BORROW RESOURCES STUDY, PHASE I
ST. MARY RIVER DIVERSION AND CONVEYANCE FACILITIES

AUGUST 2008

"Lifeline of the Hi-line"

MDT #860

MDT #353

+4" Reject – Kennedy Creek

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I. TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 3
- 2.1 Background 3
- 2.2 Purpose and Scope 5

3.0 AGGREGATE REQUIREMENTS 6
- 3.1 Introduction 6
- 3.2 Estimated Quantities 6
- 3.3 Aggregate Suitability 8
  - 3.3.1 Acceptance Testing 8
  - 3.3.2 Structural Fill 10
  - 3.3.3 Canal Armor 11
  - 3.3.4 Riprap 11
  - 3.3.5 Road Surfacing and Subbase 12
  - 3.3.6 Slope Stabilization Buttress 13
  - 3.3.7 Concrete Aggregates 14

4.0 EXISTING AND FORMER GRAVEL PITS 16
- 4.1 Background 16
- 4.2 Lower St. Mary Lake Area 20
- 4.3 Swiftcurrent Creek Alluvial Fan 25
- 4.4 St. Mary River Alluvium 30
- 4.5 Kennedy Creek Alluvial Fan 32
- 4.6 Duck Lake Drift/Outwash 40

5.0 POTENTIAL AGGREGATE SOURCES 49
- 5.1 Regional Geology 49
- 5.2 St. Mary River Valley 53
- 5.3 Duck Lake/Squaw Flat Drift 53
- 5.3 Remnant Terrace Gravels 54

6.0 SUMMARY 55
- 6.1 Project Needs 55
- 6.2 Available and Potential Resources 55
- 6.3 Recommendations 57

7.0 REFERENCES 60

II. LIST OF FIGURES

Figure No.	Description	Page
1	Map of the St. Mary Diversion Facilities	4
2	Lower St. Mary Lake Gravel Pits	18
3	Gravel Pits Near the St. Mary Canal	19
4	Swiftcurrent and Kennedy Alluvial Fans	26
5	Borrow Resource - Phase I Kennedy Creek Alluvial Fan	33
6	Geologic map of the area comprising the St. Mary River Diversion and Conveyance Facilities	51
7	Potential Gravel Deposits	52
8	Schematic Aggregate Needs vs. Sources Diagram	58

III. LIST OF TABLES

Table No.	Description	Page
1	Summary of Estimated Aggregate Quantities for New Diversion and Conveyance Structures, 850 CFS and (1,000 CFS)	7
2	Maximum Permissible Limits of Impurities	9
3	Preliminary Gradation for Granular, Structural Fill	10
4	Preliminary Gradation for Canal Armoring	11
5	Different Classes of Random Riprap	12
6	Preliminary Gradations for Surface Course and Subbase	13
7	Preliminary Gradation for Slope Stabilization Buttress	13
8	Preliminary Gradation for Concrete Sand (Fine Aggregate)	14
9	MDT-Estimated Gravel Volumes	53
10	Summary of Gravel Pits within General Vicinity of St. Mary Diversion Project	56

IV. LIST OF PHOTOGRAPHS

Photo No.	Description	Page
1	Looking northeast from Park Entrance Road at former gravel pit MDT #837	21
2	Looking southwest from Lower Lake access road at former gravel pit MDT #837	21
3	Looking south from Hwy 89 at former gravel pit MDT #850	22
4	Looking north across former gravel pit MDT #351	23
5	Looking northeast across former gravel pit MDT #848	24
6	Looking southeast at gravel pit MDT #849	28
7	Looking northwest towards Babb and undeveloped gravel pit MDT #1016	29
8	Looking north towards MDT #1016	29
9	Looking northeast across existing gravel pit MDT #826	34

10 Looking south from Chief Mountain Road at former gravel pit MDT #836 35
11 Photos shows exposed face of pit wall from MDT #860 36
12 Photos shows pile of plus 4-inch reject at MDT #860 37
13 Looking east across MDT #995 38
14 Looking east across MDT #998 39
15 Looking southwest at general area that includes undeveloped Pit MDT #55 41
16 Looking southwest from North Fork Road to active gravel pit MDT #353 42
17 Looking at stock-piles of aggregate at MDT #353 43
18 Looking southwest across existing, inactive, unreclaimed gravel pit MDT #955 44
19 Looking east at existing gravel pit MDT #956 45
20 Looking west at existing MDT #965 gravel pit from Whiskey Gap Road 46
21 Photo showing non-MDT registered, unreclaimed grave pit (#B) shown on USGS Topo Map along Whiskey Gap Road 46
22 Looking at non-MDT registered, unreclaimed gravel pit (#C) located along Whiskey Gap Road 47
23 Photos shows a partially reclaimed, formal gravel pit (#D) situated at the top of a hill over-looking Drops No. 4 and No. 5 47
24 Looking north at an existing gravel source (#E) referenced on the USGS Topo map 48
25 Close-up of pit #E 48

APPENDIX

- MDT Pit #55 (9 Pages)
- MTD Pit #995 (7 Pages)
- MDT Pit #998 (8 Pages)
- MDT Pit #1016 (9 Pages)

BORROW RESOURCES STUDY, PHASE I
ST. MARY RIVER DIVERSION AND CONVEYANCE FACILITIES

1.0 EXECUTIVE SUMMARY

Eventual rehabilitation of the St. Mary River Diversion and Conveyance Facilities will most likely include realignment or reconstruction of nearly 26 miles of earthen canal as well as several major structures These larger structures include a diversion dam and canal headgates with fish passage and fish screens; three large siphon crossings and hydraulic drops with energy dissipation. Many other hydraulic structures are required along the entire canal prism.

This large-scale, heavy-civil construction project will be completed in phases spanning up to ten years or more. The overall rehabilitation project will require significant quantities of aggregates for numerous applications including miscellaneous gravel fill, riprap, bank and slope stabilization, canal armor, road bases, pipe bedding, drainage medium and potentially for concrete aggregates. Based on previous estimates by TD&H Engineering (TD&H, 2006), nearly 500,000 cubic yards of granular aggregate materials will ultimately be required to complete the project.

Due to the overall length of the project, its remoteness and limited access, identifying potential aggregate sources along the proposed project is crucial to planning staged construction and related efforts to control construction costs. This study summarized available information from former, existing and potential gravel pits within a 200-square mile area encompassing the Project.

As a result of local geological processes, existing and potential aggregate sources are readily available from the Diversion Dam at the beginning of the project to the St. Mary River Siphon. This stretch is approximately 9 miles or one-third of the overall project (29 miles). A preliminary review of the background data indicates that sufficient quantity and quality exists in this area for the entire project. Unfortunately, haul distances progressively increase up to 20 miles away from this source towards the end of the project. Currently, travel access is a winding, single-lane road along the canal which should be avoided in the winter.

Downstream along the canal from the St. Mary River Siphon, gravel occurrences and potential sources are sporadic and discontinuous. The absence of gravel deposits may be related to peri-glacial activities. However, based on our interpretation of local landforms, road cut exposures and distribution of scattered gravel pits east of the St. Mary, we believe there is potential for additional aggregate sources south of the Hudson Bay Divide.

An evaluation of the Project aggregate needs and potential sources with respect to distribution along the 30-mile project is warranted and is the focus of this initial study. Abundant sources of sufficient quantity and quality potentially exist for the first half of the Project. An additional source near the St. Mary River Siphon would reduce haul distances and may reduce costs. Also, there is a need to locate potential gravel sources along the downstream half of the project. Two areas, Squaw Flat and Hungry Horse Flat, may provide the necessary aggregate and should be further investigated during a Phase II Study. The subsequent study should also further investigate existing gravel resources identified in the St. Mary River Valley.

A Phase II study is recommended that would include field investigations of potential or proposed borrow sources. Representative samples should be collected and submitted for laboratory testing. Applicable testing methods and procedures need to be specified in concert with the Montana Department of Natural Resources and Conservation (DNRC) and U.S. Bureau of Reclamation. A follow-up scope should also include preliminary dialogue with landowners and topographical surveys to delineate potential borrow sources.

2.0 INTRODUCTION

2.1 BACKGROUND

Ultimate rehabilitation of the St. Mary River Diversion and Conveyance Facilities will likely include realignment or reconstruction of nearly 26 miles of earthen canal as well as replacement of several major hydraulic structures. The overall project, approximately 29 miles in length, and the significant components are shown on Figure 1. The future major structures will include a new diversion dam facility on the St. Mary River incorporating a fish passage, canal headgates and fish screens. Also, replacement of three large diameter siphon structures is warranted in order to cross active streams and topographical low areas. Five hydraulic drops will either be replaced with in-kind structures or fewer, but larger, combined drop structures.

Along the canal realignment, numerous hydraulic structures including bridges, wildlife crossings, checks and wasteways, underdrains, turnouts and inlet structures are required. The new canal prism itself most likely will include an all-weather service road, canal armoring, and miscellaneous riprap. In many reaches, landslide stabilization may require use of gravel, gravity buttresses. In one reach, rehabilitation and realignment of the existing canal will necessitate the relocation of an existing Glacier County gravel road.

Overall rehabilitation of the St. Mary River Diversion and Conveyance Facilities will consist of heavy civil and earthwork construction estimated to range from $120 to $140 million (TD&H, 2006). This construction will require significant quantities of aggregate materials. Such materials include miscellaneous gravel fill, riprap, canal armoring, road base and subbase, pipe bedding, drainage rock and possibly concrete aggregates. Considerable construction time and cost savings may be realized if several suitable aggregate sources could be identified along the 29-mile project.

St. Mary Diversion Facilities

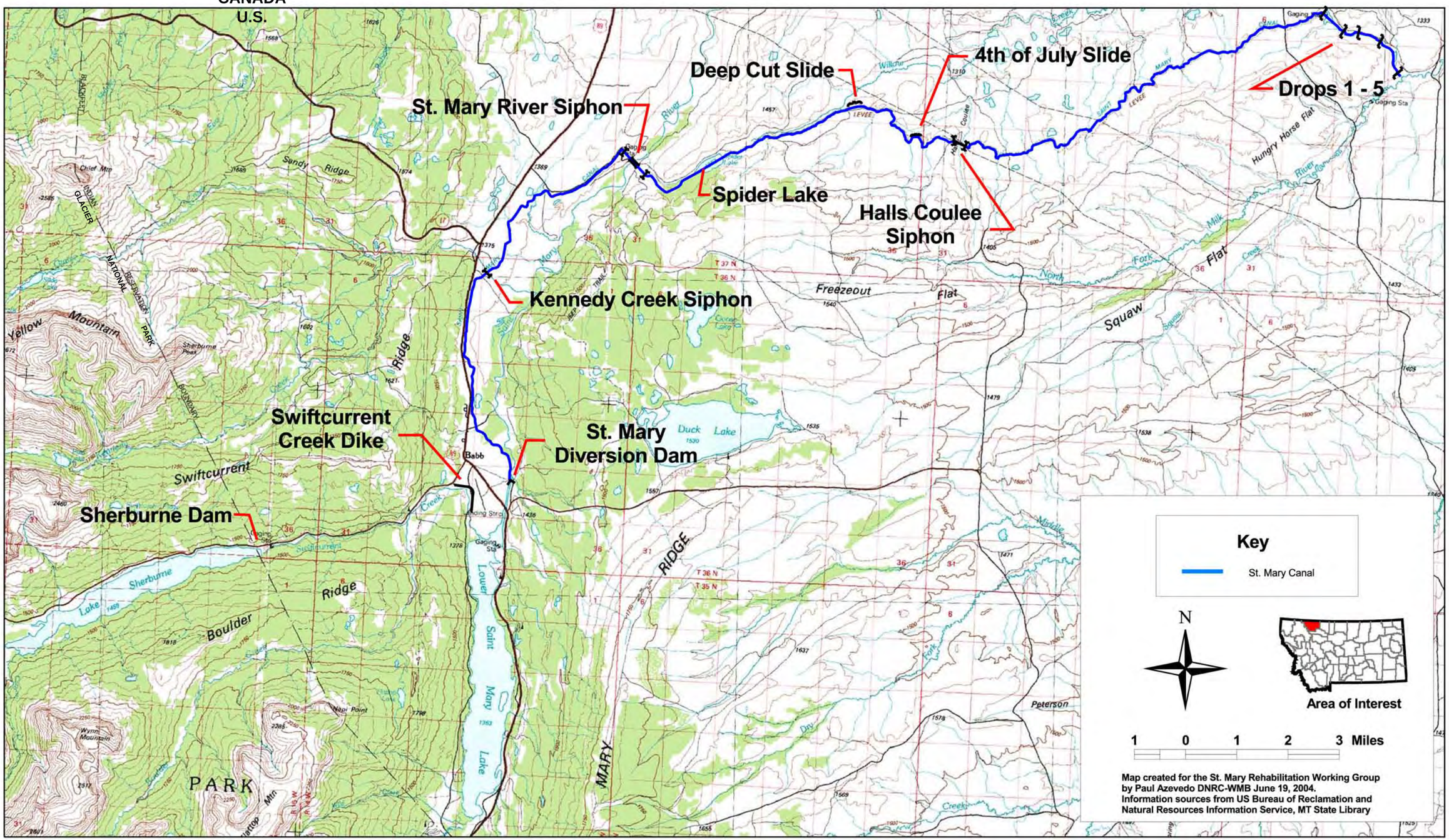


Figure 1

2.2 PURPOSE AND SCOPE

The quantity and use of construction aggregates represents a significant portion of the project rehabilitation costs. Also, even though complete rehabilitation will be most likely completed in several stages, the overall length of the project is approximately 29 miles. Therefore minimizing the haul distance between aggregate sources will help reduce construction costs. It is therefore prudent to research and summarize known gravel pits in the region that may or could provide the related construction materials. Also, identifying new potential aggregate sources based on interpretation of geologic landforms may provide alternatives where existing aggregate sources are scarce or the quality is poor.

The Montana Department of Natural Resources and Conservation (DNRC) initiated this Phase I study to summarize the scope of aggregate needs for Project rehabilitation and to provide possible recommendations to satisfying these needs. The scope of work for this study included the following:

- reviewing and summarizing the estimated quantity of various aggregate materials required for rehabilitation of the St. Mary River Diversion Facilities.
- providing discussion of aggregate quality required for the various aggregate products.
- researching and summarizing various County, State, Federal, Tribal local data bases regarding known gravel pit resources likely to serve as a potential source.
- developing a likely resource extraction plan and mass-balance diagram.
- reviewing available geologic information in order to identify other possible areas along the Project that could supply granular aggregate.
- providing recommendations for follow-up investigations, studies and aggregate suitability testing during a Phase II Study.

3.0 AGGREGATE REQUIREMENTS

3.1 INTRODUCTION

Identifying likely sources of aggregate materials must include considerations for quantity, quality and pit source economics. These economics include any ownership royalties, pit development costs, pit reclamation costs, and haul distances. Access and proximity to electricity and water are also considerations to developing an aggregate borrow source to be used for producing concrete aggregates.

3.2 ESTIMATED QUANTITIES

Construction quantities were estimated for various rehabilitation scenarios in TD&H's *Feasibility and Preliminary Engineering Report (*2006). Estimated quantities were provided for different types of replacement structures and rehabilitated capacities of 700, 850 and 1,000 cfs. The quantities of many aggregate materials are independent of the rehabilitated capacity. Examples of these include road surfacing and landslide stabilization buttress materials. Other quantities, such as those for canal armoring, riprap, cast-in-place concrete and miscellaneous structural fill, increase with increasing rehabilitated capacity.

Depending on economics at the time of construction, structural concrete may or may not be batched and produced locally at a developed borrow pit. Redi-mix concrete is readily available in Cardston, Alberta. Approximate travel distances include 28 miles to the diversion dam and 23 miles to the St. Mary River Siphon. In the past, concrete deliveries for repairs to the hydraulic drop structures have been transported across the U.S. - Canadian Border near Emigrant Gap Road upstream of Drop No. 1. This saved tremendous travel time and distance for the redi-mix concrete batched in Cardston. This is not a sanctioned border crossing and it is not known whether this would be permitted by Homeland Security in the future.

The estimated aggregate quantities from the *Feasibility and Preliminary Engineering Report* (TD&H, 2006) are summarized for the St. Mary Project rehabilitated to 850 and 1,000 cfs and are provided below in Table 1.

Table 1 - Summary of Estimated Aggregate Quantities For New Diversion and Conveyance Structures, 850 CFS and (1,000 CFS)

	Component	Structural Concrete	Rip Rap	Canal Armoring	Road Surfacing	Slope Stabilization Buttress	Misc. Structural Fill
1)	New Diversion Dam With Fish Passage, Headgates & Fish Screens	2,100 (2,200)	1,750 (1,750)	0 (0)	0 (0)	0 (0)	1,350 (1,350)
2)	New Kennedy Creek Siphon	225 (225)	400 (400)	0 (0)	0 (0)	0 (0)	1,000 (1,000)
3)	New St. Mary River Siphon(2)	6,800 (7,500)	400 (400)	0 (0)	0 (0)	0 (0)	9,450 (9,450)
4)	New Hall Coulee Siphon(2)	2,900 (3,500)	400 (400)	0 (0)	0 (0)	0 (0)	9,450 (9,450)
5)	Hydraulic Drops & Related Canals	2,700 (2,800)	760 (800)	12,515 (13,050)	8,675 (8,675)	2,200 (2,200)	5,000 (6,000)
6)	Canal Reach No. 1 - Diversion Dam to K.C. Siphon	400(3) (450(3))	140 (160)	37,050 (48,550)	21,050 (21,050)	0 (0)	500(3) (600(3))
7)	Canal Reach No. 2 - Kennedy Creek Siphon to St. Mary River Siphon	400(3) (450(3))	130 (150)	32,385 (33,350)	35,025 (35,025)	0 (0)	1,500(3) (1,600(3))
8)	Canal Reach No. 3 - St. Mary River Siphon to Sta. 715+00	400(3) (450(3))	1,500 (1,550)	30,575 (31,850)	17,400 (17,400)	38,250 (38,250)	1,500(3) (1,600(3))
9)	Canal Reach No. 4 - Sta. 715+00 to Hall Coulee. Siphon	400(3) (450(3))	1,250 (1,300)	27,925 (28,750)	15,875 (15,875)	9,990 (9,990)	1,500(3) (1,600(3))
10)	Canal Reach No. 5 - Hall Coulee Siphon to Sta. 1173+50	400(3) (450(3))	1,000 (1,100)	33,900 (34,900)	19,275 (19,275)	4,560 (4,560)	500(3) (500(3))
11)	Canal Reach No. 6 - Sta. 1173+50 to Drop No. 1	400(3) (450(3))	500 (550)	34,850 (35,850)	19,800 (19,800)	0 (0)	500(3) (500(3))
	Total Cubic Yards - 850	**17,125**	**8,230**	**209,200**	**137,100**	**55,000**	**32,250**
	Total Cubic Yards - 1,000	**18,925**	**8,560**	**226,300**	**137,100**	**55,000**	**33,650**

NOTE:

1) **Values summarized and rounded up from TD&H PER (2006).**
2) **Assumes single cast-in-place (CIP) concrete barrel.**
3) **Estimated for inlets, underdrains, turnouts and related structures.**
4) **Values for 1,000 cfs in parentheses.**

3.3 AGGREGATE SUITABILITY

A potential aggregate source must not only demonstrate economic quantity but also aggregate suitability or quality of aggregate with respect to its intended use. Aggregate quality and the ability of a proposed borrow pit to supply suitable material is established by acceptance testing.

3.3.1 Acceptance Testing

A preliminary testing program is generally performed on the raw source materials to establish aggregate quality and suitability with respect to its ultimate use. This is necessary prior to pit development and full-scale production of individual components. Final acceptance testing is typically specified on the finished product to account for the effects and impacts of the various manufacturing processes, handling and transportation.

Acceptance and aggregate suitability testing is intended to describe the inherent engineering properties and characteristics of the particle. Testing includes describing the original source gradation, plasticity of fines, specific gravity, absorption, and the susceptibility to wear, weathering, and frost action. Typical testing procedures reference the American Society for Testing and Materials (ASTM) methods and are discussed in further detail below. Actual testing procedures to be performed during a Phase II Study should consider U.S. Bureau of Reclamation (USBR) guidelines and procedures.

Impurities - In general, aggregates shall be reasonably free from wood, roots, bark, soft or disintegrated pieces, clay lumps, or other detrimental matter. Specific tests ASTM-C142 (clay lumps and friable particles) and ASTM-C40 (organic impurities) can be performed to determine the percentages by weight of these undesirable constituents. The particle shape and surface texture of aggregates influences the workability of fresh concrete. Concrete comprised of coarse aggregates that are flat, elongate, and angular or have a rough texture generally require more mixing water during the finishing process. This tendency can reduce the water to cement ratio of the final product. Acceptable limits of undesirables are presented in Table 2 below.

Table 2 - Maximum Permissible Limits of Impurities

Undesirable Substance	Concrete Aggregate Maximum Percentage by Weight	
	Fine	Coarse
Clay Lumps & Friable Particles	1%	2%
Coal and Lignite	1%	1%
Flats and Elongates	--	15%

Engineering Index Parameters - These index properties include unit weight, specific gravity, particle-size distribution, plasticity of fines, absorption and alkali-aggregate reactivity. The particle-size or grain-size distribution is the most important property of the source material needed to establish pit viability. Most gravel pit processing activities include screening and crushing that change the source material's gradation. Knowing the initial gradation of the gravel source and the target gradation limits of the finished products is fundamental to programming pit development. Final grading requirements vary considerably from riprap to concrete sand and bedding sand. Specific gravities of the coarse and fine fraction, absorption and alkali reactivity are important considerations for aggregates used in concrete mix designs.

Wear, Durability and Soundness - These properties and their related tests are meant to describe an aggregate's toughness and its ability to resist abrasion, degradation and freeze-thaw disintergration. Aggregates used for hydraulic projects in freezing climates must withstand the cyclic deterioration caused by water and ice. Wear is generally determined by ASTM C-131 (Resistance to Degradation by Abrasion and Impact). A sample of known gradation is placed along with steel balls into a drum that is rotated a specific number of times. The change in gradation or loss of material (wear) from specific sieve sizes represents the wear. The test, also known as the LA Abrasion, is a general index of aggregate durability and toughness.

Percent loss or change in grain-size distribution can also be measured as a result of simulated weathering and frost-action. This is referred to as aggregate soundness and is the test described by ASTM C-88. This aggregate quality is evaluated by immersing a sample of known gradation in either a sodium sulfate or magnesium sulfate solution for a specified time. The sample is then

removed and oven-dried. This alternating wetting and drying cycle is generally repeated 5 times. The saturation and drying process causes the progressive growth of sulfate crystals which simulates the destructive force of water absorption and freezing. The resulting aggregate disintegration is measured as a change in particle-size distribution. Magnesium sulfate is more effective in aggregate break-down than sodium sulfate and the specified wear limits are therefore adjusted accordingly.

In the past, the Montana Department of Transportation (MDT) used another test referred to as Degradation to measure an aggregate's durability. This method has since been discontinued, however older pit information on file with the MDT often references this test.

3.3.2 Structural Fill

Structural fill is a general high quality, granular material free of organics and other deleterious matter typically specified where control of soil strength and compressibility are important. Structural fill is also used to facilitate construction due to its ease of placement and compaction relative to native, fine-grained soils especially during wet or freezing conditions. It is generally well-graded and has a maximum particle size of 2 to 4 inches depending on application. Angularity or percent fractured could be specified if warranted. The percentage of fines, smaller than the No. 200 sieve is typically specified, normally less than 10% as is the plasticity index (PI) less than 10%. A typical gradation is provided below.

Table 3 - Preliminary Gradation for Granular, Structural Fill

Particle Size	Percent Passing by Weight
3-inch	100%
1½-inch	80 - 100%
¾-inch	60 - 80%
No. 4	25 - 50%
No. 40	20 - 40%
No. 200	10% max.

3.3.3 Canal Armor

Canal armor is a layer of protection for either the earthen canal prism or a synthetic liner material. It protects against erosion, seasonal sloughing, and deterioration as well inhibiting the formation of vegetation and pond weed. The canal armor is typically extended above the design freeboard level. Depending on native soils and velocities, the armor may extend the full hydraulic radius or just on the interior side slopes. Armoring for the canal prism should consist of well-graded gravel with cobbles meeting the preliminary gradation below. The armor should exhibit sufficient durability with respect to freeze-thaw cycles and shall have no more than 12% (sodium) or 18% (magnesium) loss of weight after 5 cycles in general accordance with ASTM C-88. Wear as determined by ASTM C-131 shall not exceed 45% at 500 revolutions.

Table 4 - Preliminary Gradation for Canal Armoring

Particle Size	Percent Passing by Weight
8-inch *	100%
6-inch	85 to 100%
4-inch	65 to 85%
1½-inch	30 to 55%
¾-inch	15 to 30%
No. 4	0 to 5%

* Maximum particle size may vary depending on thickness of proposed armor.

3.3.4 Riprap

Riprap is generally a protective cover of large stones, with or without cementitious grout, placed as a deterrent against erosion. Riprap can be classified as hand laid, random or grouted. The size of the riprap is generally governed by the magnitude of erosive action anticipated. Riprap stone should be hard, durable, and resistant to weathering and water action, and free of organics, seams and structural defects. The stone should have a minimum apparent specific gravity of 2.6, a maximum absorption of 4% and a minimum Coarse Durability Index (CDI per AASHTO T-10) of 52. Angular stone, if available is preferred over rounded, stream alluvium. The stone shall be relatively equi-dimensional in that its greatest dimension shall not exceed its least dimension by a factor of 3. The table below shows three classes of riprap as specified by the Montana Department of Transportation (MDT). Determination of the appropriate riprap grading will vary

with application and will be evaluated and specified during the design phase. The majority of riprap required is anticipated to be class I or II.

Table 5 - Different Classes of Random Riprap

CLASS	WEIGHT OF STONE	EQUIVALENT SPHERICAL DIAMTER [1]	% OF TOTAL WT SMALLER THAN GIVEN SIZE
I	100 pounds 60 pounds 25 pounds 2 pounds	1.05 feet 0.88 feet 0.66 feet 0.27 feet	100 70-90 40-60 0-10
II	700 pounds 500 pounds 200 pounds 20 pounds	2.00 feet 1.79 feet 1.32 feet 0.61 feet	100 70-90 40-60 0-10
III	2000 pounds 1400 pounds 700 pounds 40 pounds	2.82 feet 2.53 feet 2.00 feet 0.77 feet	100 70-90 40-60 0-10

[1] **Based on specific gravity of 2.65.**

3.3.5 Road Surfacing and Subbase

Aggregate used for road surfacing is similar to structural fill except that the maximum particle size is generally smaller. Due to its application, a maximum wear (ASTM C-131) is typically specified and limited to 30 percent for top surface courses and 50 percent for subbases or bases covered with asphalt or concrete pavement. The maintenance service road for the rehabilitated project will have a gravel surface. Therefore wear should be limited to 30 percent. Road surfacing and bases are generally crushed and require a minimum percentage of single fractured faces (SFF) depending on their application. The dust ratio should not exceed 0.66. Anticipated gradation for a crushed driving surface and subbase are provided in Table 6 below. County roads and roads joining local highways may have other or different minimum requirements. Actual requirements will be evaluated and specified during the design phase.

Table 6 - Preliminary Gradations for Surface Course and Subbase

Particle Size/ Property	Percent Passing by Weight	
	Surface Course	Subbase
4-inch	--	100%
3-inch	--	90-100%
1 ½-inch	100%	--
No. 4	40-80%	30-75%
No. 10	25-60%	--
No. 200	5-20%	0-15%
Wear	30% @ 500 Revs	50%@ 500 Revs
SFF	30%	--
Liquid Limit	25%	35%
Plastic Index	3 to 10%	15%

3.3.6 Slope Stabilization Buttress

The slope stabilization buttress will be comprised of relatively free-draining, well-graded gravel with cobbles up to 6-inches in diameter. The buttress material should exhibit a sodium sulfate loss no greater than 12% after 5 cycles as determined by ASTM C-88. The buttress aggregate should conform to the following preliminary gradation (Table 7). Final gradation and other properties for the slope stabilization buttress should be evaluated and specified following completion of additional geotechnical investigations and the earthwork grading plans.

Table 7 - Preliminary Gradation for Slope Stabilization Buttress

Particle Size	Percent Passing By Weight
6-inch	100%
3-inch	70-100%
1½-inch	50-80%
¾-inch	35-65%
No. 4	10-35%
No. 10	6-25%
No. 40	0-10%
No. 200	0-3%

3.3.7 Concrete Aggregates

Cast-in-place structural concrete may or may not be batched locally at one of the identified borrow pits. The overall quantity and timing of the proposed concrete placement along with local economics will dictate whether a Contractor elects to produce and batch concrete locally or purchase redi-mix concrete from Cardston, Alberta or elsewhere. Future changes in border crossing procedures and trade regulations between the U.S. and Canada may also impact this future decision. In general, fine and coarse concrete aggregates are manufactured to a higher tolerance than aggregates previously discussed. This is important to maintain the quality and consistency of structural concrete.

The gradation of the fine aggregate influences and controls the workability of the fresh, plastic concrete. Fines and fine sands impact this property, therefore the fineness modulus should be between 2.5 and 3.1. The fine aggregates should be relatively free of organics and impurities as discussed earlier and should exhibit no more than 10 to 15% loss when subjected to 5 cycles of sodium or magnesium sulfate soundness testing, respectively. In general, the concrete sand should conform to the following gradation.

Table 8 - Preliminary Gradation for Concrete Sand (Fine Aggregate)

Particle Size	Percent Passing By Weight
⅜-inch	100%
No. 4	95-100%
No. 8	80-100%
No. 16	50-85%
No. 30	25-60%
No. 50	5-30%
No. 100	0-10%
No. 200	0-3%

The gradation of coarse concrete aggregate will vary and is a function of the intended application of the structural concrete and will be determined during the design phase. The coarse aggregates should also be relatively free of impurities and deleterious substances. The wear (ASTM C-131)

should not exceed 40% and soundness (ASTM C-88) should not exceed 12 and 18% for sodium and magnesium sulfate respectively.

4.0 EXISTING AND FORMER GRAVEL PITS

4.1 BACKGROUND

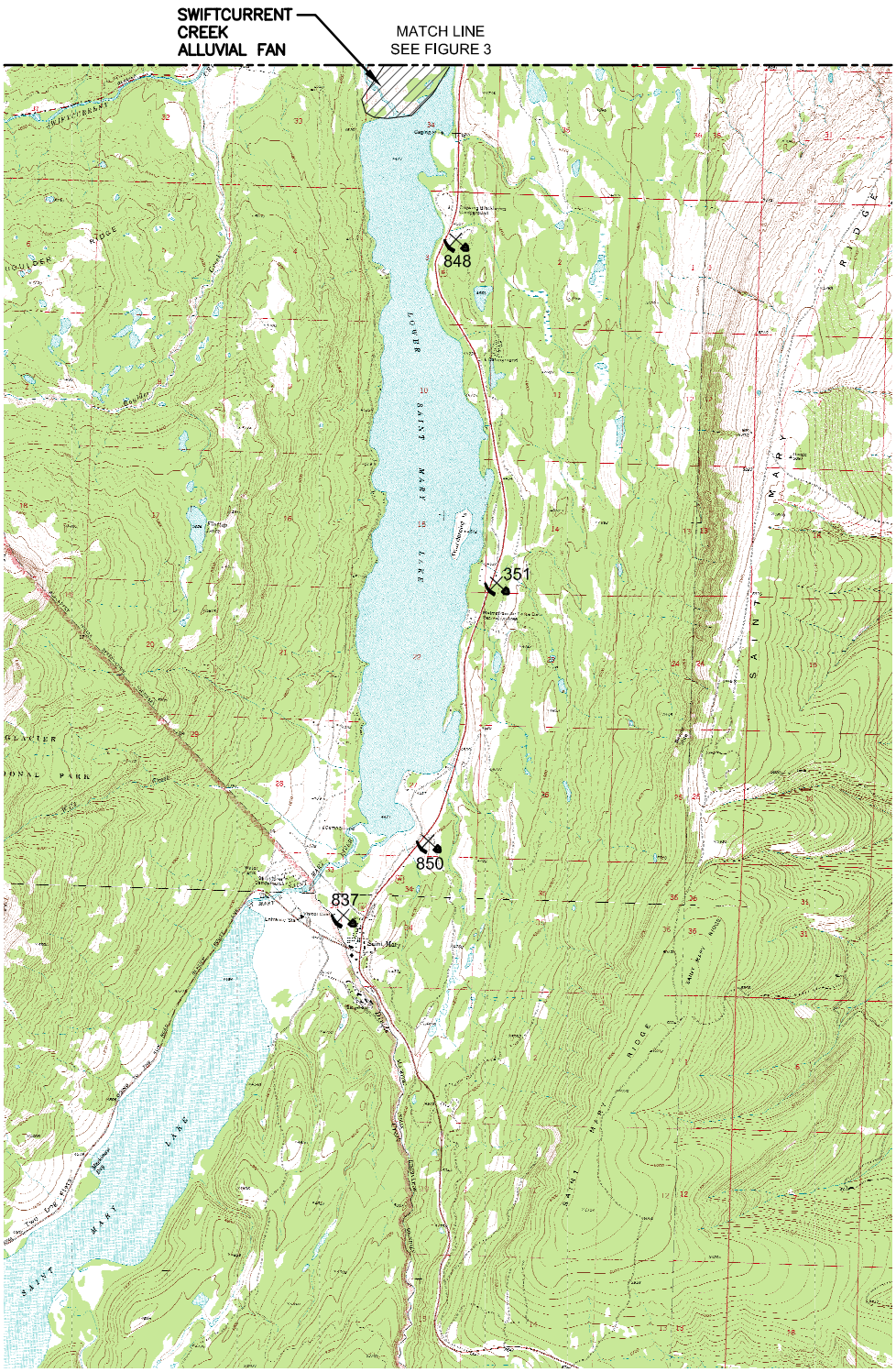
Based on our study, there are twenty former or existing gravel pits that are known in the general vicinity of the St. Mary River Diversion Project. For this study, borrow sources and gravel pits are considered "former" if they appear to have been purposely reclaimed or that no recent activity or extraction has taken place. Pits are also considered former if their location or age is so obscure they could not be definitively located in the field. On the other hand, pits are considered "existing" if they were not intentionally reclaimed or it appears that relatively recent activity has taken place. Eleven of the twenty borrow pits are considered former gravel pits and nine are considered existing pits. Of the nine existing pits, four are considered currently active.

Fifteen of the twenty existing and former gravel pits are known and registered with the Montana Department of Transportation (MDT). This means the pits have been either previously investigated, studied, sampled, tested or used as a source of aggregate for MDT projects. Of the fifteen MDT-registered pits, nine are considered former and six are considered current with four of those considered active. The listed ownership of the pits includes private, Tribal, and Federal (USBR) although this information should be researched and updated.

There are five former and existing gravel pits that are not registered with MDT. Their existence and locations are referenced and shown on USGS topographical maps of the area. Three are considered former and two are considered existing. Of these, one is active and one appears to have experienced recent activity. Little is known about the quality and reserve quantity of these pits.

The borrow pits identified and discussed as part of this study are shown on Figures 2 and 3. Figure 2 shows four former gravel pits registered with MDT located along Hwy 89 and adjacent to Lower St. Mary Lake. Figure 3 shows the remaining eleven MDT-registered, former and existing pits and the five other pits identified from USGS maps.

There are four "potential" gravel pits shown that are registered with MDT. These pits were investigated, sampled and tested but apparently were never developed. The nineteen former, existing and potential borrow pits registered with the MDT are shown on Figures 2 and 3 with their MDT Pit ID Number. The five, non-MDT pits identified on the USGS topo maps are labeled A through E. The specifics of the former and existing gravel pits are discussed below. They are grouped based on their location and/or geologic setting.



812 Borrow Pits (With MDT ID No. If Available)

N

N.T.S.

FIGURE 2

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DNRC - CARDD
ST. MARY DIVERSION FACILITIES

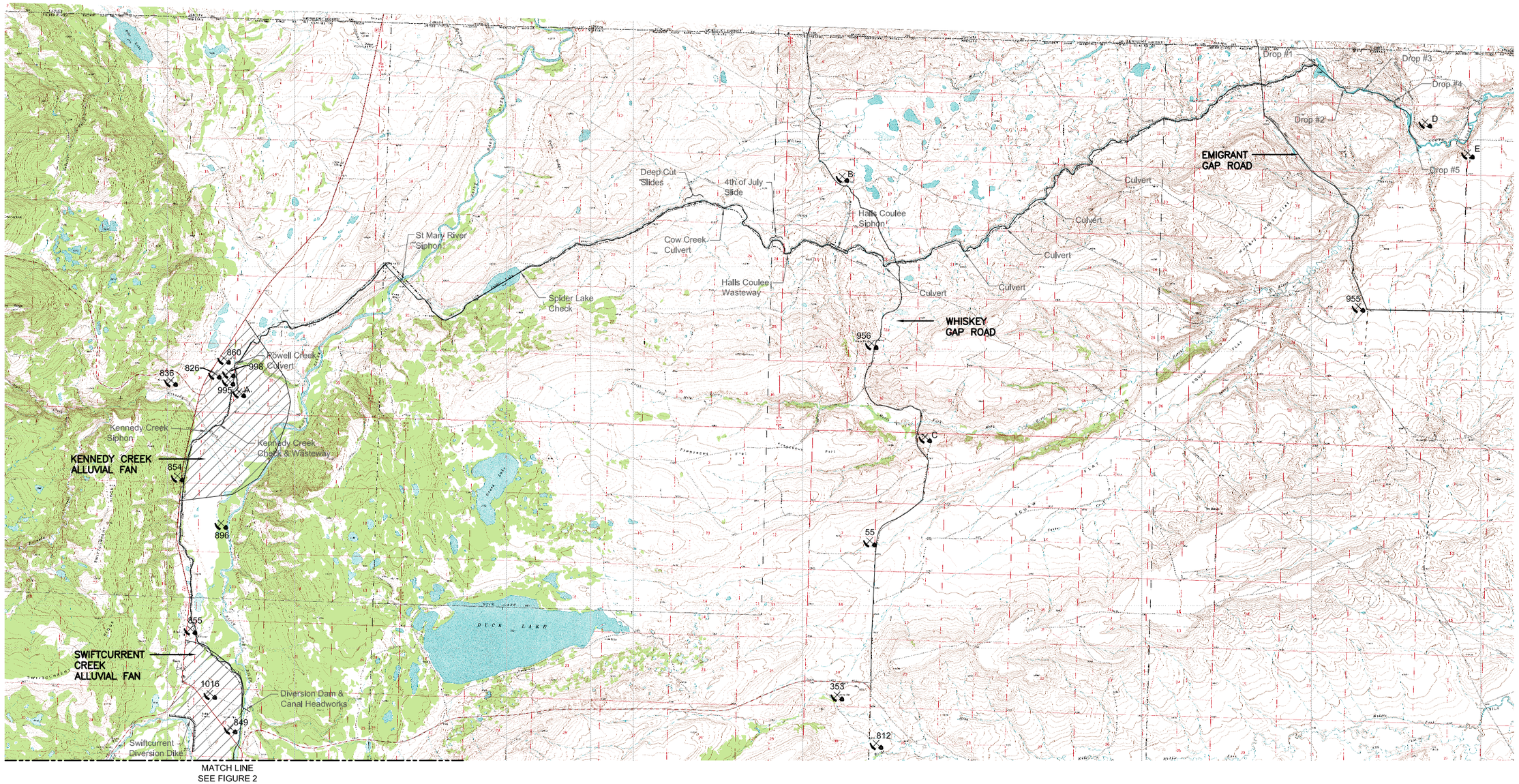
BORROW RESOURCE STUDY - PHASE I
LOWER ST. MARY LAKE GRAVEL PITS

TD&H

THOMAS, DEAN & HOSKINS, INC.
ENGINEERING CONSULTANTS
GREAT FALLS–BOZEMAN–KALISPELL MONTANA
SPOKANE WASHINGTON
LEWISTON IDAHO

DRAWN BY:	MWC	DATE:	01.24.08
DESIGNED BY:	EAJ	JOB NO.	04-167
QUALITY CHECK:		CAD NO.	ST. MARY .DWG

SHEET 1



812 Borrow Pits (With MDT ID No. if Available)

A Borrow Pits (Not registered with MDT)

N.T.S.

FIGURE 3

MONTANA
ERLING A. JUEL
10740PE
REGISTERED
PROFESSIONAL ENGINEER

REVISIONS
BY DESCR DATE
BY DESCR DATE
BY DESCR DATE

TD&H

THOMAS, DEAN & HOSKINS, INC.
ENGINEERING CONSULTANTS
GREAT FALLS–BOZEMAN–KALISPELL
SPOKANE
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MONTANA
WASHINGTON
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DRAWN BY:	MWC
DESIGNED BY:	EAJ
QUALITY CHECK:	
DATE:	02.04.08
JOB NO.	04-167
FIELDBOOK	

DNRC - CARDD
ST. MARY DIVERSION FACILITIES

BORROW RESOURCE STUDY - PHASE I
GRAVEL PITS NEAR THE ST. MARY CANAL

CAD NO. ST. MARY .DWG
SHEET 1 OF 1

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4.2 LOWER ST. MARY LAKE AREA

Figure 2 shows four former gravel pits along Hwy 89 adjacent to Lower St. Mary Lake. These four pits are listed with MDT. The latest data for three of the four pits varies from 1954 to 1959. One pit, #351, included data from 1983. The older pits most likely represent borrow sources used during a major highway construction or paving project in the 1950's. These four pits are considered former pits and have been essentially reclaimed with no recent or apparent activity. MDT testing indicates that this gravel is of high quality (wear <22%), relatively clean with nonplastic to low plasticity fines. The oversize fraction greater than 4-inches varies from 1% to 11%. Other information is listed below for these four pits. Geologically, the source of these gravel deposits include alluvium of the St. Mary River and older bench deposits most likely related to glacial outwash and /or alluvial processes. The bench deposits tend to be along the lateral limits of the valley floor and slightly higher in elevation.

<u>MDT Pit No. 837</u>

Location: SW¼, NW¼, Sec 34, T35N, R14W (Figure 2)

Latest Pit Information: 1959

Listed Owner: USBR - Milk River Project

Source: River Gravels

Status: Former, Mostly Reclaimed, Inactive

Summary of MDT Testing:

# of Samples: 8		
>12": 0 to 3%	AASHTO Class:	A-1-a(0)
6" to 12": 0 to 4%	PI:	Nonplastic to 7%
4" to 6": 1 to 4%	Wear:	16 to 22%
<4: 89 to 99%	Unit Wt:	122.4 to 131.6 pcf
<#10*:16 to 42%	Degradation:	Not Tested
< #40*:6 to 23%	R-Value:	Not Tested
< #200*:2 to 11%		

***Based on - 4" split**

Photo 1: Looking northeast from Park Entrance Road at former gravel pit MDT #837 (10/16/07).

Photo 2: Looking southwest from Lower Lake access road at former gravel pit MDT #837 (10/16/07).

MDT Pit No. 850

Location: SE¼, Sec 27, T35N, R14W (Figure 2)

Latest Pit Information: 1954

Listed Owner: Hugh Black

Source: Bench Gravels

Status: Former, Reclaimed, Inactive

Summary of MDT Testing:

# of Samples: 4

>6": 5%	AASHTO Class:	A-1-a(0)
4" to 6": 5%	PI:	Nonplastic to 2%
<4": 90%	Wear:	13 to 17%
<#10*: 14 to 36%	Unit Wt:	126.5 to 133.0 pcf
< #40*:3 to 22%	Degradation:	Not Tested
< #200*:1 to 10%	R-Value:	Not Tested

***Based on 4" split**

Photo 3: Looking south from Hwy 89 at former gravel pit MDT #850 (10/16/07).

MDT Pit No. 351

Location: Lot 7, Sec 14, T35N, R14W (Figure 2)

Latest Pit Information: 1983

Listed Owner: Roscoe Black

Source: Bench Gravels

Status: Former, Reclaimed, Inactive

Summary of MDT Testing:

# of Samples: 8

>12": 0%	AASHTO Class:	A-1-a(0)
6" to 12": 0%	PI:	Nonplastic to 4%
4" to 6": 3%	Wear:	17 to 21%
<4": 97%	Unit Wt:	Not Tested
<#10*:28 to 45%	Degradation:	1 to 6%
< #40*:12 to 18%	R-Value:	80
<#200*:2 to 9%		

***Based on - 4" split**

Photo 4: Looking north across former gravel pit MDT# 351 (10/16/07).

MDT Pit No. 848

Location: SE¼, NE¼, Sec 3, T35N, R14W (Figure 2)

Latest Pit Information: 1954

Listed Owner: Tribal Land-Blackfeet

Source: Bench Gravels

Status: Former, Reclaimed, Inactive

Summary of MDT Testing:

# of Samples: 3

>6": 10%	AASHTO Class:	A-1-a(0)
4" to 6": 15%	PI:	Nonplastic to 6%
<4" : 75%	Wear:	16 to 18%
<#10*: 14 to 21%	Unit Wt:	128.5 to 131.50 pcf
<#40*:8 to 10%	Degradation:	Not Tested
< #200*:3 to 6%	R-Value:	Not Tested

Based on - 4" split

Photo 5: Looking northeast across former gravel pit MDT# 848 (10/16/07).

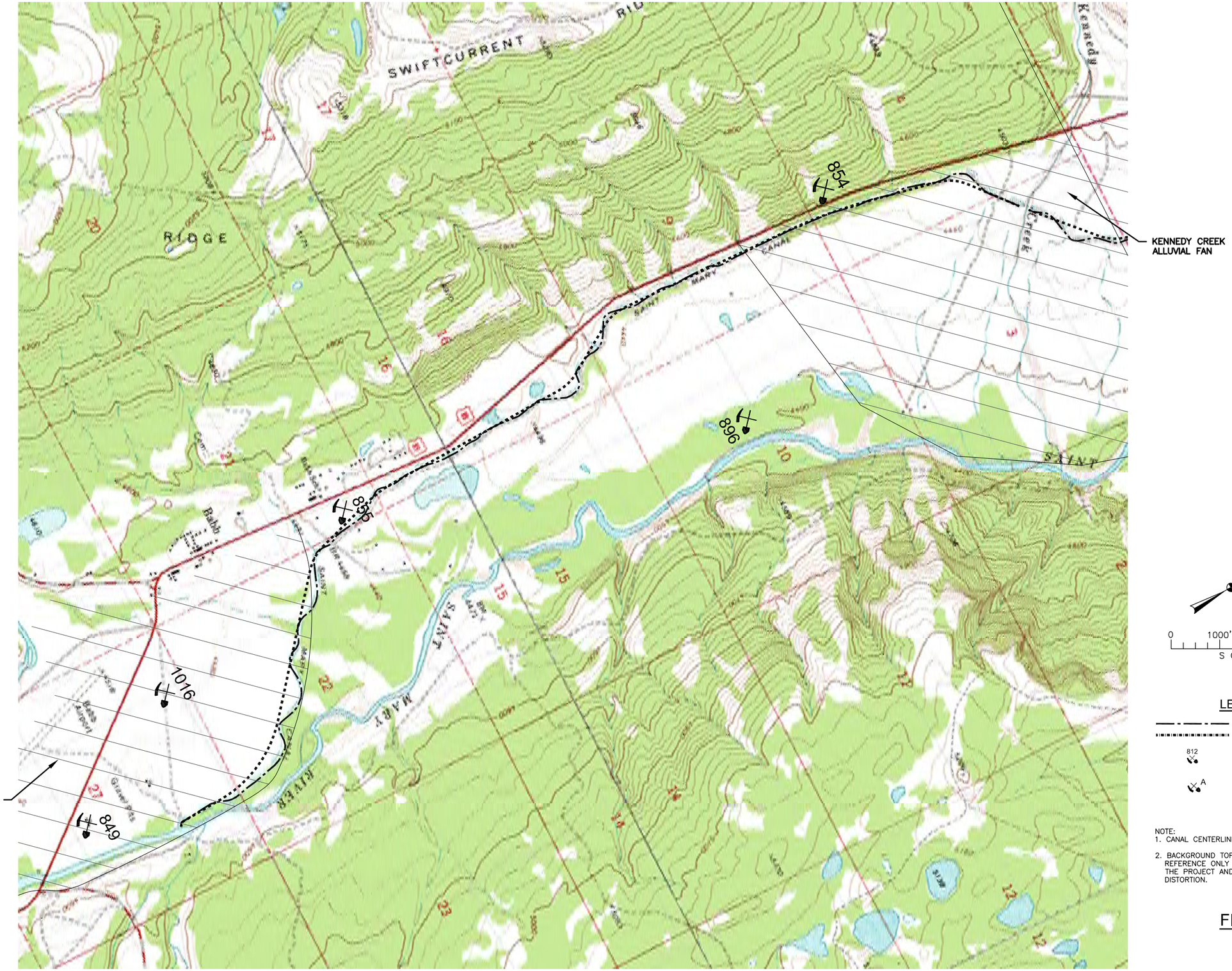
4.3 SWIFTCURRENT CREEK ALLUVIAL FAN

The Swiftcurrent Creek alluvial fan represents a large-scale, geologic depositional feature (Figures 3 and 4). The fan begins at the mouth of the Swiftcurrent Creek drainage and "fans" out and down towards the east. Just upstream of the mouth, Boulder Creek joins Swiftcurrent Creek. These two streams have mountainous origins and exhibit high-energy, grade lines and gradients. As such, they have a great propensity for erosion and an ability to transport coarse sediment. Also, the transportation path is relatively short and very close to the bedrock source. Therefore the sediment load tends to be coarse gravel with cobbles and boulders.

Approximately 90 years ago (a geologic millisecond), Sherburne Dam was built across Swiftcurrent Creek thus reducing the amount of sediment produced. However, in the past, the combined streams transported a tremendous volume of coarse sediment. Beyond the mouth, the flow gradient diminishes and therefore the streams ability to move the material and flow debris. As a result, sedimentation occurred. Because of the sedimentation, these stream channels tend to migrate regularly; typically during high flows as the active channel becomes choked with coarse sediment. Formation of a mountain stream-derived alluvial fan is analogous to a conveyor belt of coarse sediment with an oscillating, left and right motion. This has resulted in a tremendous potential source of gravel and building aggregate for the St. Mary Rehabilitation Project.

As a part of construction of Sherburne Reservoir and the St. Mary Project, the migratory tendency of Swiftcurrent Creek has been controlled and directed towards the south by a large diversion dike. The creek now discharges to the Lower St. Mary Lake (Figure 3). Unlimited extraction of gravel from the alluvial fan is hindered by an existing gravel air strip, sewage lagoons, housing development, and Hwy 89.

MDT has information on one gravel pit located on the alluvial fan between the St. Mary Canal and Hwy 89 (MDT #849). The general area appears to be filled and is now used to stock-pile building stone and miscellaneous gravels (Photo 6).



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SCALE

LEGEND

- APPROX. CANAL CENTERLINE
- ALTERNATIVE ALIGNMENT
- 812 — Borrow Pits (With MDT ID No. If Available)
- A — Borrow Pits (Not registered with MDT)

NOTE:
1. CANAL CENTERLINE SURVEY BY TD&H, 2005
2. BACKGROUND TOPOGRAPHICAL IMAGE IS FOR REFERENCE ONLY DUE TO THE LENGTH OF THE PROJECT AND SUBSEQUENT IMAGE DISTORTION.

FIGURE 4

MONTANA PROFESSIONAL ENGINEER
ERLING A. JUEL
10740PE
REGISTERED

REVISIONS
BY DATE DESCR
BY DATE DESCR
BY DATE DESCR

TD&H

THOMAS, DEAN & HOSKINS, INC.
ENGINEERING CONSULTANTS
GREAT FALLS–BOZEMAN–KALISPELL–HELENA
SPOKANE
LEWISTON
MONTANA
WASHINGTON
IDAHO

DRAWN BY:	MWC
DESIGNED BY:	EAJ
QUALITY CHECK:	
DATE:	01.25.08
JOB NO.	04-167
FIELDBOOK	

DNRC - CARDD
ST. MARY DIVERSION FACILITIES

BORROW RESOURCE STUDY - PHASE I
SWIFTCURRENT AND KENNEDY ALLUVIAL FANS

CAD NO. 04-167-ROW .DWG
SHEET 1 OF 1

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In 1991, MDT conducted a subsurface soils investigation (MDT #1016) consisting of 46 test pits extending to a maximum depth of approximately 12 feet. Thirty samples were analyzed to characterize the nature of the gravel deposit. MDT testing indicates the aggregate is durable (wear varies from 16 to 18%). Estimates of overall particle size indicate that 50% is larger than 4-inches with 20% larger than 6-inches and 5% exceeding 12-inches. The AASHTO classification for the gravel varies from an A-1-a to an A-2-6. All samples exhibited group indices less than 1. Additional test results of MDT #1016 are provided in the Appendix.

Based on a description of the test area and our field observations, it appears that this area (MDT #1016) was not developed into a gravel pit. However, many portions of the alluvial fan exhibit small scale depressions representing minor gravel extractions. Also, garbage, refuse and miscellaneous construction debris has been dumped into the former gravel extraction depressions and some natural lowlands.

<u>MDT Pit No. 849</u>

Location: NW¼, SE¼, Sec 27, T36N, R14W (Figures 3 and 4)

Latest Pit Information: 1954

Listed Owner: Blackfeet Tribal Land

Source: Alluvial Fan Gravels

Status: Former, Inactive, Used to Stock-pile Materials

Summary of MDT Testing:

# of Samples: 2

>6": 10%	AASHTO Class:	A-1-a(0)
4" to 6": 15%	PI:	3 to 4%
<4" : 75%	Wear:	18 to 19%
<#10*: 19 to 22%	Unit Wt:	131.0 to 132.0 pcf
<#40*:10 to 12%	Degradation:	Not Tested
< #200*:5%	R-Value:	Not Tested

***Based on - 4" split**

Photo 6: Looking southeast at gravel pit MDT# 849. Note stock-piled materials and miscellaneous debris (10/16/07).

MDT Pit No. 1016

Location: NE¼, NW¼, Sec 27, T36N, R14W (Figures 3 and 4)

Latest Pit Information: 1991

Listed Owner: Blackfeet Tribal Reserve

Source: Alluvial Fan Gravels

Status: Undeveloped, Pot-holes and Misc. Debris Nearby

Summary of MDT Testing:

# of Samples: 30

>12": 5%	AASHTO Class:	A-1-a(0) to A-2-6(0)
6" to 12": 15%	PI:	Nonplastic to 13%
<4" to 6": 30%	Wear:	16 to 18%
<4": 50%	Unit Wt:	Not Tested
<#10*: 13 to 26%	Degradation:	Not Tested
< #40*:20 to 43%	R-Value:	80
<#200*:2 to 7%	**See Appendix For Additional Pit and Sample Test Results**	

***Based on - 4" split**

Photo 7: Looking northwest towards Babb and undeveloped gravel pit MDT #1016. The general area (foreground) exhibits small depressions representing small scale gravel extractions(10/16/07).

Photo 8: Looking north towards MDT #1016. Note filling of small former pits and natural depressions with miscellaneous debris (10/16/07).

4.4 ST. MARY RIVER ALLUVIUM

Three gravel pits registered and previously tested by MDT exist between the Swiftcurrent Creek and Kennedy Creek alluvial fans. The reported pit locations (#854, #855 and #896) are shown on Figures 3 and 4. The source of these gravel deposits include older bench gravels (#854 and #855) and more recent alluvium (#896) associated with glacial outwash and/or the St. Mary River. Two of these pits are assumed to be former and reclaimed since they could not be located in the field. It is even possible that the pits were not ever developed. The other pit #896 exists but is relatively inactive. Based on the test results, the gravel aggregate is of suitable quality (wear <21%). The over-size fraction (>4 inches) represents between 5 and 15 %. The fines exhibit very little plasticity. Laboratory testing from MDT#896 was performed on a finished gravel product (¾" CTS B,Gr. 3) and does not necessarily reflect the raw aggregate source.

<u>MDT Pit No. 854</u>

Location: SW¼, SE ¼, Sec 4, T36N, R14W (Figures 3 and 4)

Latest Pit Information: 1950

Listed Owner: George Henkle, Jr.

Source: Bank Gravels

Status: Assumed Former and Reclaimed (Could not field locate)

Summary of MDT Testing:

# of Samples: 2	AASHTO Class:	A-1-a(0)
>6": 2%	PI:	Nonplastic
4" to 6": 3%	Wear:	19 to 21%
<4": 95%	Unit Wt:	130.0 to 131.0 pcf
>#10: 19 to 22%	Degradation:	Not Tested
<#40*:8%	R-Value:	Not Tested
< #200*:4%		

***Based on - 3" split**

MDT Pit No. 855

Location: NE¼, NE ¼, Sec 21, T36N, R14W (Figures 3 and 4)

Latest Pit Information: 1950

Listed Owner: George Henkle, Jr.

Source: Bench Gravels

Status: Assumed Former and Reclaimed (Could not field locate)

Summary of MDT Testing:

# of Samples: 1	AASHTO Class:	A-1-a(0)
>6": 5%	PI:	2%
4" to 6": 10%	Wear:	17%
<4": 85%	Unit Wt:	123.5 pcf
<#10*: 40%	Degradation:	Not Tested
<#40*:15%	R-Value:	Not Tested
< #200*:10%		

***Based on - 3" split**

MDT Pit No. 896

Location: W 1/2, Sec 10, T36N, R14W (Figures 3 and 4)

Latest Pit Information: 1986

Listed Owner: Bob Burns

Source: River Gravels

Status: Existing, Inactive

Summary of MDT Testing:

# of Samples: 8 (3/4" CTS B, Gr. 3)	AASHTO Class:	A-1-a(0)
<3/4":100%	PI:	Nonplastic
<#10: 31 to 37%	Wear:	17% to 18%
<#40: 21 to 25%	Unit Wt:	131.9 pcf @ 8.8% opt.
<#200: 9 to 11%	Degradation:	43 to 46
	R-Value:	Not Tested

4.5 KENNEDY CREEK ALLUVIAL FAN

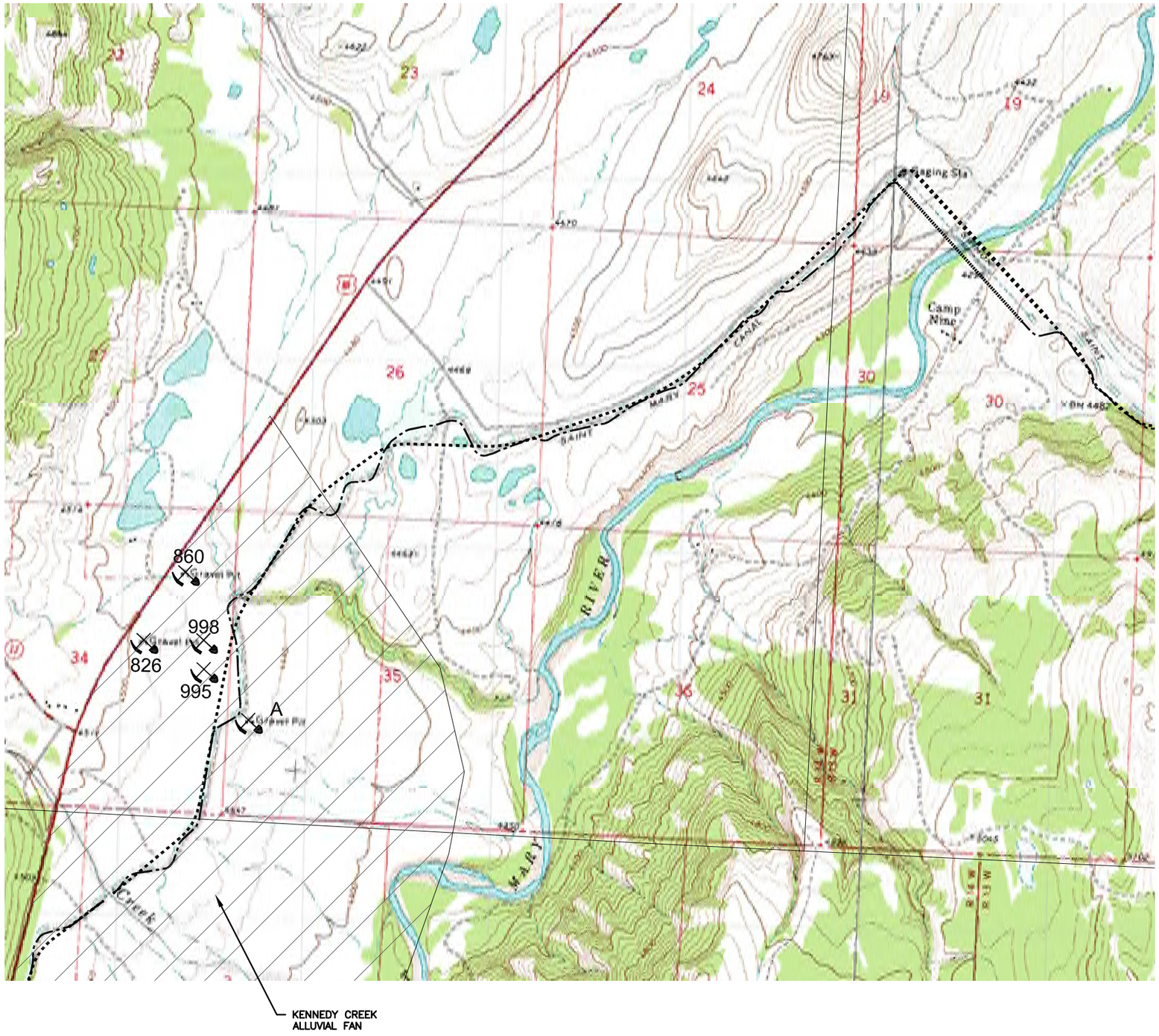
The Kennedy Creek alluvial fan is geologically similar to the Swiftcurrent Creek alluvial fan. The fan and stream are active but the tendency for stream migration is controlled via armored dikes. The dikes are warranted to maintain a controlled passage under the Hwy 89 Bridge and over the Kennedy Creek siphon (Figure 5). The siphon conveys the St. Mary Canal under Kennedy Creek.

There are two existing gravel pits registered and identified by MDT between the St. Mary Canal and Hwy 89. These two pits (MDT #826 and #860) appear to have a long history of use. Besides providing a source of quality gravel, the pits have been used to dispose of trash and debris as shown in Photos 13 and 14. Another former gravel pit (A) is identified on the USGS topographical map east of and adjacent to the St. Mary Canal. Due to its location and limited access, this pit was most likely related to original canal construction or a subsequent maintenance activity or repair of the canal.

An adjacent pit MDT#836 is located well above and west of the Kennedy Creek alluvial fan. It is a former pit and appears to be reclaimed. It is geologically different from the fan gravels and most likely represents glacial drift or an older terrace deposit of alluvium or outwash.

Two potential gravel pit areas (MDT #995 and #998) were investigated in the Fall of 1991 and the Spring of 1992, respectively. Twenty-three test pits were excavated for #995 and forty-seven test pits for #998. Maximum depth of investigation was 13 feet and terminated in gravel.

In general, the gravel deposit is of excellent quality. The wear values varied from 17 to 20%. R-values were determined on samples from two test pits (#995 and #998) which yielded values of 75 and 80. The percentage of the over-size fraction (>4 inches) varied from 2 to 50%. The fines were generally nonplastic with a few samples exhibiting plastic indices up to 10%.



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SCALE

LEGEND

- APPROX. CANAL CENTERLINE
- ALTERNATIVE ALIGNMENT
- 812 — Borrow Pits (With MDT ID No. If Available)
- A — Borrow Pits (Not registered with MDT)

NOTE:
1. CANAL CENTERLINE SURVEY BY TD&H, 2005
2. BACKGROUND TOPOGRAPHICAL IMAGE IS FOR REFERENCE ONLY DUE TO THE LENGTH OF THE PROJECT AND SUBSEQUENT IMAGE DISTORTION.

FIGURE 5

MONTANA PROFESSIONAL ENGINEER
ERLING A. JUEL
10740PE
REGISTERED

REVISIONS
BY DATE DESCR
BY DATE DESCR
BY DATE DESCR

TD&H
THOMAS, DEAN & HOSKINS, INC.
ENGINEERING CONSULTANTS
GREAT FALLS–BOZEMAN–KALISPELL–HELENA
SPOKANE
LEWISTON
MONTANA
WASHINGTON
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DESIGNED BY:	EAJ
QUALITY CHECK:	
DATE:	01.25.08
JOB NO.	04-167
FIELDBOOK	

DNRC - CARDD
ST. MARY DIVERSION FACILITIES

BORROW RESOURCE - PHASE I
KENNEDY CREEK ALLUVIAL FAN

CAD NO. 04-167-ROW .DWG
SHEET 1 OF 1

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MDT Pit No. 826

Location: SW¼, NE ¼, Sec 34, T37N, R14W (Figures 3 and 5)

Latest Pit Information: 1961

Listed Owner: Raymond Siers

Source: Alluvial Fan Gravels

Status: Existing, Unreclaimed, Inactive

Summary of MDT Testing:

# of Samples: 4	AASHTO Class:	A-1-a(0), Overburden A-2-7(0)
>12": 0 to 1%	PI:	Nonplastic to 10%
6" to 12": 0 to 2%	Wear:	18 to 19%
4" to 6": 2 to 3%	Unit Wt:	124.0 to 127.0 pcf
<4": 94 to 98%	Degradation:	Not Tested
<#10: 27 to 28%	R-Value:	Not Tested
< #40*:11 to 17%		
<#200*:4 to 10%		

***Based on - 4" split**

Photo 9: Looking northeast across existing gravel pit MDT #826 (10/16/07).

MDT Pit No. 836

Location: E½, NE¼, NE¼, SE¼, Sec 33, T35N, R14W (Figure 3)

Latest Pit Information: 1959

Listed Owner: Raymond Seirs

Source: Terrace Gravels

Status: Former, Reclaimed, Inactive

Summary of MDT Testing:

# of Samples: 9	AASHTO Class:	A-1-a(0)
>12": 2%	PI:	Nonplastic to 6%
6" to 12": 2%	Wear:	17 to 20%
4" to 6": 2%	Unit Wt:	128.0 to 134.0 pcf
<4": 94%	Degradation:	Not Tested
<#10*: 22 to 47%	R-Value:	Not Tested
< #40*:11 to 26%		
<#200*:3 to 7%		

***Based on - 4" split**

Photo 10: Looking south from Chief Mountain Road at former gravel pit MDT #836. (10/16/07).

MDT Pit No. 860

Location: NE¼, NE¼, Sec 34, T37N, R14W (Figures 3 and 5)

Latest Pit Information: 1949

Listed Owner: Blackfeet Agency and Mary Powell Trust

Source: Alluvial Fan Gravels

Status: Existing, Active

Summary of MDT Testing:

# of Samples: 4	AASHTO Class:	A-5(3) Overburden, A-1-a(0)
<2": 79 to 94%	PI:	Nonplastic
<3/4": 48 to 56%	Wear:	17%
<#10: 13 to 20%	Unit Wt:	Not Tested
< #40*:6 to 11%	Degradation:	Not Tested
<#200*:2 to 4%	R-Value:	Not Tested

***Based on - 4" split**

Photo 11. Photo shows exposed face of pit wall from MDT #860 (10/16/07).

Photo 12. Photo shows pile of plus 4-inch reject at MDT #860 (10/16/07).

MDT Pit No. 995

Location: NE¼, NE¼, SE¼, Sec 34, T37N, R14W (Figures 3 and 5)

Latest Pit Information: 1991

Listed Owner: Blackfeet Tribe

Source: Alluvial Fan Gravels

Status: Undeveloped, Considerable Debris and Trash

Summary of MDT Testing:

# of Samples: 12	AASHTO Class:	A-1-a(0)
>12": 5%	PI:	Nonplastic
6" to 12": 10%	Wear:	17 to 19%
4" to 6": 35%	Unit Wt:	Not Tested
<4": 50%	Degradation:	Not Tested
<#10*: 18 to 25%	R-Value:	80
<#40*:9 to 13%	**See Appendix For Additional Pit and Sample Test Results**	
<#200*:3 to 6%		

***Based on - 4" split**

Photo 13: Looking east across MDT #995; undeveloped pit. Note piles of construction debris and rejected oversized aggregate (10/16/07).

MDT Pit No. 998

Location: SE¼, NE¼ Sec 34, T37N, R14W (Figures 3 and 5)

Latest Pit Information: 1992

Listed Owner: Robert Powell

Source: Alluvial Fan Gravels

Status: Misc. Debris and Trash, Small Former Extractions But Essentially Undeveloped

Summary of MDT Testing:

# of Samples: 22	AASHTO Class:	A-1-a(0)
>12": 3%	PI:	Nonplastic
6" to 12": 7%	Wear:	18 to 20%
4" to 6": 20%	Unit Wt:	Not Tested
<4": 70%	Degradation:	Not Tested
<#10*: 17 to 32%	R-Value:	75
<#40*: 7 to 14%	**See Appendix For Additional Pit and Sample Test Results**	
<#200*: 2 to 4%		

***Based on - 4" split**

Photo 14. Looking east across MDT#998; undeveloped pit. Note garbage and debris (10/16/07).

4.6 DUCK LAKE DRIFT/OUTWASH

Evidence of gravel deposits were observed and documented east of Duck Lake (Figure 3) and generally south and east of the Hudson Bay Divide. In our opinion, the origin of the gravel is glacial drift and/or glacial outwash associated with ice front advances and retreats from the west; or the remnants of alluvium pre-dating the last major glacial activity.

Based on our research, there are eight former or existing gravel pits known in the general vicinity between Whiskey Gap Road and Drop No. 5 (Figure 3). One pit MDT #812 could not be field located and is assumed to be a former pit and subsequently reclaimed. Three other pits, B, C, and D, are existing pits but do not appear active. The other four pits, MDT #353, #955 and #956 and USGS #E are existing and have seen relatively recent activity. In fact gravel extraction was on-going in MDT #353 during 2006 and 2007.

Little is known about the USGS-identified pits (B, C, D and E). These pits are not registered with MDT or the Glacier County Road Department. Based on our observations, these pits appear to have been developed and used by local residents.

In 1995, The MDT performed a subsurface soils investigation for a potential gravel borrow pit (MDT #55). This potential pit is located along Whiskey Gap Road (Figure 3). Seven test pits were excavated to a maximum depth of 12.5 feet. Each test pit terminated in gravel. Estimates of the overall particle size indicate that 9% is larger than 4 inches with 3% exceeding 6 inches. The aggregate is of excellent quality as exhibited by wear values ranging from 18 to 21%. The gravels are relatively clean with respect to the material passing the No. 200 sieve. Also, the fines were granular and nonplastic. Additional field and lab test results for this investigation are included in the Appendix.

MDT Pit No. 55

Location: S½, NE¼, SE¼, Sec 7, T36N, R12W (Figure 3)

Latest Pit Information: 1995

Listed Owner: Blackfeet Tribal Reserve

Source: Bench Gravels

Status: Undeveloped, Native Ground

Summary of MDT Testing:

# of Samples: 5	AASHTO Class:	A-1-a(0)
>12": 1%	PI:	Nonplastic
6" to 12": 2%	Wear:	18 to 21%
4" to 6": 6%	Unit Wt:	Not Tested
<4": 91%	Degradation:	Not Tested
<#10*: 13 to 19%	R-Value:	72
<#40*: 4 to 7%	**See Appendix For Additional Pit and Sample Test Results**	
<#200*: 2 to 4%		

***Based on - 4" split**

Photo 15: Looking southwest at general area that includes undeveloped pit MDT #55. (10/16/07).

MDT Pit No. 353

Location: SW¼, W½, SE¼, Sec 19, T36N, R12W (Figure 3)

Latest Pit Information: 2006

Listed Owner: Meissner Bros., Inc.

Source: Bench Gravels

Status: Partially Reclaimed, Active, In-use

Summary of MDT Testing:

# of Samples: 25	AASHTO Class:	A-1-a(0)
>12": 0 to 1%	PI:	Nonplastic to 6%
6" to 12": 1 to 5%	Wear:	18 to 23%
4" to 6": 2 to 5%	Unit Wt:	122.6 to 125.0
<4": 90 to 96%	Degradation:	Not Tested
<#10*: 16 to 35%	R-Value:	Not Tested
<#40*: 6 to 20%	Na+ Soundness:	3% Loss (coarse)
<#200*: 2 to 10%		

***Based on - 4" split**

Photo 16: Looking southwest from North Fork Road to active gravel pit MDT #353. Note dump truck approaching pit (10/16/07).

Photo 17. Looking at stock-piles of aggregate at MDT #353 (10/16/07).

MDT Pit No. 812

Location: S½, SW¼, NW¼ and NW¼. SW¼ Sec 29, T36N, R12W (Figure 3)

Latest Pit Information: 1975

Listed Owner: A. Douglas

Source: Bench Gravels

Status: Assumed Former and Reclaimed (Could not field locate)

Summary of MDT Testing:

# of Samples: 14		AASHTO Class:	A-1-a(0)
>12": 2%		PI:	Nonplastic to 8%
6" to 12": 5%		Wear:	17 to 24%
4" to 6": 8%		Unit Wt:	Not Tested
<4": 85%		Degradation:	6
<#10*: 19 to 32%		R-Value:	Not Tested
<#40*: 8 to 16%			
<#200*: 4 to 8%			

***Based on - 4" split**

MDT Pit No. 955

Location: SE¼, SW¼, Sec 21, T37N, R11W (Figure 3)

Latest Pit Information: 1991

Listed Owner: Bill Rumney

Source: Bench Gravels

Status: Unreclaimed, Active

Summary of MDT Testing:

# of Samples: 6		AASHTO Class:	A-1-a(0)
>12": 0%		PI:	Nonplastic to 7%
6" to 12": 1%		Wear:	18 to 22%
4" to 6": 5%		Unit Wt:	Not Tested
<4": 94%		Degradation:	39 to 51%
<#40*: Not Tested		R-Value:	Not Tested
<#200*: Not Tested			

***Based on - 4" split**

Photo 18. Looking southwest across existing, inactive, unreclaimed gravel pit MDT #955 (01/04/08).

MDT Pit No. 956

Location: SW¼, NE¼, Sec 29, T37N, R12W (Figure 3)

Latest Pit Information: 1991

Listed Owner: Remington Construction

Source: Bench Gravels

Status: Unreclaimed, Active

Summary of MDT Testing:

# of Samples: 6		AASHTO Class:	A-1-a(0)
>12": 0%		PI:	Not Tested
6" to 12": 1%		Wear:	21 to 24%
4" to 6": 4%		Unit Wt:	Not Tested
<4": 95%		Degradation:	2 to 31
<#10*: Not Tested		R-Value:	Not Tested
<#40*: Not Tested			
<#200*: Not Tested			

***Based on - 4" split**

Photo 19: Looking east at existing gravel pit MDT #956. (10/16/07).

Photo 20. Looking west at existing MDT #956 gravel pit from Whiskey Gap Road (05/16/07).

Photo 21. Photo showing non-MDT registered, unreclaimed gavel pit (#B) shown on USGS Topo Map along Whisky Gap Road (10/16/07).

Photo 22. Looking at non-MDT registered, unreclaimed gravel pit (#C) located along Whiskey Gap Road (10/16/07).

Photos 23. Photo shows a partially reclaimed, former gravel pit (#D) situated at the top of a hill over-looking Drops No. 4 and No. 5 (05/16/07).

Photo 24. Looking north at an existing gravel source (#E) referenced on the USGS Topo map (05/16/07).

Photo 25. Close-up of pit #E (05/16/07).

5.0 POTENTIAL AGGREGATE SOURCES

5.1 REGIONAL GEOLOGY

As stated in previous reports prepared by the USBR, the general geology of the area comprising diversion and conveyance facilities varies considerably. At the beginning of the project, from the diversion dam to the Powell Creek culvert (Figure 3), the geologic setting is best described as predominantly stream alluvium, glacial outwash and alluvial fan deposits comprised of coarse gravels and cobbles. These granular soils are relatively thick and overlie Cretaceous-aged sedimentary bedrock. The USBR reports the bedrock unit to be a non-marine mudstone (Two Medicine Formation) near the diversion dam.

Downstream along the canal from the Powell Creek underdrain culvert, the earthen canal traverses increasing occurrences of fine-grained, glacial till and drift in varying thicknesses overlying earlier alluvial deposits and/or sedimentary bedrock.

Near the St. Mary River siphon, the local geology varies from the glacial till and alluvium underlain by the Cretaceous-aged, Virgelle Sandstone Formation. The glacial deposits mostly blanket the valley sidewalls and consist generally of high-plasticity, lean clay with sand with lesser occurrences of silty sand with gravel. The alluvium closer to the river can be described as cleaner material, typically composed of coarse gravel with sand, cobbles and boulders. The Virgelle Sandstone is yellowish-brown to gray, fine to medium-grained, and slightly to moderately fractured. It is described as soft to moderately hard depending on the degree of weathering. The early USBR reports state that in this area, the sandstone geologically stikes north-northwest, dips about 25 degrees toward the northeast, and has been thrust over the adjacent and younger Cretaceous-aged Two Medicine Formation.

Downstream from the St. Mary River siphon, along the canal, the physiographic terrain changes to predominately glacial till of varying thickness underlain by Cretaceous and Tertiary-aged sedimentary bedrock. Spider Lake drainage represents a hanging valley as it joins the St. Mary River drainage. Alluvial and fluvial deposits are less common and most likely limited to drainage lowlands. Occasional occurrences of terrace and outwash gravel deposits are known. Bedrock outcrops are observed along the hillsides and occasionally in the bottom of the canal

when dewatered. In general, the sequence is older to younger from west to east. High angle normal faults and reverse faults are likely and are associated with the folding, faulting and thrusting of the Rocky Mountains. A generalized geologic map of the area is presented on Figure 6. This shows the basement rock and prominent structural features.

Significant gravel deposits extend from the diversion dam downstream to the Powell Creek underdrain (Figure 3). These deposits are the combined influences of Swiftcurrent and Kennedy Creek alluvial fans and St. Mary River alluvium processes. Downstream of Kennedy Creek along the canal, surficial gravel deposits are expected to be limited to and in close proximity to the St. Mary River. Based on our experience and field observations, gravel deposits along the canal downstream of the St. Mary River Siphon along the canal are very sporadic, discontinuous and relatively small in size. The Spider Lake hanging valley and the Willow Creek drainage seem to be void of significant gravel deposits. This also corresponds to the Hudson Bay Divide that delineates the Willow Creek Drainage to the north and the North Fork of the Milk River to the south.

The headwaters of the North Fork originate at Duck Lake which roughly straddles the Hudson Bay - Gulf of Mexico Divide. Eastward and downstream of Duck Lake, gravel deposits are frequent and are of excellent quality and quantity. It is postulated the alpine glaciations were confined to the St. Mary River Valley by the St. Mary Ridge on the east. Previous alluvial gravels in the Spider Lake - Willow Creek drainage, if any, were most likely eroded by advancing ice. The existing gravel deposits east and downstream of Duck Lake may have escaped the impact of alpine glaciations and represent former alluvial deposits emanating from the mountains. Figure 7 summarizes the known and potential gravel deposits.

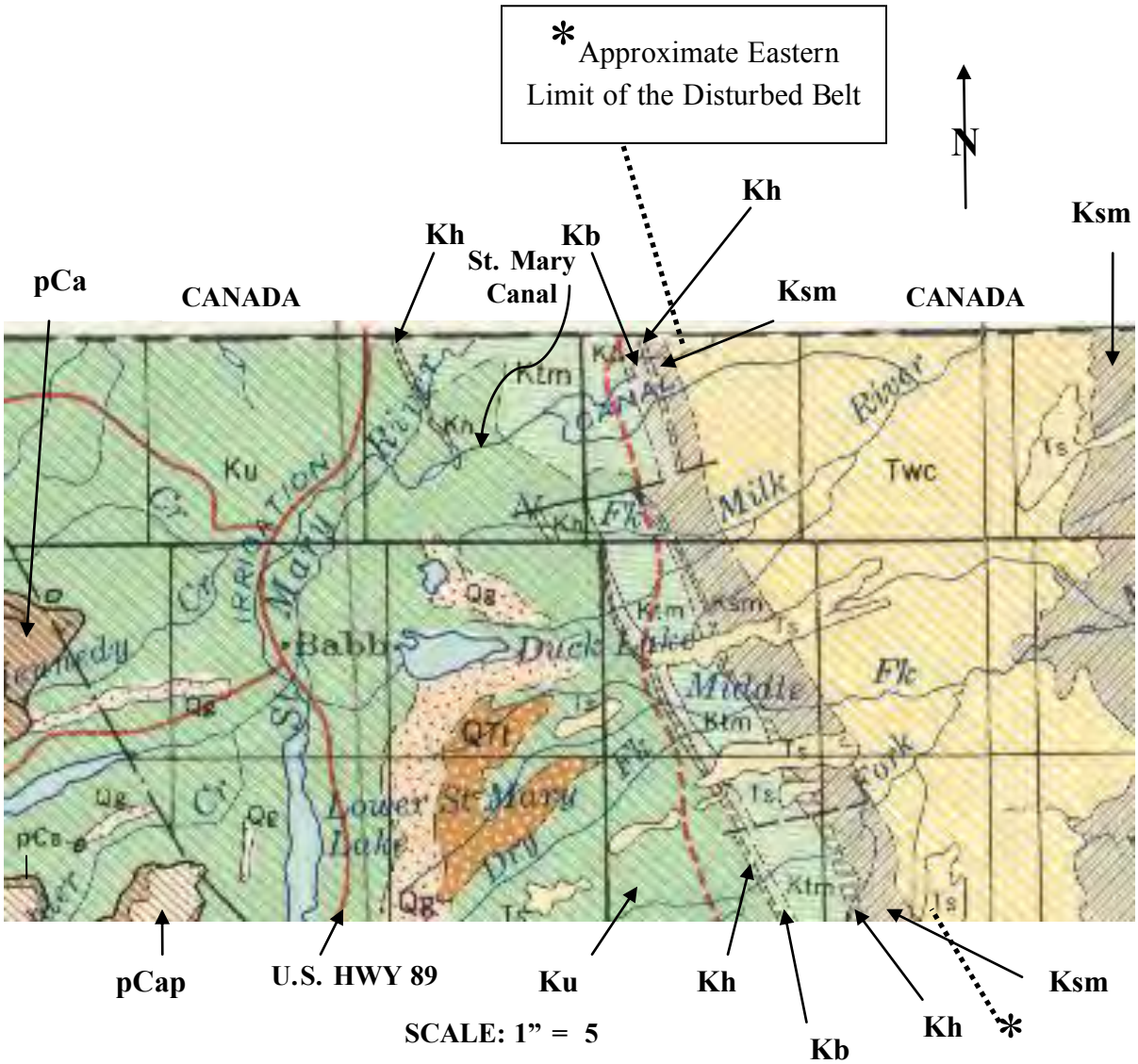


Figure 6. Geologic map of the area comprising the St. Mary River Diversion and Conveyance Facilities (from USGS Geol. Map of MT MR2235, 1955).

Q_g - Pleistocene Glacial Drift
Morainal and outwash plain deposits of mountain glaciers; mainly ill-sorted and poorly rounded boulders, cobbles, pebbles and sand; may include alluvium in places.

Q_{Tf} – Terrace Deposits
Gravel, sand, and silt of terrace remnants

T_s - Tertiary Sedimentary Rocks Undifferentiated
Poorly consolidated gravel, sand, silt, clay and other - tuff, lignite, bentonite, deposits, in valleys.

T_{wc} - Tertiary (Paleocene) Willow Creek Formation
Variegated clay and soft sandstone, chiefly maroon to chocolate brown; local lenses of purple-gray nodular limestone.

K_{sm} - Upper Cretaceous St. Mary River Formation
Greenish-gray clay with local nodular limestone and cross-bedded sandstone.

K_h - Upper Cretaceous Horsethief Sandstone
Shaley sandstone grading upward into massive brownish cliff-forming sandstone with local concentrations of magnetite in beds near top.

K_b - Upper Cretaceous Bearpaw Shale
Dark gray and brownish clay shale; thick units of
non-fissile bentonitic shale; contains some thick bentonite beds.

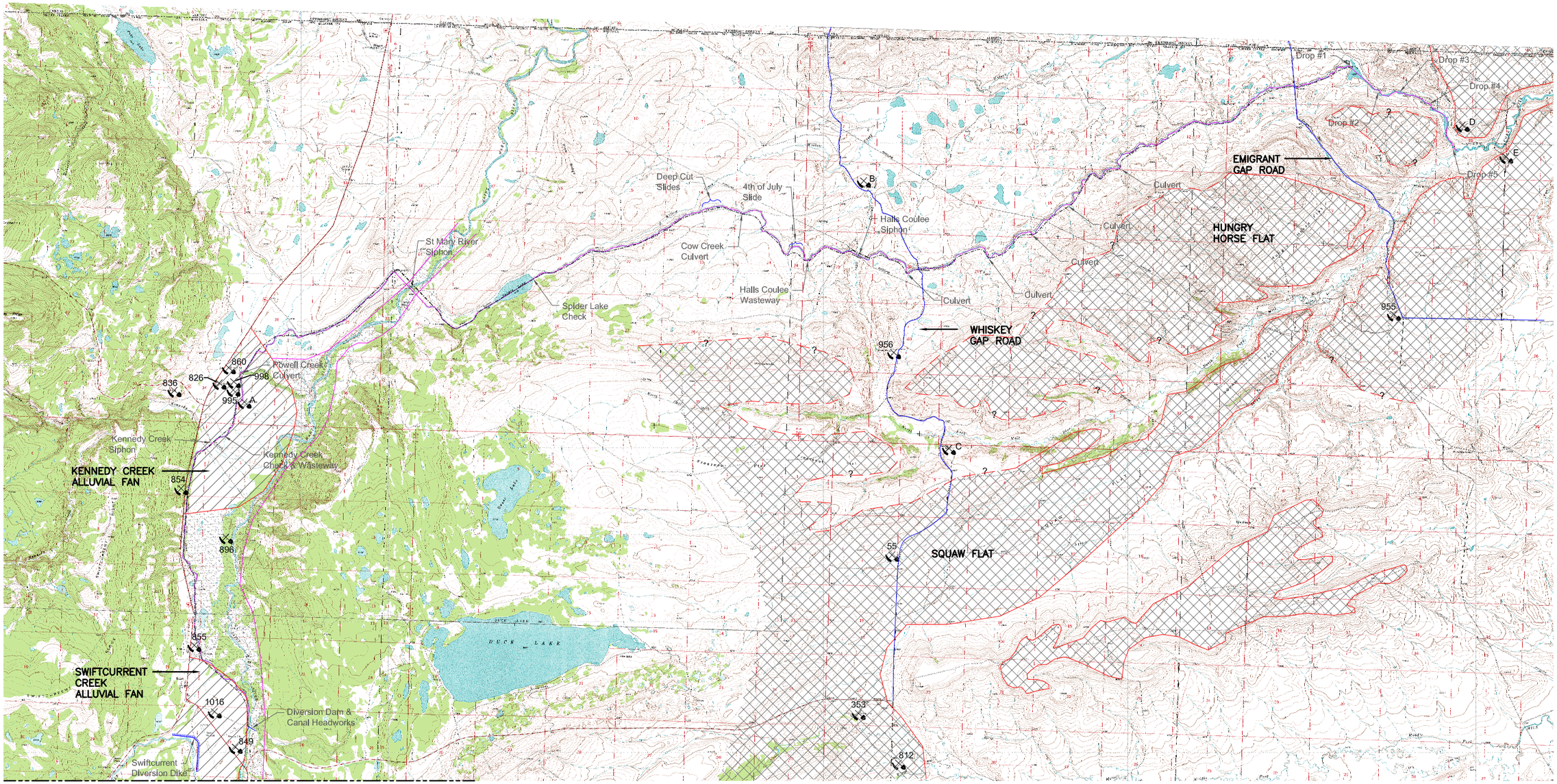
K_{tm} - Upper Cretaceous Two Medicine Formation
Greenish-gray clay with local nodular limestone and cross-bedded sandstone; locally some coal in lower part.

K_u - Cretaceous Undifferentiated
(disturbed belt – subdivision difficult – contains **K_{vi} Virgelle formation** Gray to buff massive cliff forming sandstone with iron-stained concretions in the upper part)

pC_{ap} – Appekunny Argillite
Gray quartzitic argillite and quartzite

pC_a – Altyn Limestone
Dolomite and magnesian limestone

Fault observed _____ inferred --------



ALLUVIAL FAN DEPOSITS

ST. MARY RIVER ALLUVIUM

GLACIAL DRIFT/OUTWASH

812 Borrow Pits (With MDT ID No. if Available)

A Borrow Pits (Not registered with MDT)

N

N.T.S.

FIGURE 7

MONTANA
ERLING A. JUEL
10740PE
REGISTERED
PROFESSIONAL ENGINEER

REVISIONS
BY DATE DESCR
BY DATE DESCR
BY DATE DESCR

TD&H

THOMAS, DEAN & HOSKINS, INC.
ENGINEERING CONSULTANTS
GREAT FALLS—BOZEMAN—KALISPELL
LEWISTON
MONTANA
WASHINGTON
IDAHO

DRAWN BY:	MWC
DESIGNED BY:	EAJ
QUALITY CHECK:	
DATE:	02.01.08
JOB NO.	04-167
FIELDBOOK	

DNRC - CARDD
ST. MARY DIVERSION FACILITIES

BORROW RESOURCE STUDY - PHASE I
POTENTIAL GRAVEL DEPOSITS

CAD NO. ST. MARY .DWG
SHEET 1 OF 1

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5.2 ST. MARY RIVER VALLEY

As stated earlier, the St. Mary River Valley from the Diversion Dam to the St. Mary River Siphon crossing exhibits numerous occurrences of gravel in sufficient quality and quantity. Specifically the Swiftcurrent Creek and Kennedy Creek alluvial fans are exceptional sources of gravel including a desirable percentage of over-size fraction. The over-size portion, that amount greater than 4-inches, is needed for a source of riprap, canal armor and slope stabilization buttress material.

A preliminary research of land ownership indicates that the USBR owns the majority of the Swiftcurrent Creek alluvial fan between Hwy 89, the St. Mary Canal and the Babb townsite. The USBR also owns large tracts of the Kennedy Creek alluvial fan. The extent of USBR ownership as well as the actual ownership of the remaining and adjacent tracts should be confirmed with additional research during a follow-up Phase II Study.

The undeveloped pit on the Swiftcurrent fan (MDT #1016) and the two undeveloped pits on the Kennedy Creek fan (MDT #995 and MDT #998) are likely areas for additional studies. Based on their preliminary studies, the MDT determined the following, estimated quantities of gravel. The volumes are based on the areas investigated by MDT and an assumed 10-foot deep pit.

Table 9 - MDT-Estimated Gravel Volumes

Potential Pit	Est. Quantity
1016	305,100 C.Y.
995	162,500 C.Y.
998	374,000 C.Y.

5.3 DUCK LAKE/SQUAW FLAT DRIFT

The area east of Duck Lake and south of the Hudson Bay Divide also exhibits tremendous potential for gravel deposits based on our field observations and a review of available information. Based on our preliminary geologic reconnaissance, the area referred to as Squaw Flat is represented by the investigations and lab testing performed for potential pit MDT #55.

MDT estimates approximately 47,800 C.Y. of gravel based on a surface area of 2.9 acres and a 10-foot depth. As a comparison, expanding the extraction area to 8.4 acres would yield approximately 135,500 C.Y. of gravel and aggregate. This area is situated on Whiskey Gap Road and provides relatively good access to the Hall Coulee Siphon area and Canal Reaches No. 4 and No. 5 (Table 1).

5.4 REMNANT TERRACE GRAVELS

There are scattered gravel deposits amongst the hills along the Hudson Bay Divide. They are situated south of the St. Mary Canal and north of the North Fork of the Milk River as shown of Figure 7. These occurrences are sporadic and discontinuous and tend to be located at higher elevations then the Duck Lake/Squaw Flat deposits. Geologically these small pockets of gravel most likely represent the erosional remnants of former mountain alluvial outwash not entirely impacted or eroded by later glaciations. Examples of these pits include MDT #956, #B, #C, #D, and #E. In our opinion, these deposits of gravel may not necessarily offer a tremendous opportunity for a multi-aggregate pit. Also, based on our experience, these smaller deposits of gravel often exhibit marginal quality or inconsistency with respect to quality.

6.0 SUMMARY

6.1 PROJECT NEEDS

Based on a review of the *Feasibility and Preliminary Engineering Report* (TD&H, 2006), prepared by TD&H Engineering approximately 500,000 cubic yards may be needed to rehabilitate the St. Mary River Diversion and Conveyance Facilities. This quantity would be distributed over nearly 30 miles. As part of the PER, the canal portion was subdivided into six segments or reaches for the purpose of future design and discussion. Most of the canal reaches begin and end at the five major hydraulic structures. Many other, yet smaller hydraulic structures are warranted and their aggregate needs are combined with their respective canal reach.

The quality of the proposed aggregate must be compatible with the harsh and aggressive conditions which they will be exposed. By their nature, hydraulic structures are subjected to constant saturation during their use. In the off-season, extreme freezing temperatures can cause severe stresses and damage to water-logged aggregates and concrete. This repeated, freeze-thaw cycle can lead to accelerated deterioration of inadequate aggregate. Therefore, potential aggregate sources must be evaluated for wear, soundness and overall durability.

To save construction time and minimize costs, it is desirable to identify several potential aggregate sources along the entire project. It is important to establish potential quantity, aggregate suitable, and any logistics that may limit pit development. Such economic parameters may include land owner agreements, imposed royalties, reclamation requirements, access, availability to power and water, overburden stripping ratios, and the degree of aggregate processing required to manufacture the desired finished products.

6.2 AVAILBLE AND POTENTIAL SOURCES

Based on the results of our study, we have identified twenty existing or former gravel pits within an approximate 200 square mile area encompassing the St. Mary Diversion Project. In that area, four additional, potential pits exist that were investigated, sampled and tested but apparently

were never developed. Table 10 summarizes the twenty-four known gravel pits identified as part of this study.

In general, all of the pits that were sampled and tested yielded aggregate of suitable quality. The remaining usable quantity of the existing or former pits is not known. However, the four undeveloped pits sampled and tested by MDT reportedly have sufficient quantity to meet the project needs. Unfortunately, the majority of available gravel is located in the initial 5 miles of the Project.

Table 10 - Summary of Gravel Pits within General Vicinity of St. Mary Diversion Project

Identified Gravel Resource	Status of Resource
55	**Undeveloped**, Native Ground
351	Former, Reclaimed, Inactive
353	Existing, **Active**, Partially Reclaimed
812	Could Not Find, Assumed Former And Reclaimed
826	Existing, Unreclaimed, Inactive
836	Former, Reclaimed, Inactive
837	Former, Mostly Reclaimed, Inactive
848	Former, Reclaimed, Inactive
849	Former, Inactive, Used to Stock-pile Materials
850	Former, Reclaimed, Inactive
854	Could Not Find, Assumed Former and Reclaimed
855	Could Not Find, Assumed Former and Reclaimed
860	Existing, **Active**, Unreclaimed
896	Existing, Inactive
955	Existing, Unreclaimed, Inactive
956	Existing, **Active**, Unreclaimed
995	**Undeveloped,** Considerable Debris and Trash
998	**Undeveloped,** Miscellaneous Debris and Trash
1016	**Undeveloped,** Occasional Pot-holes and Misc. Debris
A	Former, Partially Reclaimed
B	Former, Partially Reclaimed
C	Existing, **Active**, Unreclaimed
D	Former, Partially Reclaimed
E	Existing, Inactive

Figure 8 graphically summarizes the distribution of aggregate needs along the entire length of the Project. In addition, potential sources along with approximate haul distances are provided. Downstream of the St. Mary River Siphon, only two access points currently connect to the existing road network. They are the Whiskey Gap and Emigrant Gap Roads. Both are gravel-surfaced roads maintained by Glacier County.

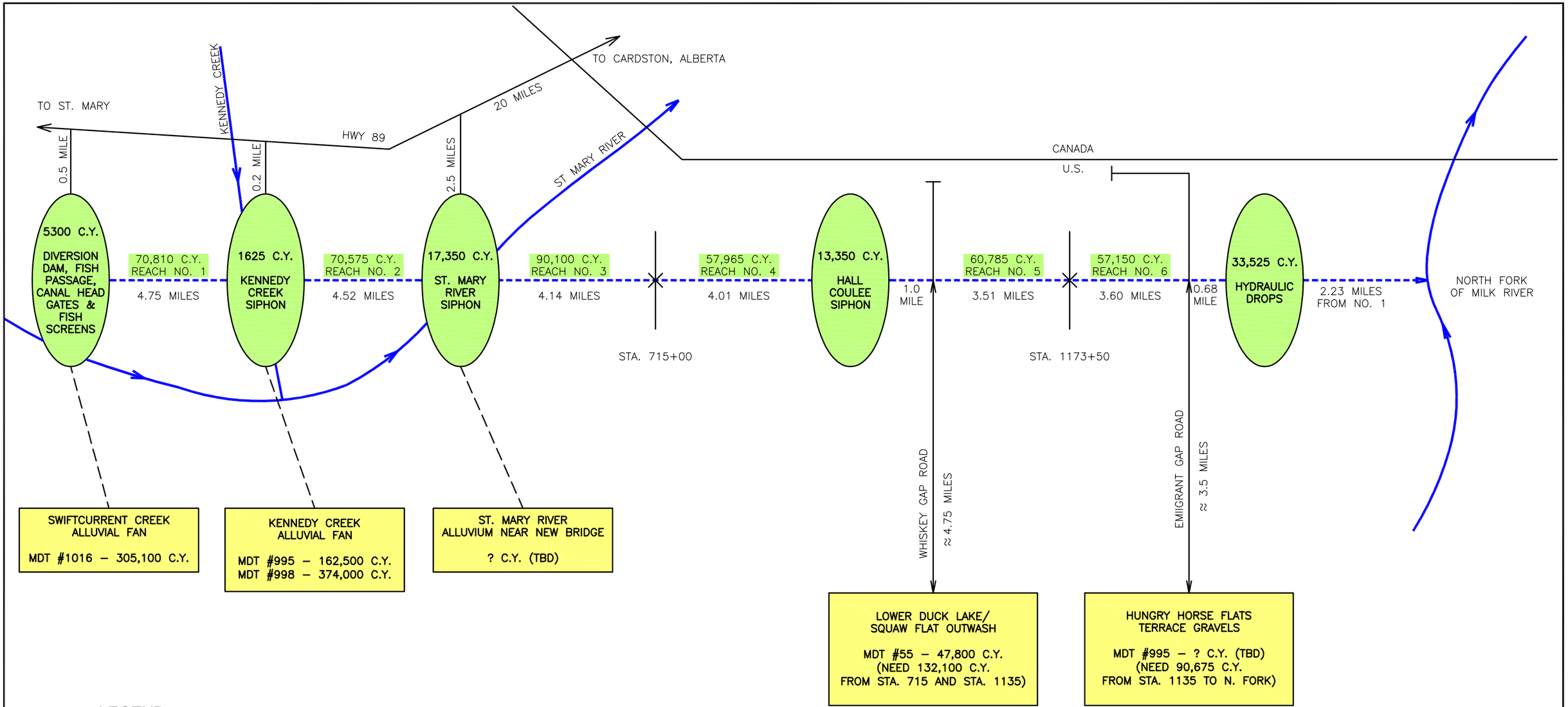
As can be seen from the schematic aggregate balance diagram, there is a need to locate potential gravel sources along the downstream half of the project. Based on our observations and the available data, the opportunity to locate additional quantity of gravel is favorable. The concern regarding these yet identified sources is the quality of the source. Specifically, the percent of over-size material that is needed for canal armor and riprap. Also, the amount of fines (<#200 sieve) and their plasticity is a concern. In general, the amount of over-size material is expected to decrease while the percentage of fines is expected to increase with increasing distance from the gravel source, i.e. the Rocky Mountains.

6.3 RECOMMENDATIONS

It is recommended that a second level study be implemented to identify and secure gravel and aggregate sources for the eastern half of the Project. Also, confirmation sampling and testing should be performed on likely aggregate sources within the St. Mary River Valley to ensure compatibility with Project needs. Discussions with USBR should be conducted to develop a suite of aggregate suitability testing methods and procedures. The Phase II Borrow Resource Study should include, at a minimum the following scope of work.

<u>St. Mary River Valley</u>

- Research current land ownerships and establish preliminary dialogue with the owners with respect to potential pit development, limitations, royalties, and reclamation requirements, etc. Likely areas of focus include Pits #995, #998 and #1016 investigated by MDT.



LEGEND

- ST. MARY CANAL WITH AGGREGATE NEEDS AND LENGTHS
- MAJOR HYDRAULIC STRUCTURE WITH AGGREGATE NEEDS
- POTENTIAL AGGREGATE SOURCES

SCHEMATIC AGGREGATE NEEDS VS. SOURCES DIAGRAM

NOTE:
1. ADDITIONAL AGGREGATE SOURCES FOR CANAL REHAB. BETWEEN STA. 715+00 TO N. FORK NEED TO BE ESTABLISHED.
2. AN ADDITIONAL AGGREGATE SOURCE NEAR THE ST. MARY RIVER BRIDGE AND SIPHON WOULD SHORTEN HAUL DISTANCE AND MAY REDUCE COSTS.

FIGURE 8

TD&H
THOMAS, DEAN & HOSKINS, INC.
ENGINEERING CONSULTANTS
GREAT FALLS–BOZEMAN–KALISPELL MONTANA
SPOKANE WASHINGTON
LEWISTON IDAHO

J:\2004\04-167\landdevelopment\g167\dwg\04167-SCHEMATIC.dwg, 8/14/2008 2:58:13 PM, OTR

- Perform confirmation test pits, sampling and testing on potential aggregate borrow sources on the Swiftcurrent and Kennedy Creek alluvial fans. It is imperative to confirm that the gravel has not been previously mined and that the subsequent area has not been filled and reclaimed beyond detection.

- Conduct discussions with land owners in the vicinity of the St. Mary River Siphon to discuss the possibility of developing additional gravel sources. This will reduce haul distances to Reaches No. 3 and No. 4. If favorable, conduct a preliminary subsurface investigation and an aggregate suitability testing program.

- Contingencies need to be developed should these potential pits not prove favorable.

- Land surveying of the borrow areas and/or legal surveys to establish property limits may be initiated at favorable pit locations.

Lower Duck Lake/Squaw Flat

- Research current land ownerships and establish preliminary dialogue with the owners with respect to potential pit development, limitations, royalties, and reclamation requirements, etc. Likely areas of focus include Pit #55 investigated by MDT and the surrounding vicinity.

- Perform confirmation test pits, sampling and testing on potential aggregate borrow sources for MDT #55 and adjacent areas. It is imperative to confirm that the gravel has not been previously mined (#55) and that the subsequent area has not been filled and reclaimed beyond detection.

- Land surveying of the borrow areas and/or legal surveys to establish property limits may be initiated at favorable pit locations.

Hungry Horse Flats/Terrace Gravels

- Research current land ownerships and establish preliminary dialogue with the owners with respect to potential pit development, limitations, royalties, and reclamation requirements, etc. Likely areas of focus include the general vicinity of Pit #955 investigated by MDT.

- Perform confirmation test pits, sampling and testing on potential aggregate borrow sources.

- Land surveying of the borrow areas and/or legal surveys to establish property limits may be initiated at favorable pit locations.

7.0 REFERENCES

Canal and Related Structures, Design Standards No. 3, USBR, December 1967.

Canal Systems Automation Manual, Vols. 1 and 2, USBR, 1991 and 1995.

Design of Small Canal Structures, USBR, 1978.

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MDT PIT #55

Form No. 92
(Rev. 1-93)

MASTER FILE COPY

STATE OF MONTANA

Index #55

DEPARTMENT OF TRANSPORTATION
Helena, Montana

PROSPECTED AREA REPORT

Lab.No. 712335-42

Sample SEE PAGE TWO

County GLACIER

Complete this form in full. Mail three copies to the Materials Bureau in Helena, and send one copy with the sample.

Project No. RTS 464-1(6)1 PE Designation BROWNING - NORTH

Sampled by C. KIRBY & J. BALLARD Title M.L.T. II

Address GREAT FALLS Date Sampled 6-21-95

Type of Material GRAVEL Sample Tested for PROPOSED SURFACING

Owner BLACKFOOT TRIBAL RESERVE #2 Address BROWNING, MONTANA

CONTACT DON DuBRAY, TRIBAL LAND OFFICE 338-7201

Location(Give ¼/¼ s Sec.) S½, NE¼, SE¼, SEC.7, T36N, R12W

Area is 2.5 Miles N - S / Feet E - W of Mile Post 24.0 on Project RTS 464-1(6)1 PE

Extent of Area 358.01 ft. X 353.67 ft.= 126615.46 sq.ft.= 2.91 acres

Thickness (Gravel) (Above apparent water line 10.0 ft.)
(Scoria)
(Sand) (Below apparent water line 0.0 ft.)
Total 10.0 ft.

Probable cubic yards available 46,894.6 How much O/B? 1.0' to 2.5' AVG. 1.4'

Over 12" 1 % Between 12" & 6" 2 % Between 4" & 6" 6 % Less than 4" 91 %

For what is land used? GRAZING Is water available for washing? NO

Deposit-Is it river, bank or bench gravel? BENCH

Haul road; * 2.5 miles to M.P. 24.0 on Project No. RTS 464-1(6)1 PE

Maximum grade 3% Estimated cost of haul road $200.00 Condition GOOD

Type of existing bridges NONE Condition N/A

Additional bridges required NONE

Haul road owner

ORIGINAL & 3 COPIES - MATERIALS BUREAU 1 - DIST. LAB. FILE, GREAT FALLS

RTS 464-1(6)1 PE
BROWNING - NORTH
JUNE 21, 1995

N½ SE¼ SEC. 7 T36N, T12W
BLACKFOOT TRIBAL
RESERVE

LOG OF TEST HOLES

1. 0.5' TOP SOIL - 0.5' DIRTY GRAVEL - 10.0' GRAVEL - STOPPED IN GRAVEL.

2. 1.5' TOP SOIL - 1.0' O.B. - 10.0' GRAVEL - STOPPED IN GRAVEL.

3. 1.5' TOP SOIL - 0.5' O.B. - 10.0' GRAVEL - STOPPED IN GRAVEL.

4. 0.5' TOP SOIL - 0.5' O.B. - 10.0' GRAVEL - STOPPED IN GRAVEL.

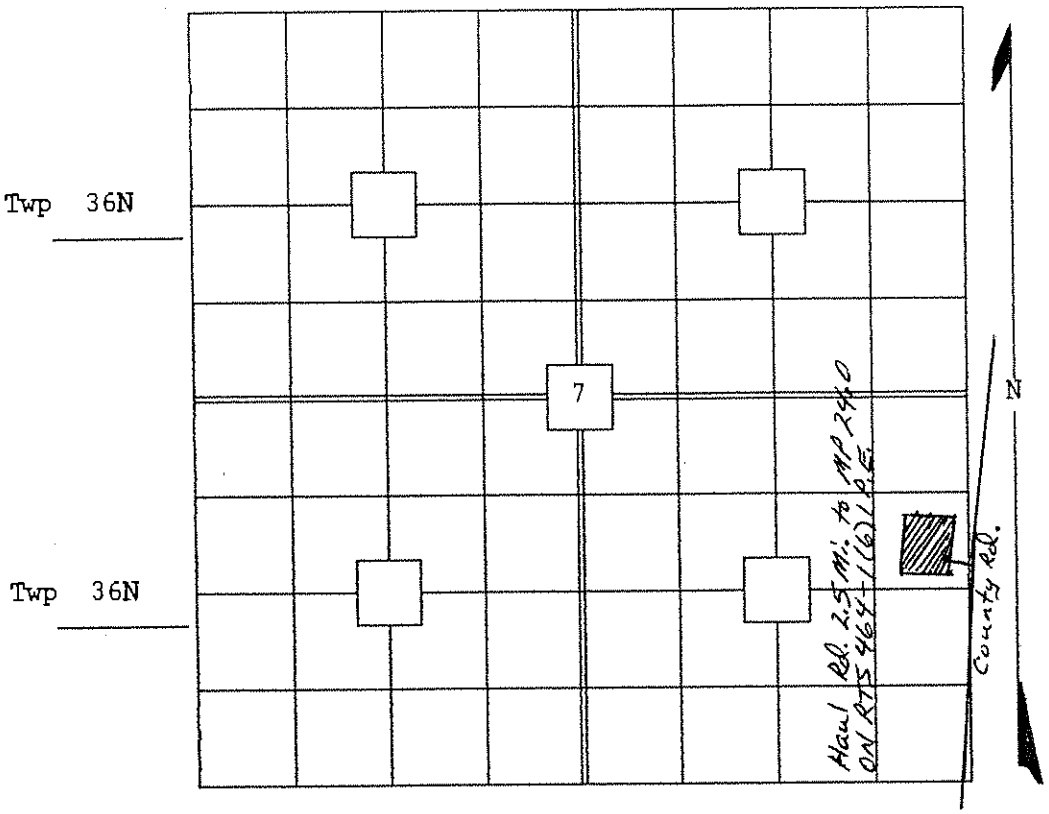
5. 0.5' TOP SOIL - 0.5' O.B. - 10.0' GRAVEL - STOPPED IN GRAVEL.

6. 0.5' TOP SOIL - 0.5' O.B. - 10.0' GRAVEL - STOPPED IN GRAVEL.

7. 0.5' TOP SOIL - 0.5' O.B. - 10.0' GRAVEL - STOPPED IN GRAVEL.

Sec 7 Twp 36N Range 12W

Range 12W Range 12W



The accompanying sketch covers either one complete or four complete sections. In locating area use the section, or sections, which best permits the showing of the prospected area in an approximate relation to the project, haul road, etc. Use solid lines for indication existing haul roads and dashed lines for proposed haul roads.

MINIMUM SAMPLE REQUIREMENTS FOR AN ESTIMATED VOLUME

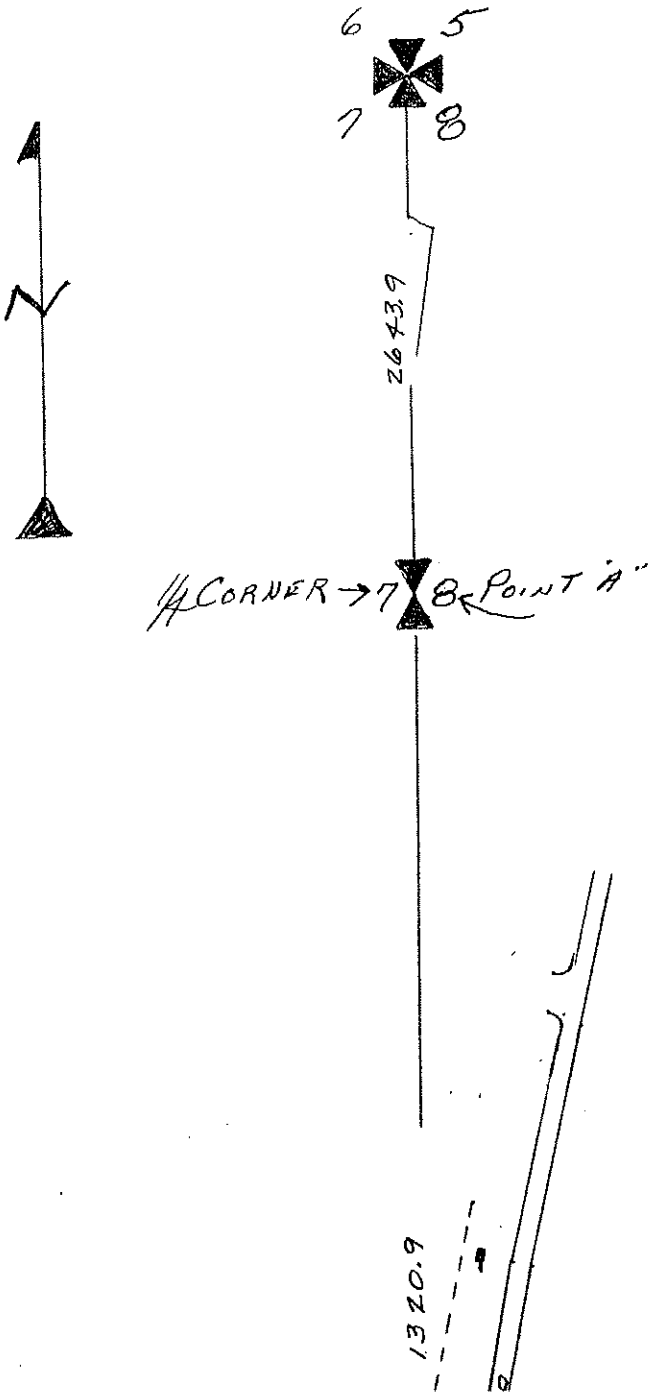
Cubic Yards	No. of Samples
Up to 50,000	Min. of 3
50,000 to 100,000	3 to 5
100,000 to 150,000	5 to 8
150,000 to 200,000	8 to 10

No sample shall represent more than 3 test holes.

SAMPLES SUBMITTED TO MATERIALS BUREAU

TYPE OF SAMPLE	SAMPLE NO.	HOLE NO.
PROPOSED SURFACING	1	1
	2	2
	3	3
	4	4
	5	5
"R" VALUE	"R"	COMPOSITE 1,2,3,4, & 5
MODIFIED LOTTMAN	M/L	COMPOSITE 1,2,3,4, & 5

RTS 464-1(6) P.E
PIT TIE



BROWNING NORTH
S½, NE¼, SE¼, Sec. 7
T 36 N R 12 W

GLACIER COUNTY
BLACKFEET TRIBAL

1" = 200'

100ex #55

MASTER FILE COPY

MB Lab Form 123A

PROSPECTED AREA REPORT

PROJECT NO. RTS 464-1(6)1 P.E.

TERMINI Browning - N.

LAND LOCATION N½SE¼, Sec. 7, T-36-N, R-12-W

OWNER Blackfoot Tribal Reserve ADDRESS Browning, MT

The sampler estimated the area averaged 1.4 feet of overburden. 1 percent of the sampled material was greater than 12 inches in size, 2 percent was between 6 and 12 inches, 6 percent was between 4 and 6 inches and 91 percent was less than 4 inches in size.

NOTE: This composite sample passes the petrographic examination for surfacing aggregate.

NON-BITUMINIZED SURFACING

The attached test results indicate this material is satisfactory. The Standard Specification of 50% Maximum Wear has been met.

BITUMINIZED SURFACING

The attached test results indicate that hydrated lime improves the Modified Lottman and may be recommended. Otherwise this material is satisfactory. The Supplemental Specification of 40% Maximum Wear has been met.

THIS REPORT INCLUDES THE FOLLOWING LAB NOS. WHICH ARE ATTACHED:

712335 through 712342

R. Scott Barnes DATE: 7-17-95

1 Dist. Mat'ls. Supr. Great Falls
1 Project Managers Great Falls
1 Surfacing Design Unit - Helena
1 Glacier County File
1 Bituminous Section - Helena
1 Materials Bureau File
1 M. Lynch

PE:G:MT:78.cg

Attachment

ATTACHMENT TO LAB FORM NO. 123A
SUMMARY OF LABORATORY TESTS

Prep'd by PE
Date 07/13/95

LAB NO. 712335 TO 712342 INCLUSIVE. ESTIMATED VOLUME (Cu. Yds.) ---

DATE SAMPLED 6-21-95 DATE RECEIVED IN HELENA 6-27-95

PROJECT NO. RTS 464-1(6)1 P.E.

TERMINI Browning - N.

LAND LOCATION N½SE¼, Sec. 7, T-36-N, R-12-W

OWNER Blackfoot Tribal Reserve ADDRESS Browning, MT

Lab No.	Sam. No.	Hole No.	Wear	LL	PI	Vol. Swell	Soil Class	4 Mesh rec'd	4 Mesh tested	200M rec'd	200M tested
712335	1	1	19	NP	NP	2.8 hard	A-1-a(0)	22	22	1.6	1.6
712336	2	2	21	NP	NP	3.5 hard	A-1-a(0)	26	26	2.1	2.1
712337	3	3	19	NP	NP	2.2 hard	A-1-a(0)	18	18	1.4	1.4
712338	4	4	18	NP	NP	1.9 hard	A-1-a(0)	13	13	1.1	1.1
712339	5	5	19	NP	NP	1.9 hard	A-1-a(0)	18	18	1.3	1.3
712340	1	RV Comp		NP	NP	2.7 hard	A-1-a(0)	35	36	2.2	2.3
712341	1	IC Comp		NP	NP	2.7 hard	A-1-a(0)	34	55	3.0	6.0
712342							Rutting				

Adhesion	75%	No Additive
Adhesion	85%	+ 1.5 H.L.
Sand Equiv.	37%	712341
Fractured	81%	712341
R-Value	72	712340

MODIFIED LOTTMAN RESULTS
Pen. Asphalt 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.0	47.4	31.1	65.6%
1.4	HYD LIME	6.0	46.2	40.6	88.0%

Frac. %	Add.	4.5% AC Stab. lbs.	4.5% AC Voids %	5.5% AC Stab. lbs.	5.5% AC Voids %	6.0% AC Stab. lbs.	6.0% AC Voids %	6.5% AC Stab. lbs.	6.5% AC Voids %
81	None	1649	6.8	1749	4.6	1818	3.5	1886	2.5
81	HL	1820	7.0	1528	4.5	1690	3.3	1851	2.1

PE:G:MT:79.cg

MBT Form No. 39
(Rev. 3-92)GFL

MASTER FILE COPY

STATE OF MONTANA
Department of Transportation

FIELD PROPOSED SURFACING REPORT

Project No. : RIS 464-1(6)1 P.E.
Date: JUNE 21, 1995
Submitted By : JAMES O. BLOSSUM
Land Location: N½, SE¼, SEC.7, T36N, R12W
Owner: BLACKFOOT TRIBAL RESERVE

Termini: BROWNING - NORTH
District: GREAT FALLS
Title: DMS
Est. Volume(Cys.): UNDETERMINED
County: GLACIER
Address: BROWNING, MONT.

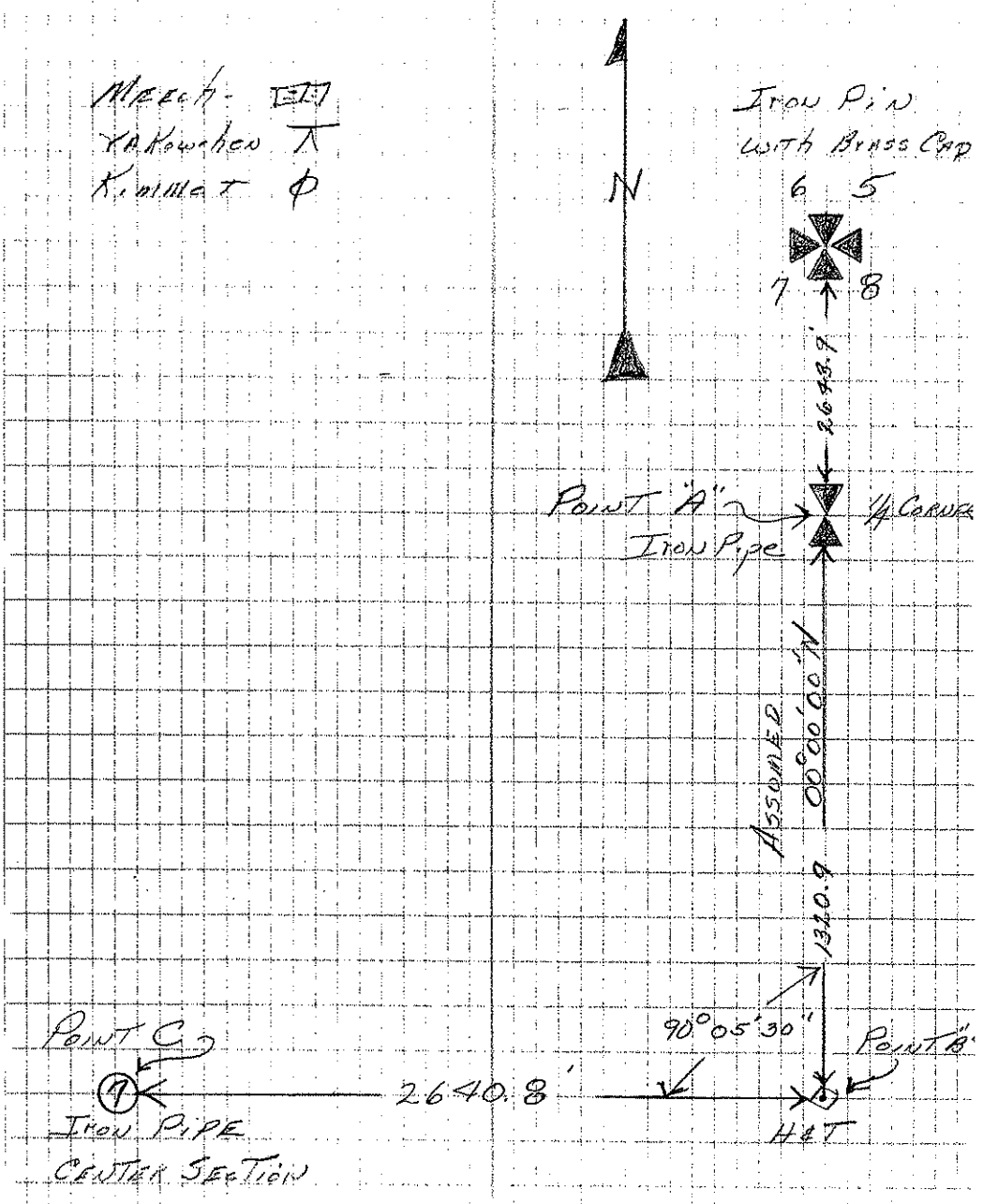
Dist.Lab. No.	Sample No.	Hole No.	6"	5"	4"	3"	2"	1½"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	SOIL CLASS	VOLUME SWELL 24 HOUR
30637	1	1			100	93	72	67	53	47	38	33	24	15	4	2	1.8	NP	NP	A-1-a(0)	3.9
30638	2	2		100	100	87	71	67	57	49	41	36	26	19	7	4	3.5	NP	NP	A-1-a(0)	4.1
30639	3	3			100	89	71	66	55	48	38	33	22	13	4	2	1.9	NP	NP	A-1-a(0)	3.6
30640	4	4			100	85	71	64	55	49	40	36	27	18	6	3	2.7	NP	NP	A-1-a(0)	2.7
30641	5	6		100	89	81	75	65	53	45	37	32	22	13	5	3	1.8	NP	NP	A-1-a(0)	2.6

Sampled By: C. KIRBY & J. BALLARD
Remarks:
1-Materials Bureau, Pat Ernst
1-Dist. Lab. File

Index #55

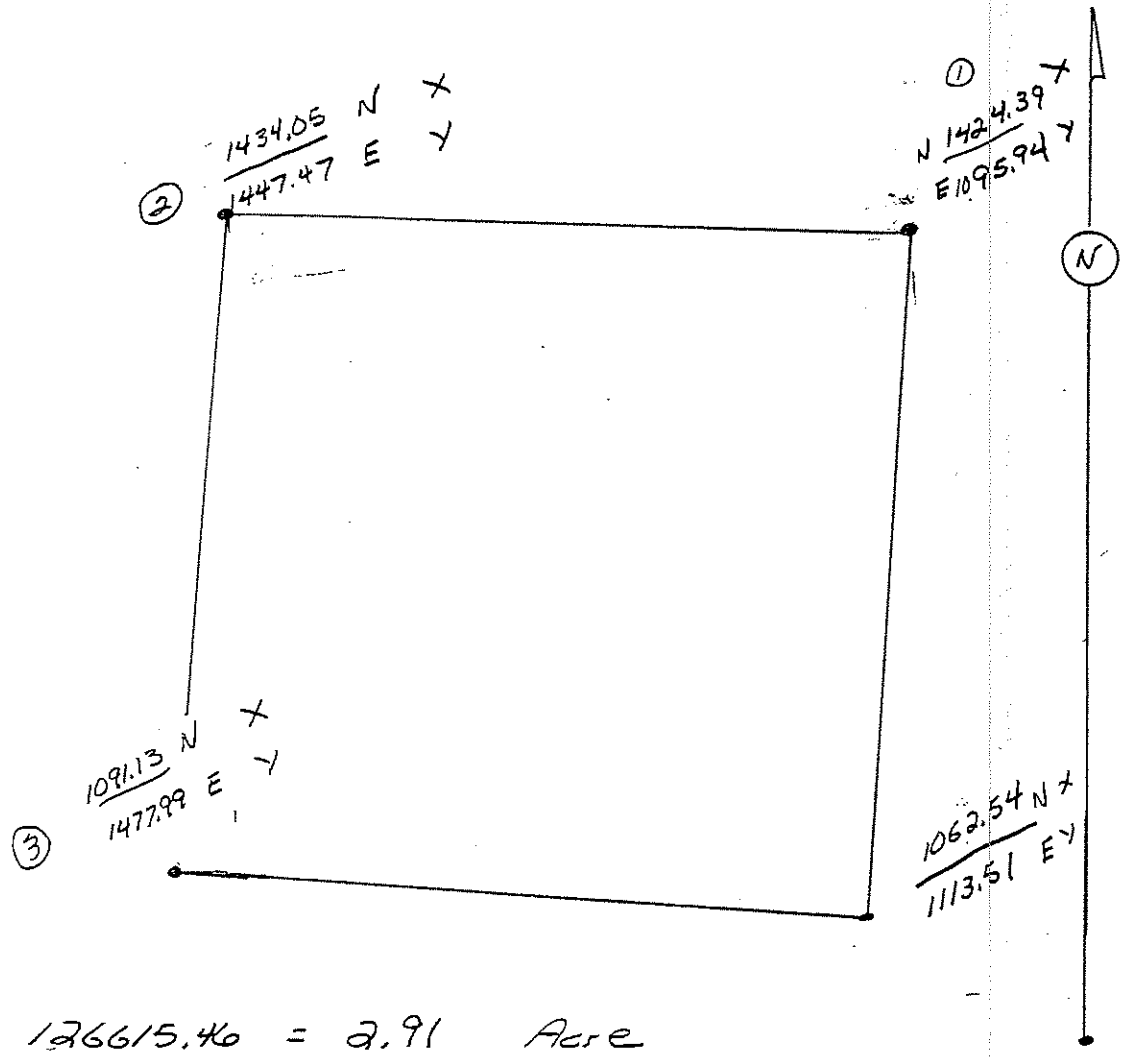
7/27/95
RTS 464-1(6) P.E.
Browning North

Meech - [illegible]
K.A. Kowalchen [illegible]
K. Willatt [illegible]



FORM CSN-02

Notes: W. Meech



126615.46 = 2.91 Acre

1000/1000

MDT PIT #995

Index # 995

Form No. 92
(Rev. 2-78)

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS
Helena, Montana

Lab.No. 667945 - 52

Sample See Reverse Side

PROSPECTED AREA REPORT

County Glacier

Complete this form in full. Mail three copies to the Materials Bureau in Helena, and send one copy with the sample.

Project No. F-58-1-(7)32 PE Designation St. Mary - Canadian Line

Sampled by Stan Kuntz Title MLT II

Address Gt. Falls Date Sampled 9-23-91

Type of Material Gravel Sample Tested for Proposed Surfacing

Owner Blackfoot Tribe Address P.O.Box 850 Browning,Mt. 59417

Contact Don Dubray at the Blackfoot Tribal Land Office at 338-7201

Location(Give ¼ ¼ Sec.) NE¼NE¼SE¼,Sec.34,T37N,R14W

Area is 0.1 Miles ~~N~~ - S Feet E - ~~W~~ of Station 243+83 on Project FAP 58

Extent of Area 662 ft. x 663 ft.= 438,934 sq.ft.= 10.08 acres

Thickness (Gravel) (Above apparent water line 10.0 ft.)
(~~XXXXXXX~~) Total 10.0 ft.
(~~XXXX~~) (Below apparent water line ft.)

Probable cubic yards available 162,568 How much O/B? From 1.0' to 2.5' 1.5 Ft.

Over 12" 5 % Between 12" and 6" 10 % Between 4" and 6" 35 % Less than 4" 50 %

For what is land used? Grazing Is water available for washing? No

Deposit-Is it river, bank or bench gravel? Bench

Haul Road; * 0.1 miles to sta. 243+83 on Project No. FAP 58
*(Measured to nearest 1/10 mile over practicable truck route to definite station on project)

Maximum grade 1% Estimated cost of haul road $100. Condition Poor

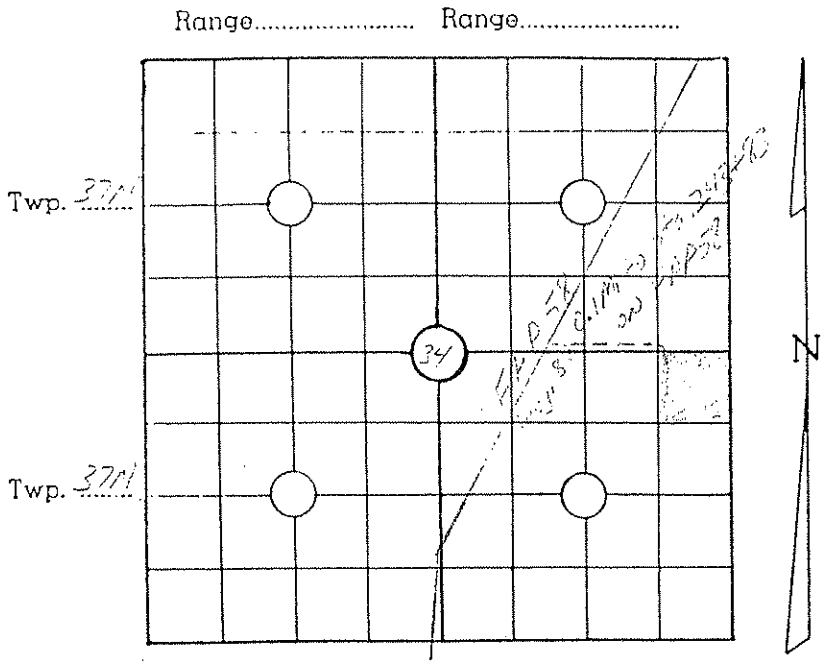
Type of existing bridges None Condition

Additional bridges required None

Haul road owner Address
(Name and address of owner of land crossed by haul road to a public highway)

3-Helena ~~1-Dist.~~ Lab Index

Sec. 34 Twp. 37N Range 12W



The accompanying sketch covers either one complete or four complete sections. In locating area use the section, or sections, which best permits the showing of the prospected area in an approximate relation to the project, haul road, etc. Use solid lines for indicating existing haul roads and dashed lines for proposed haul roads.

MINIMUM SAMPLE REQUIREMENTS
FOR AN ESTIMATED VOLUME

Cubic Yards	No. of Samples
Up to 50,000	Min. of 3
50,000 to 100,000	3 to 5
100,000 to 150,000	5 to 8
150,000 to 200,000	8 to 10

No sample shall represent more than 3 test holes.

LOG OF TEST HOLES

Use separate sheet for area sketch.
Attach Form C.B. 18 for reclamation information.

Samples Submitted

Proposed Surfacing	#1	Hole 1
" "	#2	Hole 5
" "	#3	Hole 13
" "	#4	Hole 18
" "	#5	Hole 23

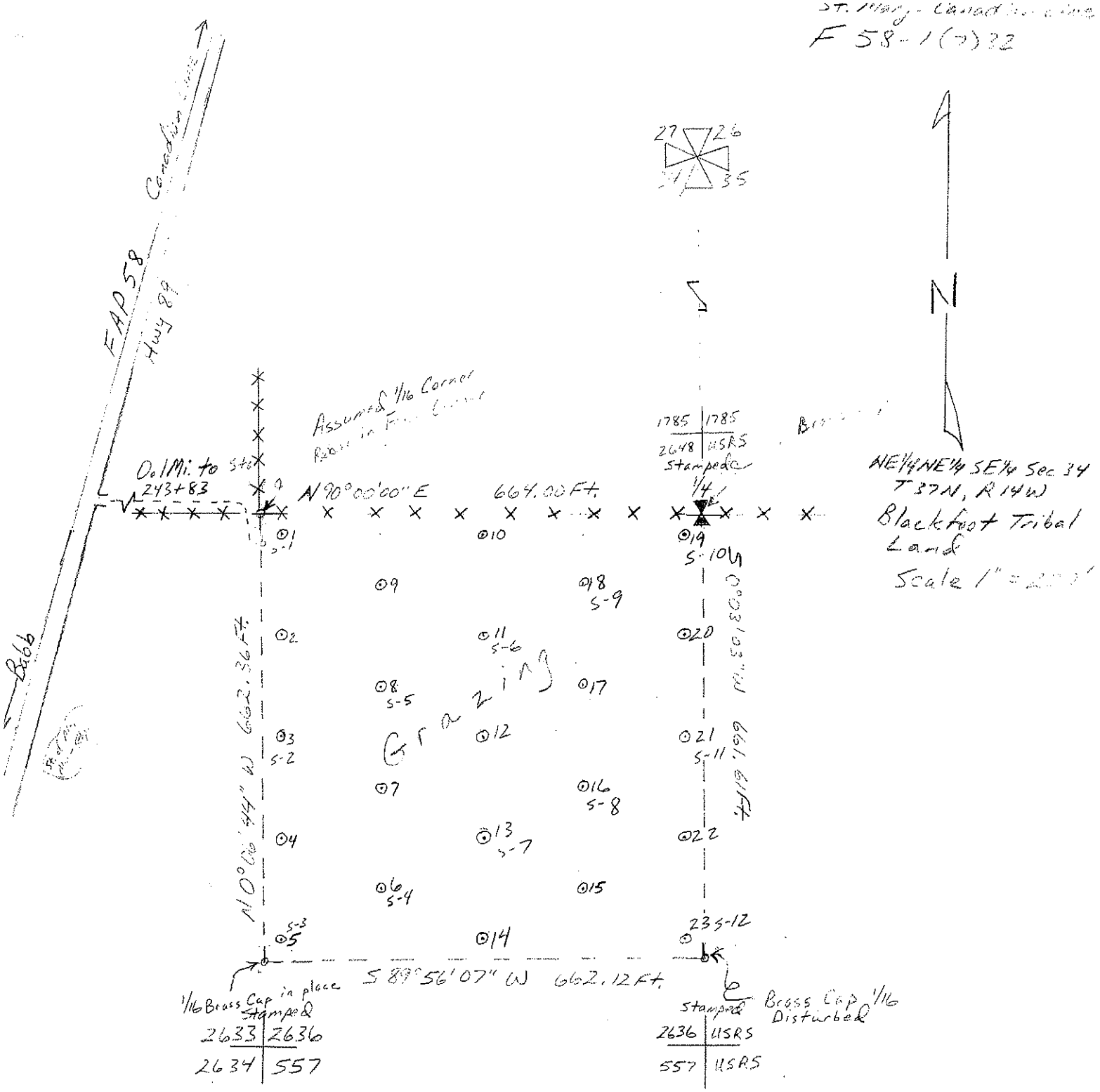
Immersion Compression	I/ C	Composite of Holes:1,3,5,6,8,11,13,16,18,19, 21,&23.
"R" Value	"R"	Composite of Holes:1,3,5,6,8,11,13,16,18,19, 21,&23.

F 58-1(7)32PE
ST.Mary-Canadian Line
NE¼NE¼SE¼,Sec.34,T37N,R14W

Log of Holes

1. 0.5'Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
2. 0.5'Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
3. 0.5'Topsoil,1.5'Overburden,11.0'Gravel,Stop in Gravel
4. 0.5'Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
5. 0.5'Topsoil,2.0'Overburden,9.5'Gravel,Stop in Gravel
6. 0.5'Topsoil,0.5'Overburden,11.0'Gravel,Stop in Gravel
7. 0.5'Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
8. 0.5'Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
9. 0.5'Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
10. 0.5'Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
11. 0.5'Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
12. 0.5'Topsoil,1.5'Overburden,9.5'Gravel,Stop in Gravel
13. 0.5'Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
14. 0.5'Topsoil,0.5'Overburden,10.0'Gravel,Stop in Gravel
15. 0.5'Topsoil,1.0'Overburden,10.0'Gravel,Stop in Gravel
16. 0.5'Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
17. 0.5'Topsoil,1.5'Overburden,9.5' Gravel,Stop in Gravel
18. 0.5'Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
19. 0.5'Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
20. 0.5'Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
21. 0.5'Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
22. 0.5'Topsoil,2.0'Overburden,9.0'Gravel,Stop in Gravel
23. 0.5'Topsoil,0.5'Overburden,10.0'Gravel,Stop in Gravel

St. Mary - Canadian Crossing
F 58-1(7)32



Index #995

MB Lab Form 123A

91 OCT 30 AM 10:29
GREAT FALLS

PROSPECTED AREA REPORT

PROJECT NO. F 58-1(7)32 P.E.

TERMINI St. Mary - Canadian Line

LAND LOCATION NE¼NE¼SE¼, Sec. 34, T. 37 N., R. 14 W.

OWNER Blackfoot Tribe **ADDRESS** Browning, Montana

Current samples at this location are covered by Lab Nos. 667945 through 667952 inclusive.

NON-BITUMINIZED SURFACING

The attached test results indicate this material is satisfactory. The Special Provision of 40% Maximum Wear has been met.

BITUMINIZED SURFACING

The attached test results indicate that 75% rejection of the natural fines is required to reduce the volume swell. Hydrated lime improves the Immersion Compression, Modified Lottman and Marshall stability and may be recommended. Otherwise this material is satisfactory. The Special Provision of 40% Maximum Wear has been met.

THIS REPORT INCLUDES THE FOLLOWING LAB NOS. WHICH ARE ATTACHED:

667945 through 667952

Bradley Bruce DATE: Oct 28, 1991

T. Scott Brown
MATERIALS BUREAU
Dated 10/28/91

1 Dist. Mat'ls. Supr. Great Falls
1 Project Managers Great Falls
1 Pavement Analysis Unit - Helena
1 Glacier County File
1 Bituminous Section - Helena
1 Materials Bureau File
1 M. Lynch

PE:D:MT:180.cg

Attachment

"A quantity of material may have/has been removed from this source since originally prospected."
A Kurtz Date 4-7-97

ATTACHMENT TO LAB FORM NO. 123A
SUMMARY OF LABORATORY TESTS

Prep'd by PE
Date 10/25/91

LAB NO. 667945 TO 667952 INCLUSIVE. ESTIMATED VOLUME (Cu. Yds.) ---

DATE SAMPLED 9-23-91 DATE RECEIVED IN HELENA 10-9-91

PROJECT NO. F 58-1(7)32 P.E.

TERMINI St. Mary - Canadian Line

LAND LOCATION NE¼NE¼SE¼, Sec. 34, T. 37 N., R. 14 W.

OWNER Blackfoot Tribe ADDRESS Browning, Montana

Lab No.	Sam. No.	Hole No.	Wear	LL	PI	Vol. Swell	Soil Class	4 Mesh rec'd	4 Mesh tested	200M rec'd	200M tested
667945	1	1	19	NP	NP	11.3 soft	A-1-a(0)	30	30	3.1	3.1
667946	2	5	17	NP	NP	13.5 soft	A-1-a(0)	31	31	4.8	4.8
667947	3	13	17	NP	NP	17.4 soft	A-1-a(0)	31	31	3.8	3.8
667948	4	18	17	NP	NP	11.5 soft	A-1-a(0)	26	26	2.6	2.6
667949	5	23	17	NP	NP	12.3 soft	A-1-a(0)	28	28	3.9	3.9
667950	1	RV Comp		NP	NP	12.1 soft	A-1-a(0)	34	45	4.2	5.5
667951	1	IC Comp		NP	NP	11.6 soft	A-1-a(0)	47	55	6.2	6.0
						8.4 firm	50% Rejection				
						7.0 firm	50% Rejection with HL				
				NP	NP	7.0 firm	75% Rejection				
						4.6 firm	75% Rejection with HL				
						4.3 firm	100% Rejection				
						1.8 hard	100% Rejection with HL				
667952							Rutting				

Adhesion	75%	No Additive
Adhesion	90%	+ 1.5% H.L.
Sand Equiv.	26%	667951
Fractured	68%	667951
R-Value	80	667950

IMMERSION-COMPRESSION RESULTS

75% Rejection **Pen. Asphalt** 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.4	235.6	153.6	65.2%
1.4	HYD LIME	6.3	280.9	233.2	83.0%

MODIFIED LOTTMAN RESULTS

75% Rejection **Pen. Asphalt** 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.4	58.8	19.3	32.8%
1.4	HYD LIME	6.3	62.9	49.5	78.8%

Frac. %	Cr. Fines	Add.	4.5% AC Stab. lbs.	4.5% AC Voids %	5.5% AC Stab. lbs.	5.5% AC Voids %	6.3% AC Stab. lbs.	6.3% AC Voids %	6.4% AC Stab. lbs.	6.4% AC Voids %	6.5% AC Stab. lbs.	6.5% AC Voids %
68	75%	None	1680	8.3	1680	5.6			1814	3.4	1829	3.1
68	75%	HL	1868	6.9	2028	5.9	1862	3.5			1821	2.9

PE:D:MT:181.cg

MBF Form No. 99
(REV. 1-83)

STATE OF MONTANA
Department of Highways

FIELD PROPOSED SURFACING REPORT

Project No. F-58-1(7)PE Termini St.Mary - Canadian Line
Date 10-7-91 District Gt. Falls
Submitted By Jim Powell Title DMS Est. Volume (Cys.)
Land Location NE¼NE¼SE¼,Sec.34,T37N,R14W County Glacier
Owner Blackfoot Tribe Address P.O.BOX 850 Browning,Mt. 59417

Div.Lab.No.	Sample No.	Hole No.	4"	3"	2"	1 1/2"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	Soil Class	Volume Swell 24 Hour	Volume Swell 8 Day	Deg.
3133-35813	1	1	94	81	63	56	48	44	39	35	27	19	9	8	3.6	NP	NP	A-1-a(0)	9.4		
35814	2	3	100	89	80	73	62	54	46	41	31	22	10	9	4.4	NP	NP	A-1-a(0)	12.3		
35815	3	5	100	88	78	72	61	56	49	43	31	21	12	10	5.7	NP	NP	A-1-a(0)	12.2		
35816	4	6	100	86	73	66	56	51	44	39	29	21	10	8	4.3	NP	NP	A-1-a(0)	10.1		
35817	5	8	100	88	75	71	61	55	47	42	31	21	10	9	4.5	NP	NP	A-1-a(0)	13.8		
35818	6	11	100	84	75	60	48	43	37	33	25	18	8	7	3.3	NP	NP	A-1-a(0)	12.0		
35819	7	13	94		74	61	51	45	39	35	26	18	10	8	4.5	NP	NP	A-1-a(0)	16.2		
35820	8	16	100	90	76	68	59	54	45	39	28	20	10	8	4.3	NP	NP	A-1-a(0)	13.1		
35821	9	18	100	87	78	68	57	50	43	38	28	20	9	8	4.1	NP	NP	A-1-a(0)	13.9		
35822	10	19	91	87	74	68	60	55	47	42	33	25	13	11	4.1	NP	NP	A-1-a(0)	9.4		

Sampled By S. Kuntz MLT II
Remarks: No previous history on usage of gravel on this area.

EHW/dk/21R2 1-Matls.Bureau 1-Dist.Lab

MDT PIT #998

INDEX #998

Form No. 92
(Rev. 1-92)

STATE OF MONTANA

DEPARTMENT OF TRANSPORTATION
Helena, Montana

Lab.No. 671490-99

Sample See page 2

PROSPECTED AREA REPORT

County Glacier

Complete this form in full. Mail three copies to the Materials Bureau in Helena, and send one copy with the sample.

Project No. F 58-1(7)32 P.E. Designation ST. MARY - CANADIAN LINE

Sampled by STAN KUNTZ Title MLT. II

Address GREAT FALLS Date Sampled 2/25/92

Type of Material GRAVEL Sample Tested for PROPOSED SURFACING

Owner ROBERT POWELL Address P.O. BOX 129, BABB, MONTANA 59411

PHONE NO.732-5508

Location(Give 1/4 1/4 Sec.) SE1/4 NE1/4, SEC. 34, T37N, R14W

Area is 205 Feet [redacted] - S E - [redacted] of Station 258+00 on Project F 58-1(7)32 P.E.

Extent of Area 1043 ft. X 940 ft.= 980435.41 sq.ft.= 22.5077 acres

Thickness (Gravel) (Above apparent water line 10.3 ft.)
(Below apparent water line 10.3 ft.) Total 10.3 ft.

Probable cubic yards available 374,017 How much O/B? 0.5 - 2.5 AVG. 1.6 FT.

Over 12" 3 % Between 12" & 6" 7 % Between 4" & 6" 20 % Less than 4" 70 %

For what is land used? Grazing Is water available for washing? No

Deposit-Is it river, bank or bench gravel? Bench

Haul road; * 205 Feet to sta. 258+00 on Project No. F 58-1(7)32 P.E.

Maximum grade 0% Estimated cost of haul road $100 Condition Good

Type of existing bridges None Condition

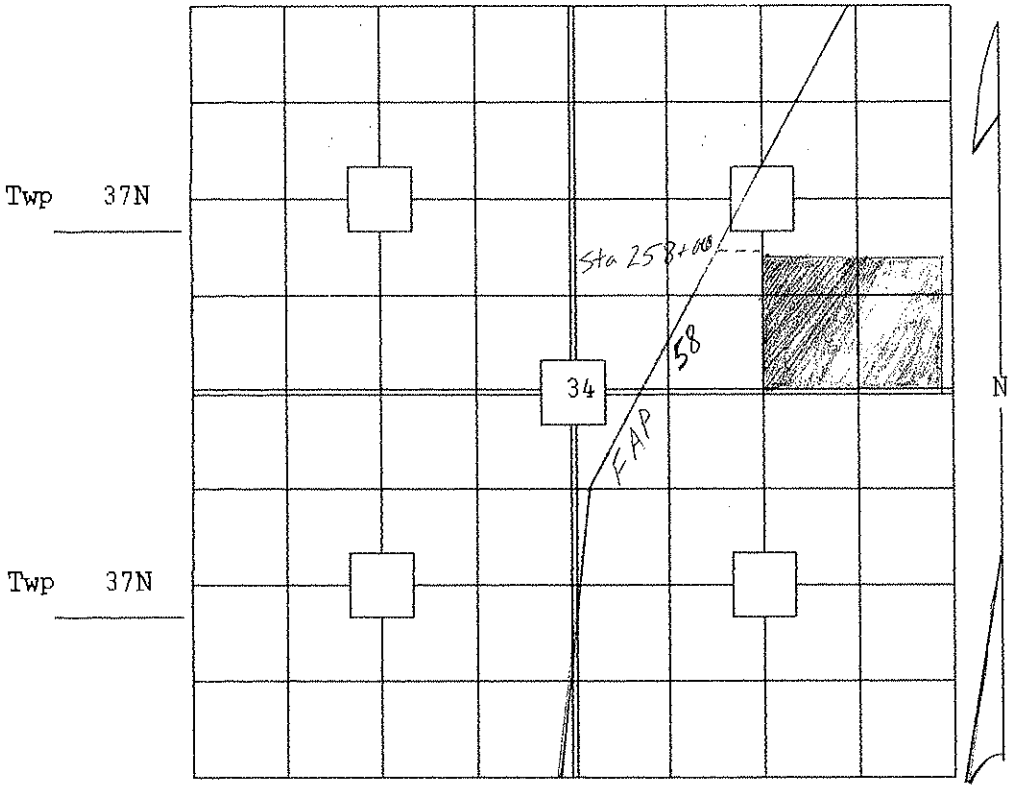
Additional bridges required None

Haul road owner

ORIGINAL & 2 COPIES - MATERIALS BUREAU 2 - DIST. LAB. FILE, GREAT FALLS

Sec 34 Twp 37N Range 14W

Range 14W Range 14W



The accompanying sketch covers either one complete or four complete sections. In locating area use the section, or sections, which best permits the showing of the prospected area in an approximate relation to the project, haul road, etc. Use solid lines for indication existing haul roads and dashed lines for proposed haul roads.

MINIMUM SAMPLE REQUIREMENTS FOR AN ESTIMATED VOLUME

Cubic Yards	No. of Samples
Up to 50,000	Min. of 3
50,000 to 100,000	3 to 5
100,000 to 150,000	5 to 8
150,000 to 200,000	8 to 10

No sample shall represent more than 3 test holes.

SAMPLES SUBMITTED TO MATERIALS BUREAU

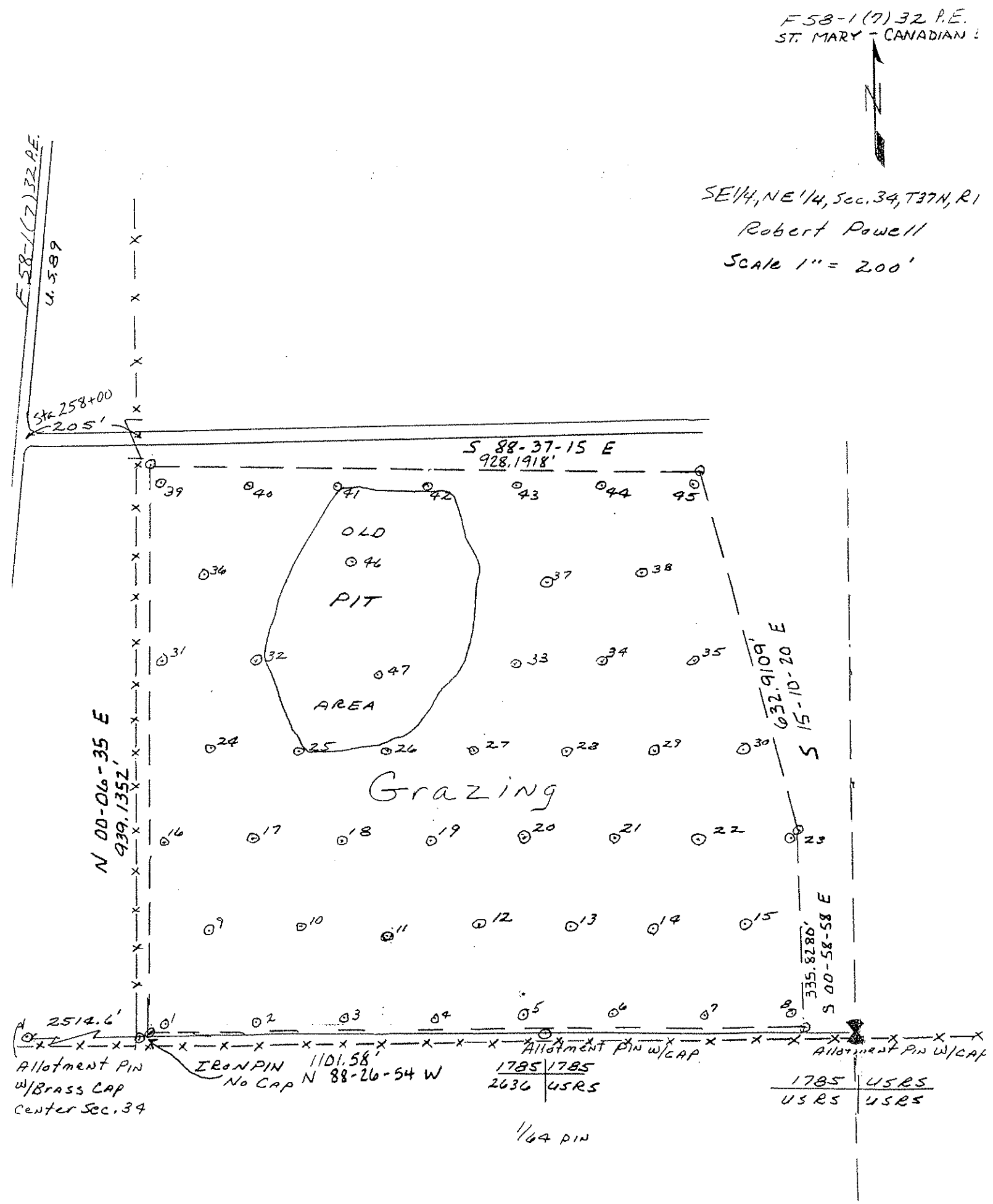
Sample	Sample No.	Hole No.
Proposed Surfacing	1	10
" "	2	13
" "	3	25
" "	4	30
" "	5	33
" "	6	36
" "	7	43
"R" Value	"R"	Composite 1,4,7,10,13,15,16, 19,21,23,25,28,30, 31,33,36,38,39,41, 43,45,47.
I/C	I/C	Composite 1,4,7,10,13,15,16, 19,21,23,25,28,30, 31,33,36,38,39,41, 43,45,47.

F 58-1(7)32 P.E.
FEB. 25, 1992

St. Mary-Canadian Line
SE1/4 NE1/4, SEC. 34,
T37N, R14W
ROBERT POWELL

LOG OF TEST HOLES

1. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
2. 0.5' Topsoil - 1.5' Dirty Gravel - 10.0' Gravel - Stop in Gravel
3. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
4. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
5. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
6. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
7. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
8. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
9. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
10. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
11. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
12. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
13. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
14. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
15. 0.5' Topsoil - 1.5' Dirty Gravel - 10.0' Gravel - Stop in Gravel
16. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
17. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
18. 0.5' Topsoil - 1.5' Dirty Gravel - 10.5' Gravel - Stop in Gravel
19. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
20. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
21. 0.5' Topsoil - 1.5' Dirty Gravel - 10.0' Gravel - Stop in Gravel
22. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
23. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
24. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
25. 0.5' Topsoil - 1.5' Dirty Gravel - 10.0' Gravel - Stop in Gravel
26. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
27. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
28. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
29. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
30. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
31. 0.5' Topsoil - 1.0' Dirty Gravel - 10.0' Gravel - Stop in Gravel
32. 0.5' Topsoil - 11.0' Gravel - Stop in Gravel
33. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
34. 0.5' Topsoil - 1.0' Dirty Gravel - 10.5' Gravel - Stop in Gravel
35. 0.5' Topsoil - 1.0' Dirty Gravel - 12.0' Gravel - Stop in Gravel
36. 0.5' Topsoil - 1.5' Dirty Gravel - 10.5' Gravel - Stop in Gravel
37. 0.5' Topsoil - 1.5' Dirty Gravel - 11.0' Gravel - Stop in Gravel
38. 0.5' Topsoil - 1.5' Dirty Gravel - 11.0' Gravel - Stop in Gravel
39. 0.5' Topsoil - 2.0' Dirty Gravel - 9.5' Gravel - Stop in Gravel
40. 0.5' Topsoil - 1.5' Dirty Gravel - 10.5' Gravel - Stop in Gravel
41. 0.5' Topsoil - 1.5' Dirty Gravel - 10.0' Gravel - Stop in Gravel
42. 0.5' Topsoil - 1.5' Dirty Gravel - 10.5' Gravel - Stop in Gravel
43. 0.5' Topsoil - 1.0' Dirty Gravel - 11.0' Gravel - Stop in Gravel
44. 0.5' Topsoil - 1.5' Dirty Gravel - 10.0' Gravel - Stop in Gravel
45. 0.5' Topsoil - 2.0' Dirty Gravel - 9.5' Gravel - Stop in Gravel
46. 0.5' Topsoil - 11.0' Gravel - Stop in Gravel
47. 0.5' Topsoil - 11.5' Gravel - Stop in Gravel


F58-1(7)32 P.E.
ST. MARY - CANADIAN
N
SE1/4, NE1/4, Sec. 34, T37N, R1
Robert Powell
Scale 1" = 200'
F58-1(7)32 P.E.
U.589
Sta 258+00
205'
S 88-37-15 E
928.1918'
OLD
PIT
AREA
Grazing
N 00-06-35 E
939.1352'
632.9109'
S 15-10-20 E
335.8280'
S 00-58-58 E
2514.6'
Allotment Pin
w/Brass Cap
Center Sec. 34
Iron Pin
No Cap
1101.58'
N 88-26-54 W
Allotment Pin w/Cap
1785 1785
2636 USRS
Allotment Pin w/Cap
1785 USRS
USRS USRS
1/64 pin

INDEX #998

MB Lab Form 123A

PROSPECTED AREA REPORT

PROJECT NO. F 58-1(7)32 P.E.

TERMINI St. Mary - Canadian Line

LAND LOCATION SE¼NE¼, Sec. 34, T. 37 N., R. 14 W.

OWNER Robert Powell **ADDRESS** Babb, Montana

Current samples at this location are covered by Lab Nos. 671490 through 671499 inclusive. Sampler estimates the area averages 1.6 feet of overburden and sampled matter shows 3 percent over 12 inches in size, 7 percent between 6 and 12 inches, 20 percent between 4 and 6 inches, and the remaining 70 percent less than 4 inches.

NON-BITUMINIZED SURFACING

The attached test results indicate this material is satisfactory. The Special Provision of 40% Maximum Wear has been met.

BITUMINIZED SURFACING

The attached test results indicate that 75% rejection of the natural fines is required to reduce the volume swell. Hydrated lime improves the Immersion Compression and the Modified Lottman and may be recommended. Otherwise this material is satisfactory. The Special Provision of 40% Maximum Wear has been met.

THIS REPORT INCLUDES THE FOLLOWING LAB NOS. WHICH ARE ATTACHED:

671490 through 671499

W Patrick Ernst DATE: 4/10/92

MATERIALS BUREAU
Dated 4/10/92

1 Dist. Mat'ls. Supr. Great Falls
1 Project Managers Great Falls
1 Pavement Analysis Unit - Helena
1 Glacier County File
1 Bituminous Section - Helena
1 Materials Bureau File
1 M. Lynch

"A quantity of material may have/has been removed from this source since originally prospected."
Date 4-7-97

PE:D:MT:199.cg-1

Attachment

ATTACHMENT TO LAB FORM NO. 123A
SUMMARY OF LABORATORY TESTS

Prep'd by PE
Date 04/09/92

LAB NO. 671490 TO 671499 INCLUSIVE. ESTIMATED VOLUME (Cu. Yds.) ----

DATE SAMPLED 2-25-92 DATE RECEIVED IN HELENA 3-18-92

PROJECT NO. F 58-1(7)32 P.E.

TERMINI St. Mary - Canadian Line

LAND LOCATION SE¼NE¼, Sec. 34, T. 37 N., R. 14 W.

OWNER ROBERT Powell ADDRESS Babb, Montana

Lab No.	Sam. No.	Hole No.	Wear	LL	PI	Vol. Swell	Soil Class	4 Mesh rec'd	4 Mesh tested	200M rec'd	200M tested
671490	1	10	19	NP	NP	13.2 soft	A-1-a(0)	31	31	3.5	3.5
671491	2	13	19	NP	NP	10.8 soft	A-1-a(0)	24	24	2.6	2.6
671492	3	25	20	NP	NP	9.2 firm	A-1-a(0)	31	31	3.1	3.1
671493	4	30	19	NP	NP	6.8 firm	A-1-a(0)	30	30	1.5	1.5
671494	5	33	19	NP	NP	6.4 firm	A-1-a(0)	27	27	2.0	2.0
671495	6	36	18	NP	NP	8.9 firm	A-1-a(0)	27	27	2.6	2.6
671496	7	43	19	NP	NP	5.7 firm	A-1-a(0)	27	27	1.8	1.8
671497	1	RV Comp		NP	NP	9.3 firm	A-1-a(0)	31	37	2.8	3.4
671498	1	IC Comp		NP	NP	7.4 firm	A-1-a(0)	33	55	2.9	6.0
						8.6 firm	50% Rejection				
						4.0 firm	50% Rejection with HL				
				NP	NP	5.7 firm	75% Rejection				
						3.2 hard	75% Rejection with HL				
						4.9 firm	100% Rejection				
						1.9 hard	100% Rejection with HL				
671499							Rutting				

Adhesion	60%	No Additive
Adhesion	85%	+ 1.5% H.L.
Sand Equiv.	43%	671498
Fractured	81%	671498
R-Value	75	671497

IMMERSION-COMPRESSION RESULTS

75% Rejection **Pen. Asphalt** 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.3	199.7	150.4	75.3%
1.4	HYD LIME	6.1	222.0	240.3	108.2%

MODIFIED LOTTMAN RESULTS

75% Rejection **Pen. Asphalt** 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.3	82.0	31.8	38.8%
1.4	HYD LIME	6.1	86.0	48.5	56.4%

Frac. Cr.			4.5% AC		5.5% AC		6.1% AC		6.3% AC		6.5% AC	
%	Fines	Add.	Stab. lbs.	Voids %	Stab. lbs.	Voids %	Stab. lbs.	Voids %	Stab. lbs.	Voids %	Stab. lbs.	Voids %
81	75	None	1703	8.4	1716	5.7			1884	3.3	1926	2.7
81	75	HL	1641	8.8	1573	5.2	1779	3.4			1916	2.1

PE:D:MT:200.cg-1

(Rev. 1-92)

STATE OF MONTANA
Department of Transportation

FIELD PROPOSED SURFACING REPORT

Project No. : F 58-1(7)32 P.E.
Date: MARCH 13, 1992
Submitted By : JAMES D. BLOSSOM
Land Location: S1/2 NE1/4 SEC. 34, T37N, R14W
Owner: HENRY POWELL

Termini: ST. MARY - CANADIAN LINE
District: GREAT FALLS
Title: DLS. II Est. Volume(Cys.): N/A
County: GLACIER
Address: BABB, MONTANA

Dist.Lab. No.	Sample No.	Hole No.	4"	3"	2"	1 1/2"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	SOIL CLASS	VOLUME SWELL 24 HOUR	DEG.
35964	1	1	100	79	72	67	59	53	46	40	31	21	10	5	4.1	NP	NP	A-1-a(0)	14.5	
35965	2	4	100	91	80	74	64	58	51	45	35	25	13	6	4.2	NP	NP	A-1-a(0)	7.5	
35966	3	7	100	92	78	75	66	58	50	44	34	22	9	4	2.6	NP	NP	A-1-a(0)	6.5	
35967	4	10	77	74	66	59	51	45	39	34	27	19	8	4	2.8	NP	NP	A-1-a(0)	7.7	
35968	5	13	93	85	72	65	56	49	41	36	28	19	8	4	2.8	NP	NP	A-1-a(0)	7.3	
35969	6	15	92	87	80	76	66	58	50	44	32	21	9	4	2.3	NP	NP	A-1-A(0)	5.3	
35970	7	16	100	92	76	69	58	53	46	41	33	24	12	6	4.4	NP	NP	A-1-a(0)	8.9	
35971	8	19	100	87	73	68	59	53	43	36	26	17	7	5	3.5	NP	NP	A-1-a(0)	9.4	
35972	9	21	84	84	74	65	55	49	42	36	28	20	7	3	2.0	NP	NP	A-1-a(0)	5.2	
35973	10	23	100	88	79	72	63	56	47	41	31	22	8	3	1.9	NP	NP	A-1-a(0)	4.1	
35974	11	25	100	88	79	74	63	56	49	44	34	24	11	5	3.2	NP	NP	A-1-a(0)	5.9	
35975	12	28	92	92	78	62	53	47	40	34	26	18	9	4	2.8	NP	NP	A-1-a(0)	8.0	
35976	13	30	100	90	88	80	69	61	52	46	36	26	11	5	3.3	NP	NP	A-1-a(0)	4.3	
35977	14	31	100	86	67	65	58	51	44	39	31	21	10	5	3.3	NP	NP	A-1-a(0)	6.3	
35978	15	33	100	89	79	73	63	56	48	42	32	22	7	3	1.9	NP	NP	A-1-a(0)	4.2	
35979	16	36	100	90	75	63	53	46	40	36	28	21	10	4	2.8	NP	NP	A-1-a(0)	6.5	
35980	17	38	100	97	83	77	68	60	51	45	34	23	10	4	2.3	NP	NP	A-1-a(0)	4.2	

Sampled By: STAN KUNTZ
Remarks:

(Rev. 1-92)

STATE OF MONTANA
Department of Transportation

FIELD PROPOSED SURFACING REPORT

Project No. : F 58-1(7)32 P.E.
Date: MARCH 13, 1992
Submitted By : JAMES O. BLOSSOM
Land Location: S1/2 NE1/4 SEC. 34, T37N, R14W
Owner: HENRY POWELL

Termini: ST. MARY - CANADIAN LINE
District: GREAT FALLS
Title: DLS. II Est. Volume(Cys.): N/A
County: GLACIER
Address: BABB, MONTANA

Dist.Lab. No.	Sample No.	Hole No.	4"	3"	2"	1 1/2"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	SOIL CLASS	VOLUME SWELL 24 HOUR	DEG.
35981	18	39	100	91	77	71	62	55	48	43	33	23	9	4	2.6	NP	NP	A-1-a(0)	5.1	
35982	19	41	100	100	85	74	63	57	49	42	32	22	10	5	3.5	NP	NP	A-1-a(0)	6.2	
35983	20	43	100	91	75	69	59	51	44	38	28	20	10	4	1.9	NP	NP	A-1-a(0)	4.5	
35984	21	45	100	96	88	86	76	68	61	54	43	32	14	5	2.8	NP	NP	A-1-a(0)	3.7	
35985	22	47	100	100	88	76	63	55	47	40	29	20	9	4	2.4	NP	NP	A-1-a(0)	4.5	

Sampled By: STAN KUNTZ
Remarks:

MDT PIT #1016

INDEX # 1016

Form No. 92
(Rev. 2-78)

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS
Helena, Montana

PROSPECTED AREA REPORT

Lab.No. 667929 - 38

Sample See Page 2

County Glacier

Complete this form in full. Mail three copies to the Materials Bureau in Helena, and send one copy with the sample.

Project No. F-58-1(7)32 P.E. Designation St. Mary - Canadian Line

Sampled by Stan Kuntz Title MLT II

Address Gt. Falls Date Sampled 9-9-91

Type of Material Gravel Sample Tested for Proposed Surfacing

Owner Blackfoot Tribal Reserve Address P.O.Box 850 Browning, Mt. 59417

Contact Don DuBray at the Blackfoot Tribal Land Office at 338-7201

Location(Give ¼ ¼ Sec.) NE¼NW¼ & SE¼NW¼ Sec,27,T36N,R14W

Area is 0.1 Miles N - ~~S~~ ~~XXXX~~ E - ~~W~~ of Station 410 + 11 on Project F-58-1(7)32

Extent of Area 895 ft. x 902 ft.= 807,655 sq.ft.= 18.54 acres

Thickness (Gravel) (Above apparent water line 10.2 ft.) Total 10.2 ft.
(~~XXXXXX~~)
(~~XXXX~~) (Below apparent water line ft.)

Probable cubic yards available 305,114 How much O/B? 0.5' to 3.0' Avg. 1.3 ft.

Over 12" 5 % Between 12" and 6" 15 % Between 4" and 6" 30 % Less than 4" 50 %

For what is land used? Grazing Is water available for washing? No

Deposit-Is it river, bank or bench gravel? Bench

Haul Road; * 0.1 miles to sta. 410 + 11 on Project No. F-58-1(7)32
*(Measured to nearest 1/10 mile over practicable truck route to definite station on project)

Maximum grade 1% Estimated cost of haul road $100 Condition Poor

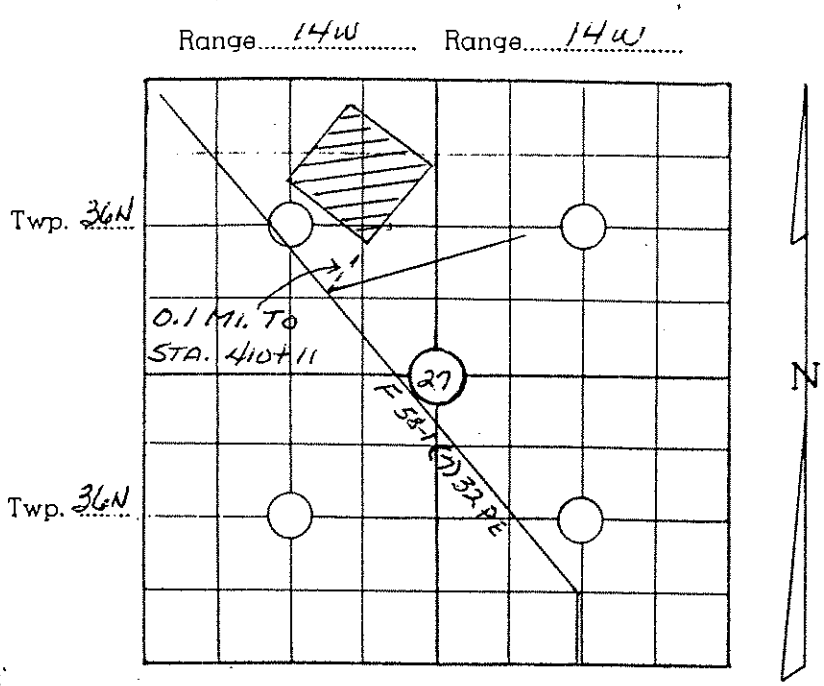
Type of existing bridges None Condition

Additional bridges required None

Haul road owner Address
(Name and address of owner of land crossed by haul road to a public highway)

Original & 2 Copies - Materials Bureau 2 - Dist. Lab

Sec. 27 Twp. 36N Range 14W



The accompanying sketch covers either one complete or four complete sections. In locating area use the section, or sections, which best permits the showing of the prospected area in an approximate relation to the project, haul road, etc. Use solid lines for indicating existing haul roads and dashed lines for proposed haul roads.

MINIMUM SAMPLE REQUIREMENTS
FOR AN ESTIMATED VOLUME

Cubic Yards	No. of Samples
Up to 50,000	Min. of 3
50,000 to 100,000	3 to 5
100,000 to 150,000	5 to 8
150,000 to 200,000	8 to 10

No sample shall represent more than 3 test holes.

LOG OF TEST HOLES

Use separate sheet for area sketch.
Attach Form C.B. 18 for reclamation information.

Samples Submitted

Proposed Surfacing	#1	Hole 1
" "	#2	Hole 7
" "	#3	Hole 19
" "	#4	Hole 25
" "	#5	Hole 33
" "	#6	Hole 39
" "	#7	Hole 46

Immersion Compression I/C Composite Hole #'s:1,3,5,7,11,13,15,17,19,22,25,27 29,31,33,35,37,39,42,44,&46.

"R" Value "R" Composite Hole #'s:1,3,5,7,11,13,15,17,19,22,25,27 29,31,33,35,37,39,42,44,&46.

F 58-1(7)32 PE
St.Mary-Canadian Line
NE¼NW¼ & SE¼ only Sec.27,T36N,R14W

Log of Holes

1. 0.5' Topsoil, 11.5' Gravel, Stop in Gravel
2. 0.5' Topsoil, 1.0' Overburden, 9.5' Gravel, Stop in Gravel
3. 0.5' Topsoil,6.0' Gravel, 5.5' Clay & Gravel,Stop in Clayey Gravel. Water Level 12.0'
4. 0.5' Topsoil, 11.5' Gravel, Stop in Gravel
5. 0.5' Topsoil, 11.5' Gravel, Stop in Gravel
6. 0.5' Topsoil, 1.0' Overburden, 9.5' Gravel, Stop in Gravel Sluffing
7. 0.5' Topsoil, 1.0' Overburden,10.5' Gravel, Stop in Gravel Sluffing
8. 12.0' Gravel, Stop in Gravel Sluffing (Floor of old pit)
9. 0.5' Topsoil,8.5'Gravel,3.0'Clayey Gravel,Stop in Clayey Gravel
10.0.5' Topsoil,8.5'Gravel,Stop in Gravel Sluffing
11,0.5' Topsoil,1.5'Overburden,10'Gravel,Stop in Gravel Sluffing
12.0.5' Topsoil,10.5'Gravel,Stop in Gravel Sluffing
13.0.5' Topsoil,1.0'Overburden,10.5'Gravel,Stop in Gravel
14.0.5' Topsoil,11.5'Gravel,Stop in Gravel
15.0.5' Topsoil,2.5'Overburden,8.5'Gravel,Stop in Gravel
16.0.5' Topsoil,10.5'Gravel,Stop in Gravel Sluffing
17.0.5' Topsoil,1.0'Overburden,10.5'Gravel, Stop in Gravel
18.0.5' Topsoil,1 0'Overburden,10'Gravel,Stop in Gravel
19.o.5' Topsoil,1.0'Overburden,10'Gravel,Stop in Gravel
20.0.5' Topsoil,1 0'Overburden,10'Gravel,Stop in Gravel
21.0.5' Topsoil,1.0'Overburden,10'Gravel,Stop in Gravel
22.0.5' Topsoil,0.5'Overburden,6.5'Gravel,4'Clayey Gravel,Stop in Clayey Gravel Sluffing
23.0.5' Topsoil,1 0'Overburden,10'Gravel,Stop in Gravel
24.0.5' Topsoil,0.5'Overburden,10'Gravel,Stop in Gravel
25.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel Sluffing
26.0.5' Topsoil,1 5'Overburden,9'Gravel,Stop in Gravel Sluffing
27.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
28.0.5' Topsoil,0.5'Overburden,10'Gravel,Stop in Gravel
29.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
30.0.5' Topsoil,11'Gravel,Stop in Gravel Sluffing
31.0.5' Topsoil,10.5'Gravel,Stop in Gravel Sluffing
32.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
33.0.5' Topsoil,1.5'Overburden,9.5'Gravel,Stop in Gravel
34.0.5' Topsoil,1.0'Overburden,10'Gravel,Stop in Gravel
35.0.5' Topsoil,0.5'Overburden,10'Gravel,Stop in Gravel
36.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
37.1.0' Topsoil,1.0'Overburden,9'Gravel,Stop in Gravel
38.1.0' Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
39.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
40.1.0' Topsoil,2.0'Overburden,8.5'Gravel,Stop in Gravel Sluffing
41.1.0' Topsoil,1.0'Overburden,9.5'Gravel,Stop in Gravel
42.0.5' Topsoil,1.0'Dirty Gravel,1.0'Overburden,9'Gravel,Stop in Gravel
43.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel
44.0.5' Topsoil,0.5'Overburden,10'Gravel,Stop in Gravel
45.1.0' Topsoil,1.5'Overburden,9'Gravel,Stop in Gravel
46.0.5' Topsoil,0.5'Overburden,10.5'Gravel,Stop in Gravel

INDEX - 1016

MB Lab Form 123A

91 OCT 30 AM 10:31

GREAT FALLS

PROSPECTED AREA REPORT

PROJECT NO. F 58-1(7)32 P.E.

TERMINI St. Mary - Canadian Line

LAND LOCATION NE¼ NW¼ & SE¼ NW¼, Sec. 27, T36N, R14W

OWNER Tribal Reserve **ADDRESS** Browning, Montana

Current samples at this location are covered by Lab Nos. 667929 through 667938 inclusive.

NON-BITUMINIZED SURFACING

The attached test results indicate the area represented by hole #19 must be avoided due to high PI. Otherwise this material is satisfactory. The Special Provision of 40% Maximum Wear has been met.

BITUMINIZED SURFACING

The attached test results indicate that 100% rejection of the natural fines is required to reduce the volume swell. Hydrated lime improves the Immersion Compression, Modified Lottman and Marshall stability and may be recommended. Otherwise this material is satisfactory. The Special Provision of 40% Maximum Wear has been met.

THIS REPORT INCLUDES THE FOLLOWING LAB NOS. WHICH ARE ATTACHED:

667929 through 667938

Bradley Bruce DATE: Oct 28, 1991

MATERIALS BUREAU
Dated 10/23/91

1 Dist. Mat'ls. Supr. Great Falls
1 Project Managers Great Falls
1 Pavement Analysis Unit - Helena
1 Glacier County File
1 Bituminous Section - Helena
1 Materials Bureau File
1 M. Lynch

PE:D:MT:185.cg

Attachment

"A quantity of material may have/has been removed from this source since originally prospected."
R. Kurtz Date 4-7-97

ATTACHMENT TO LAB FORM NO. 123A
SUMMARY OF LABORATORY TESTS

Prep'd by PE
Date 10/25/91

LAB NO. 667929 TO 667938 INCLUSIVE. ESTIMATED VOLUME (Cu. Yds.) ----

DATE SAMPLED 9-9-91 DATE RECEIVED IN HELENA 10-9-91

PROJECT NO. F 58-1(7)32 P.E.

TERMINI St. Mary - Canadian Line

LAND LOCATION NE1/4 NW1/4 & SE1/4 NW1/4, Sec. 27, T 36N, R14W

OWNER Blackfeet Tribe ADDRESS Browning, Montana

Lab No.	Sam. No.	Hole No.	Wear	LL	PI	Vol. Swell	Soil Class	4 Mesh rec'd	4 Mesh tested	200M rec'd	200M tested
667929	1	1	16	22	5	15.1 soft	A-1-a(0)	22	22	3.4	3.4
667930	2	7	16	23	6	10.4 soft	A-1-a(0)	22	22	4.4	4.4
667931	3	19	18	28	11	15.7 soft	A-2-6	26	26	4.5	4.5
667932	4	25	18	21	3	19.8 soft	A-1-a(0)	18	18	2.8	2.8
667933	5	33	17	24	7	8.7 firm	A-2-4	19	19	2.4	2.4
667934	6	39	17	NP	NP	12.6 soft	A-1-a(0)	22	22	1.9	1.9
667935	7	46	17	21	2	11.7 soft	A-1-a(0)	34	34	5.6	5.6
667936	1	RV Comp		23	6	9.0 firm	A-1-a(0)	14	18	2.4	3.0
667937	1	IC Comp		20	NP	10.4 soft	A-1-a(0)	38	55	4.8	6.0
						8.5 firm	50% Rejection				
						6.1 firm	50% Rejection with HL				
						8.2 firm	75% Rejection				
						4.3 firm	75% Rejection with HL				
				NP	NP	4.5 firm	100% Rejection				
						2.5 hard	100% Rejection with HL				
667938							Rutting				

Adhesion	75%	No Additive
Adhesion	85%	+ 1.5% H.L.
Sand Equiv.	27%	667937
Fractured	74%	667937
R-Value	80	667936

IMMERSION-COMPRESSION RESULTS

100% Rejection Pen. Asphalt 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.5	222.8	65.3	29.3%
1.4	HYD LIME	6.3	252.3	233.2	92.4%

MODIFIED LOTTMAN RESULTS

100% Rejection Pen. Asphalt 85/100 MRC

Mineral %	Filler Type	Percent Asphalt	Dry Break psi	Wet Break psi	Retained Strength
--	NONE	6.5	64.5	11.0	17.0%
1.4	HYD LIME	66.3	69.1	66.8	96.7%

Frac. %	Cr. Fines	Add.	4.5% AC Stab. lbs.	4.5% AC Voids %	5.5% AC Stab. lbs.	5.5% AC Voids %	6.3% AC Stab. lbs.	6.3% AC Voids %	6.5% AC Stab. lbs.	6.5% AC Voids %
74	100%	None	1627	9.5	1996	6.6			1986	3.3
74	100%	HL	1909	9.2	2218	6.0	2246	3.5	2253	2.9

PE:D:MT:186.cg

MBF Form No. 99
(REV. 1-83)

STATE OF MONTANA
Department of Highways

FIELD PROPOSED SURFACING REPORT

Project No. F-58-1(7)32 PE
Termini St. Mary - Canadian Line
Date 10-7-91
District Gt. Falls
Submitted By Jim Powell
Title DMS
Est. Volume (Cys.)
Land Location NE¼ NW¼ & SE¼ NW¼, Sec. 27, T36N, R14W
County Glacier
Owner Blackfoot Tribe
Address P.O.Box 850 Browning,Mt. 59417

Div.Lab.No.	Sample No.	Hole No.	4"	3"	2"	1 1/2"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	Soil Class	Volume Swell 24 Hour	Volume Swell 8 Day	Deg.
3133-35792	1	1	94	85	63	56	46	41	35	32	24	16	7	5	3.9	23	7	A-2-4(0)	11.4		
35793	2	3	94		71	67	59	53	45	39	29	20	10	9	7.3	25	10	A-2-4(0)	18.2		
35794	3	5	91	76	66	59	51	46	40	36	27	18	7	6	4.4	23	8	A-2-4(0)	11.4		
35795	4	7	76	68	49	42	36	32	27	24	17	11	6	4	3.3	23	8	A-2-4(0)	11.9		
35796	5	11		85	67	57	47	41	35	31	24	17	9	7	6,0	30	13	A-2-6(0)	23.9		
35797	6	13	91	77	63	54	48	42	37	33	23	15	7	6	4.7	23	6	A-1-a(0)	9.9		
35798	7	15	93	76	58	50	42	37	33	29	21	14	6	4	2.8	21	4	A-1-a(0)	7.0		
35799	8	17	78	69	60	54	47	43	38	34	26	18	7	4	3.0	20	4	A-1-a(0)	10.7		
35800	9	19	92	81	68	64	58	54	48	43	31	19	8	7	5.6	29	13	A-2-6(0)	15.9		
35801	10	22	73	70	58	53	47	43	38	33	24	17	8	6	4.6	25	8	A-2-4(0)	10.3		

Sampled By S. Kuntz MLT II
Remarks: No previous history on usage of gravel from this area.

EHW/dk/21R2

1- Matls. Bureau 1-Dist. Lab File

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Div.Lab.No.	Sample No.	Hole No.	4"	3"	2"	1 1/2"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	Soil Class	Volume Swell 24 Hour	Volume Swell 8 Day	Deg.
3133-35802	11	25	100	83	60	53	44	38	32	29	21	15	7	5	3.4	21	5	A-1-a(0)	7.2		
35803	12	27	100	80	62	57	50	46	41	37	28	19	8	7	4.1	24	8	A-2-4(0)	12.5		
35804	13	29	100	70	61	56	47	44	38	33	25	16	6	6	3.4	23	8	A-2-4(0)	10.8		
35805	14	31	89	86	65	62	55	49	42	37	27	18	7	6	4.5	24	8	A-2-4(0)	12.1		
35806	15	33	100	85	72	63	53	46	39	34	24	15	8	5	4.0	24	8	A-2-4(0)	12.2		
35807	16	35	100	80	60	51	41	36	31	27	20	13	4	3	2.3	20	2	A-1-a(0)	7.1		
35808	17	37	92	70	68	60	52	48	41	36	27	18	7	5	3.5	NP	NP	A-1-a(0)	7.9		
35809	18	39	100	85	75	68	58	51	44	39	28	18	7	5	2.7	NP	NP	A-1-a(0)	7.0		
35810	19	42	84	73	66	57	50	45	39	34	23	14	7	5	3.9	21	6	A-1-a(0)	11.0		
35811	20	44	100	100	75	67	59	52	45	39	27	17	7	6	4.3	23	5	A-1-a(0)	12.4		

Sampled By S. Kuntz MLT II
Remarks: No previous history on usage of gravel from this area.

EHW/dk/21R2 1- Matls.Bureau 1-Dist. Lab

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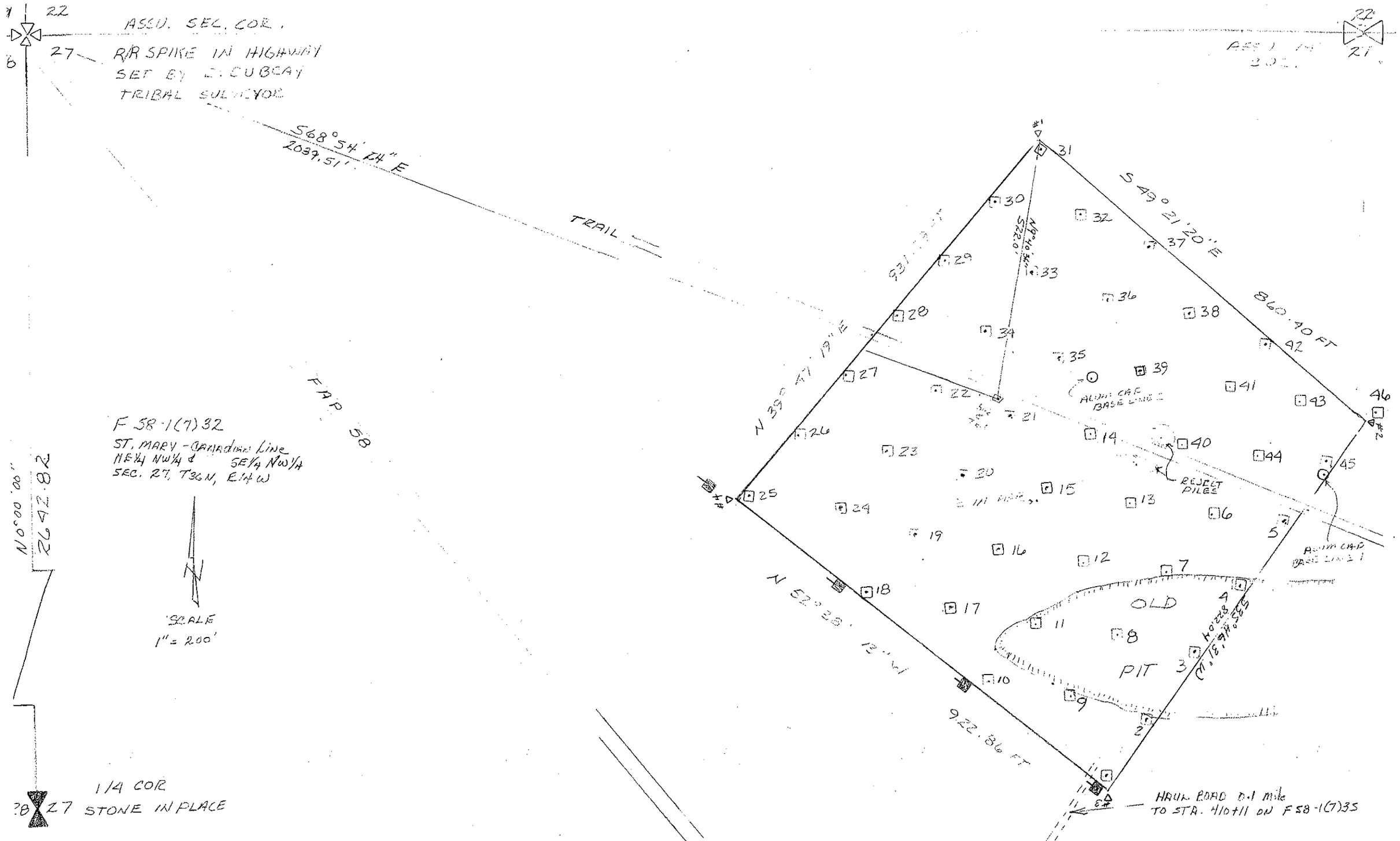
Project No. F 58-1(7)32 PE Termini St. Mary - Canadian Line
Date 10-7-91 District Gt. Falls
Submitted By Jim Powell Title DMS Est. Volume (Cys.)
Land Location NE¼ NW¼ & SE¼ NW¼ Sec. 27, T 36N, R14W County Glacier
Owner Blackfoot Tribe Address P.O.Box 850 Browning, Mt. 59417

Div.Lab.No.	Sample No.	Hole No.	4"	3"	2"	1 1/2"	1"	3/4	1/2	3/8	4M	10M	40M	80M	200M	LL	PI	Soil Class	Volume Swell 24 Hour	Volume Swell 8 Day	Deg.
3133-35812	21	46	93	68	57	51	44	40	35	32	25	18	9	8	5.2	22	2	A-1-a(0)	11.8		

Sampled By S. Kuntz MLT II
Remarks: No previous history on usage of gravel from this area.

EHW/dk/21R2 1-Matls.Bureau 1-Dist.Lab


22
ASSU. SEC. COR.
27
R/R SPIKE IN HIGHWAY
SET BY L. CUBEAY
TRIBAL SURVEYOR
S68°54'14" E
2039.51'
TRAIL
FAP 58
F 58-1(7)32
ST. MARY - Canadian Line
NE¼ NW¼ & SE¼ NW¼
SEC. 27, T36N, R14W
N0°00'00"
2642.82
SCALE
1" = 200'
1/4 COR
28 27 STONE IN PLACE
S49°21'20" E
860.40 FT
N39°47'19" E
N52°28'12" W
922.86 FT
N16°34'
522.0
S35°46'31" E
(1,318.23)
ALUM. CAP BASE LINE
REJECT PILES
OLD
PIT 3
HAUL ROAD 0.1 mile
TO STA. 410+11 ON F 58-1(7)35