils loose their strength and possess a very low strength. The slightly silty to silty sand and gravel soils classify under the Highway Research Board Classification System as A-1-a soils with occasional deposits of A-1-b to A-2-4 soils. These soils classify as excellent subgrade soils and have a high strength as indicated by the CBR and Hveem stabilometer test results. As indicated by the location of soft spots and the old river channel on Fig. 2, it is possible that many more such areas exist in Area II and additional old river channels or localized soft spots may be encountered throughout the street system in this area during construction. Water soluble sulfate contents of the soils in this area are less than 0.01 percent.

Area III consisted of the area located south and west of the Hugus Irrigation Ditch between Cypress Avenue and Myrtle Avenue, east of Highway 130/230. In general, subsoils in this area consisted of the finer-grained silts to silty sands or the coarse silty sand and gravel soils. In general, the silts classify as A-4 to A-7-6 under the Highway Research Board Classification System and are similar in strength characteristics to the clay soils encountered in Area I. The sand and gravel is similar to that encountered in Area II and possess a high strength value. With the exception of Test Hole 69, the water soluble sulfate content of the soils was found to be less than 0.01 percent. In the area of Test Hole 69, the water soluble sulfate content was determined to be 1.95 percent.

Free water was encountered in many of the test holes. In general, the majority of the test holes in which water was encountered are located immediately adjacent to the Hugus Irrigation Ditch, the Platte River, or in the more granular soils located in the downtown area. In general, the groundwater table when encountered varied from approximately 1 foot to 7 feet below the existing ground surface. We would expect the free water level to fluctuate with the flow of the water in the Hugus Irrigation Ditch or North Platte River.

RECOMMENDATIONS FOR ROAD CONSTRUCTION

The required pavement thickness for any section along the street will depend on the soils exposed in the subgrade and the type of street proposed for that area. A convenient method of pavement design would be to use a constant thickness of bituminous pavement and recompacted subgrade soils throughout the proposed street system for both the minor arterial streets, collector streets, and local streets. However, this would result in some very conservative or undesigned sections throughout the street system. The pavement sections, therefore, have been designed using the ASSHTO Guide for Design of Pavement Structures in conjunction with the Wyoming Thickness Design for Flexible Pavement based on street type and soil type anticipated to be encountered at subgrade elevation. The present elevation of most of the street systems is such that over-excavating the existing subgrade soils will be required to allow construction of a pavement section. Pavement sections have been prepared for the different street types and soil types for each of the three areas described under the subsoil conditions. Pavement sections have been prepared for full depth asphalt section placed on a prepared subgrade and for a layered asphalt structure consisting of asphalt and untreated base course placed on a prepared subgrade. For all of the proposed streets, the base course should consist of a granular base course meeting the requirements of Section 304 of the Specifications for Road and Bridge Construction of the Wyoming Highway Department and be compacted to 100% standard Proctor density. The asphalt should meet the requirements of Section 403 of the same specifications. The subgrade for all streets should consist of 12 inches of the existing soil recompacted to at least 95% standard Proctor density at optimum moisture content. The recommended pavement sections have been summarized in Table IV and are as follows:

Area I: The majority of the soils which will be exposed at subgrade elevation will consist of the finer-grained clay soils. Pavement sections have been prepared assuming this soil will be encountered throughout Area I. For the minor arterial streets, the pavement section should consist of 2 inches of plant mix pavement and 6½ inches of plant mix base placed on a prepared subgrade or 2 inches of plant mix pavement, 4 inches of plant mix base, and 8 inches of base course placed on a prepared subgrade. The collector streets should consist of 2 inches of plant mix pavement and 4 inches of plant mix base placed on a prepared subgrade or 3 inches of plant mix pavement and 8 inches of base course placed on a prepared subgrade. For the local streets, the pavement section should consist of 1½ inches of plant mix pavement and 4 inches of plant mix base placed on a prepared subgrade or 2 inches of plant mix pavement and 5 inches of base course placed on a prepared subgrade.

Area II: The soils encountered in Area II will consist predominately of the A-1-a silty sand and gravel soils or the slightly to highly organic silty sand to sandy silt soils. The silty sand and gravel soils classify as an excellent subgrade soil. As mentioned above, the slightly to highly organic sandy silt to silty sand soils lose most of their strength once saturated. Due to the present elevation of the existing street system, it will be necessary to over-excavate the streets to allow placement of a pavement structure. Once the street systems have been over-excavated we believe an inspection should be made of the subgrade soils to identify those areas where the poor subgrade soils, the slightly organic to highly organic silty sands to sandy silts are encountered. Because these soils lose their strength upon being saturated, we recommend that instead of scarifying and recompacting the subgrade soils for a depth of 12 inches, these materials be removed for a depth of 12 inches and a Mirafi 140 or Mirafi 500X fabric be installed on the existing soils and backfilled with an aggregate meeting the gradation requirements as outlined under the specifications presented in the Brochure PM-6 Constructing Roads with Mirafi 140 Fabric as presented by the Calanese Marketing Company. We recommend the Mirafi 500X fabric be used in lieu of the Mirafi 140 fabric as the Mirafi 500X fabric is especially made for stabilization purposes. By use of this fabric, we believe the long term effect would be to provide a more stable subgrade for the pavement structure and reduce potential pavement failures. As indicated on Fig. 2, numerous soft spots do exist in the existing street system. By use of the Mirafi fabric, we feel an economical method can be achieved to insure a stablized subgrade for the pavement structure. The only alternative to insure a stabilized roadway surface is to over-excavate the poor subgrade soils in their entirety and replace them with a more suitable granular soil. Pavement structures placed on the A-1-a silty sand and gravel soils will vary from a minimum section, as required by standards, of 1½ inches of plant mix pavement and 4 inches of plant mix base to a maximum of 2 inches of plant mix pavement and 4 inches of plant mix base placed on a prepared subgrade for a full depth asphalt structure or from 2 to 3 inches of plant mix pavement and 4 to 5 inches of base course placed on a prepared subgrade. For pavement sections placed on the slightly organic to highly organic silty sand to sandy silt soils the pavement structure will vary from 3 inches of plant mix pavement and 8 inches of plant mix base to a minimum pavement section of 2 inches of plant mix pavement and 4 inches of plant mix base for a full depth asphalt structure or from 2 inches of plant mix pavement, 6 inches of plant mix base and 9 inches of base course to a minimum section of 2 inches of plant mix pavement and 8 inches of base course if placed directly on the prepared subgrade soils. If the slightly to highly organic silty sand and sandy silt soils are over-excavated for a depth of 1 foot and replaced using the Mirafi fabric and gravel backfill, the pavement structure may consist of 2 inches of plant mix pavement and 6 inches of plant mix base for minor arterial streets and 2 inches of plant mix pavement and 4 inches of plant mix base for both collector and local streets.

Area III: In general, the subsoils which will be encountered in this area will consist predominately of the silty sand and gravel soils or the silt soils. For a full depth asphalt section, the pavement section should consist of the minimum pavement section of 1½ inches of plant mix pavement and 4 inches of plant mix base to a maximum of 2 inches of plant mix pavement and 4 inches of plant mix base placed on a prepared subgrade or from 2 inches of plant mix pavement and 8 inches of base course to a minimum of 2 inches of plant mix pavement and 4 inches of base course placed on a prepared subgrade.

## STAGE CONSTRUCTION

It may be desirable to construct a pavement for an estimated design period of only a few years anticipating that the second stage can be more adequately designed as traffic patterns become established. This approach to stage construction design can be valuable for city streets where future traffic patterns may vary considerably from that predicted. If stage construction is to be employed for the subject project, stage construction may be employed if the full depth asphalt section is used by omitting the plant mix pavement from those pavement structures listed above. This will require placing the plant mix base for all the pavement sections and possibly chipping and sealing. Once the future traffic patterns have been evaluated, the pavement structure can be completed by addition of the plant mix pavement section. Stage construction will also provide the advantage of allowing the street system to be used for an initial period time to evaluate the subgrade soils and to determine any soft spots which might develop within the initial design period of the pavement structure. The local soft spots could then be identified more readily and remedial measures made.

## CURB AND GUTTER CONCRETE

The water soluble sulfate content of typical samples of the finer grained soils was determined to be 0.01 percent or less with the exception of the area of Test Hole 69. We believe that Type II cement can be used for all curb and gutter concrete.

MISCELLANEOUS

Our exploratory borings were spaced as closely as feasible in order to obtain a comprehensive picture of the subsoil conditions, however, erratic soil conditions may occur between test holes, if such conditions are found in the exposed street system subgrade, it is advisable that we be notified to inspect the exposed street system subgrade.

CHEN AND ASSOCIATES, INC.

BY ______________________
Kenneth E. Temme, P.E.

REVIEWED BY ______________________
Harold Hollingsworth, Jr., P.E.

KET:bec