

2/23/09
**HYDRO-
POWER
UPDATES:
SUSITNA &
CHAKACH-
AMNA**

ALASKA STATE LEGISLATURE

Senate Resources Committee

Senator Lesil McGuire, Co-Chair

State Capitol Building, Room 125
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AGENDA

Monday, February 23, 2009

Update on the Susitna Hydroelectric Project & New Cost Estimates

Jim Hemsath, Deputy Director, Alaska Energy Authority

Overview: Proposed Chakachamna Hydro Project

TDX Power: Nick Goodman, President
Eric Yould, Program Director

MEMORANDUM

TO: James Hemsath
 FROM: Bryan Carey
 DATE: February 20, 2009
 SUBJECT: HDR Alaska Susitna Hydroelectric Updated Energy Cost Report Summary

Proposed Hydroelectric Projects

Watana was to be a large rockfilled embankment dam located on the Susitna River upstream of Talkeetna. Devil Canyon was to be a 646' tall double curvature thin arch concrete dam located 32 river miles downstream of Watana.

Alternatives Analyzed

Updated energy production, construction cost estimates, and price per energy unit (\$/kWh) were analyzed for the following four alternatives: Low Watana (700'), Watana (885'), Watana followed by Devil Canyon, Staged Watana and Devil Canyon (Low Watana, Devil Canyon, Watana (Same as November 1985 FERC Amendment)).

Schedule

Federal Energy Regulatory Commissioning (FERC) licensing for a new hydro project is extensive. Eight years until license is thought to be similar for all the alternatives.

Energy & Economics

	Construction Completion (yrs)	Energy (billion kWhrs/yr)	Annual Average (MW)	Cost Estimate (2008 billions)	Energy Unit Cost during payment of financing (1)
Watana 700'	14 – 16	2.6	297	\$6.9	\$0.24 kWhr
Watana 885'	15 – 17	3.2	365	\$8.4	\$0.24 kWhr
Watana & Devil Canyon	15 – 20	7.2	822	\$11.6	\$0.16 kWhr
Staged Projects	14 – 23	7.2	822	\$12.8	\$0.19 kWhr

- (1) Cost estimate for each alternative assumes no state funds, financed by 50 year bonds @ 5% interest.
- (2) Construction completion is from start of funding for permitting & design.

After bonds repaid the cost of energy for all alternatives is \$0.03-\$0.04/kWhrs.



**Alaska
Industrial
Development
and Export
Authority**

Investing in Alaskans

**James Hemsath
Deputy Director – Project Development**

February 23, 2009

Susitna Hydro Evaluation Project

Seminar on the Development of Large Hydroelectric Projects with a Focus on the Susitna Project

presented to
Alaska Energy Authority

November 2008

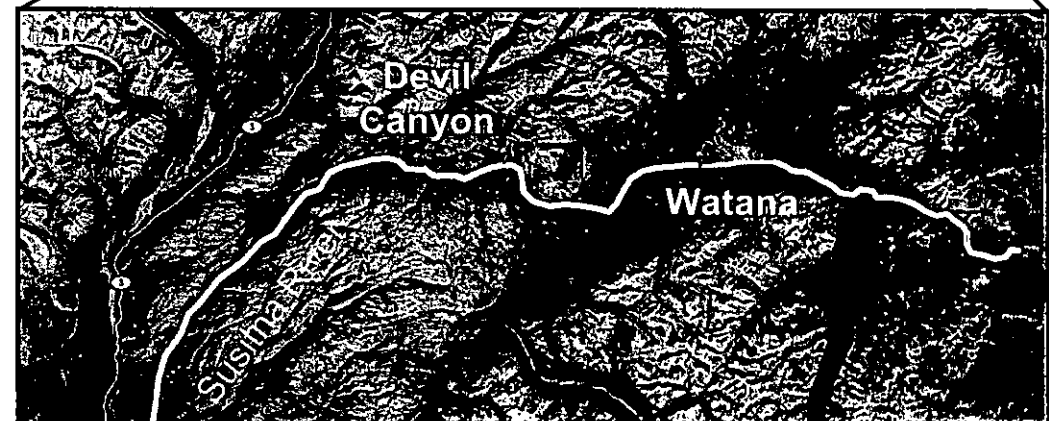
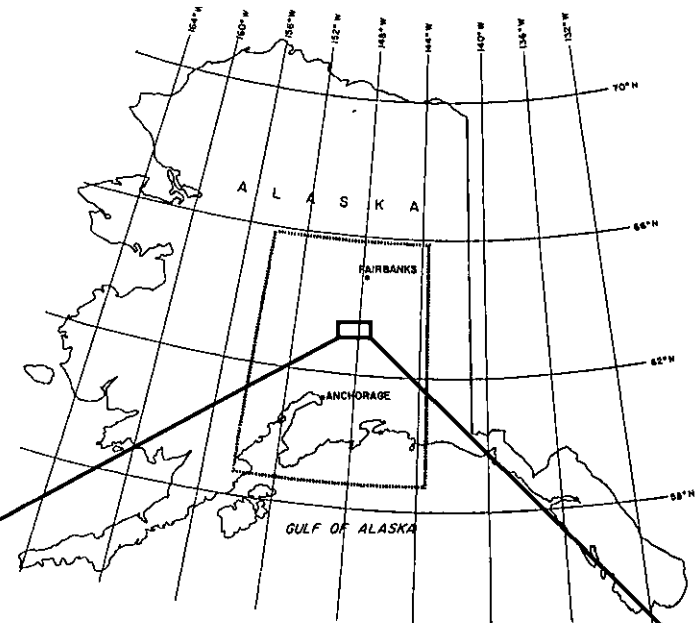


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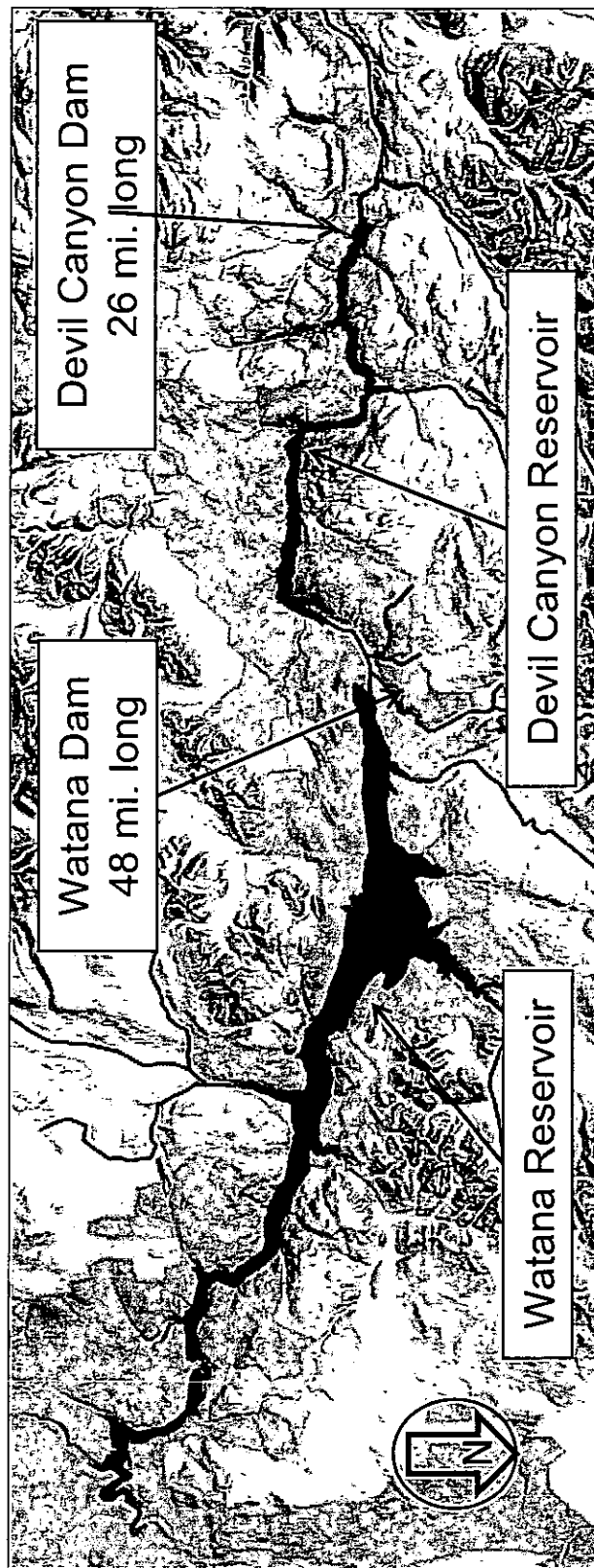
Susitna Project Civil Works Considerations

Susitna Project - Civil Works

- Dams and related facilities
 - Spillways
 - Powerhouses
 - Tunnels
 - Intakes & outlets
 - Construction camps and villages
- Infrastructure
 - Roads and bridges
 - Rail
 - Airports
- Stage options

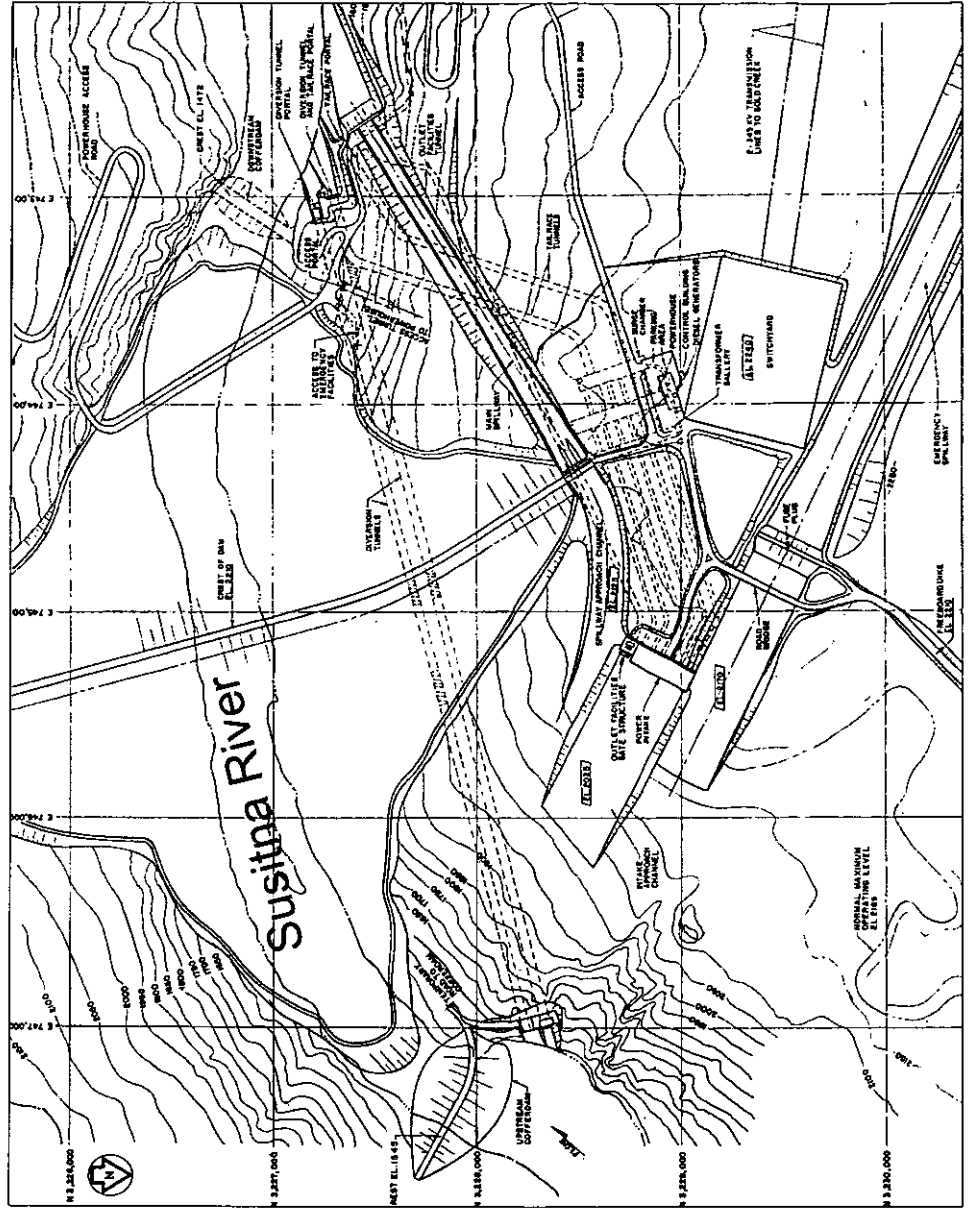


Watana and Devil Canyon Dams and Reservoirs



Watana Dam

- Rock-fill, gravity dam
- 885 feet tall
- 4,100-foot crest length

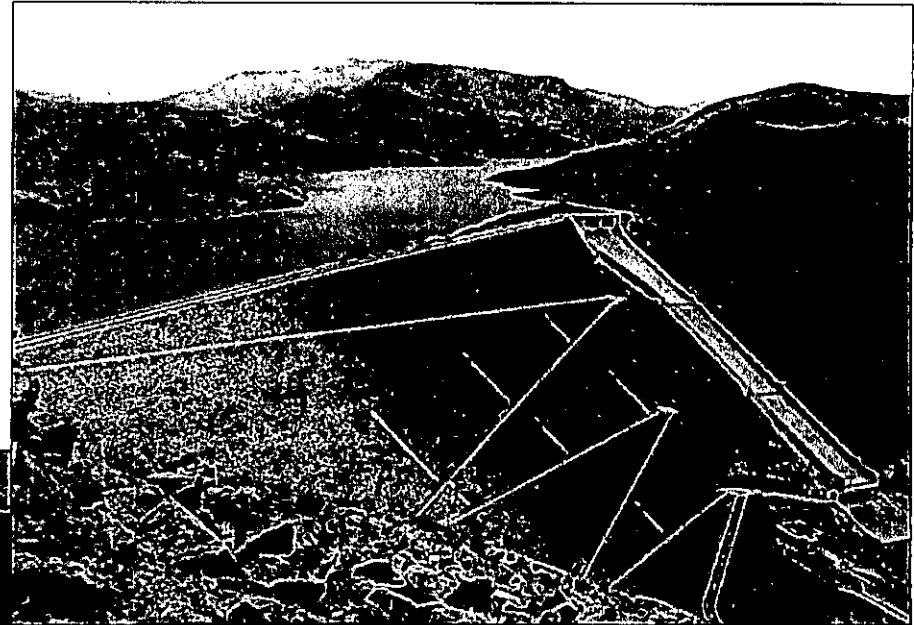


Watana Project Characteristics

- Underground power facilities with 600-foot rockfill dam
- Dam structure: Height – 885 feet
Crest length – 4,100 feet
- Diversion of flow during construction by two 30-foot tunnels
- Underground power facilities with six 200-MW generators
- Spillway capacity: 115,000 cfs + fuse plug
140,000 cfs

Rock-fill Embankment Dams

- Considerably more massive than arch or buttress dams but constructed with lower unit-cost materials
- Rely on weight of dam for stability and structural mass to impound water

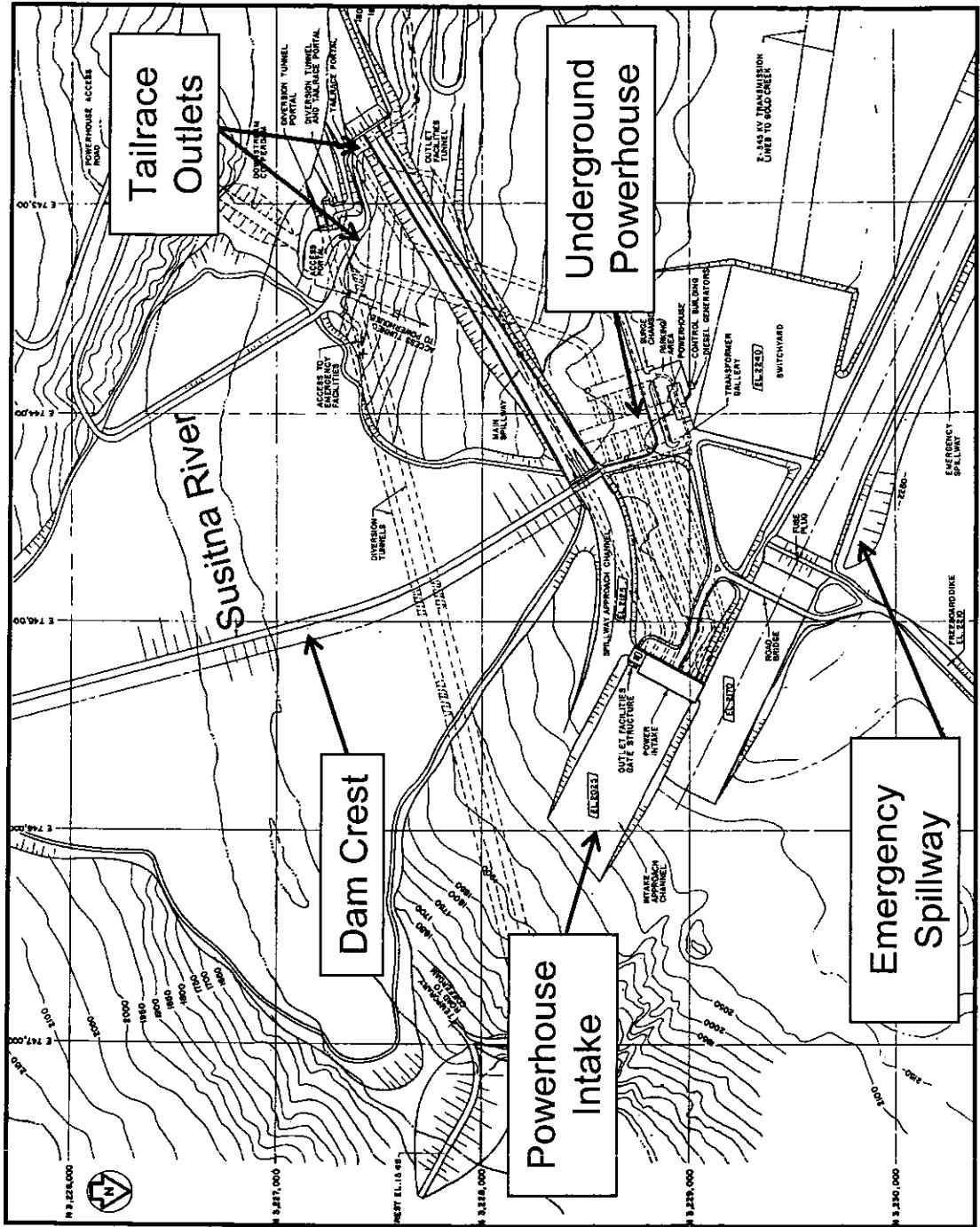


Mohle Dam, Lesotho

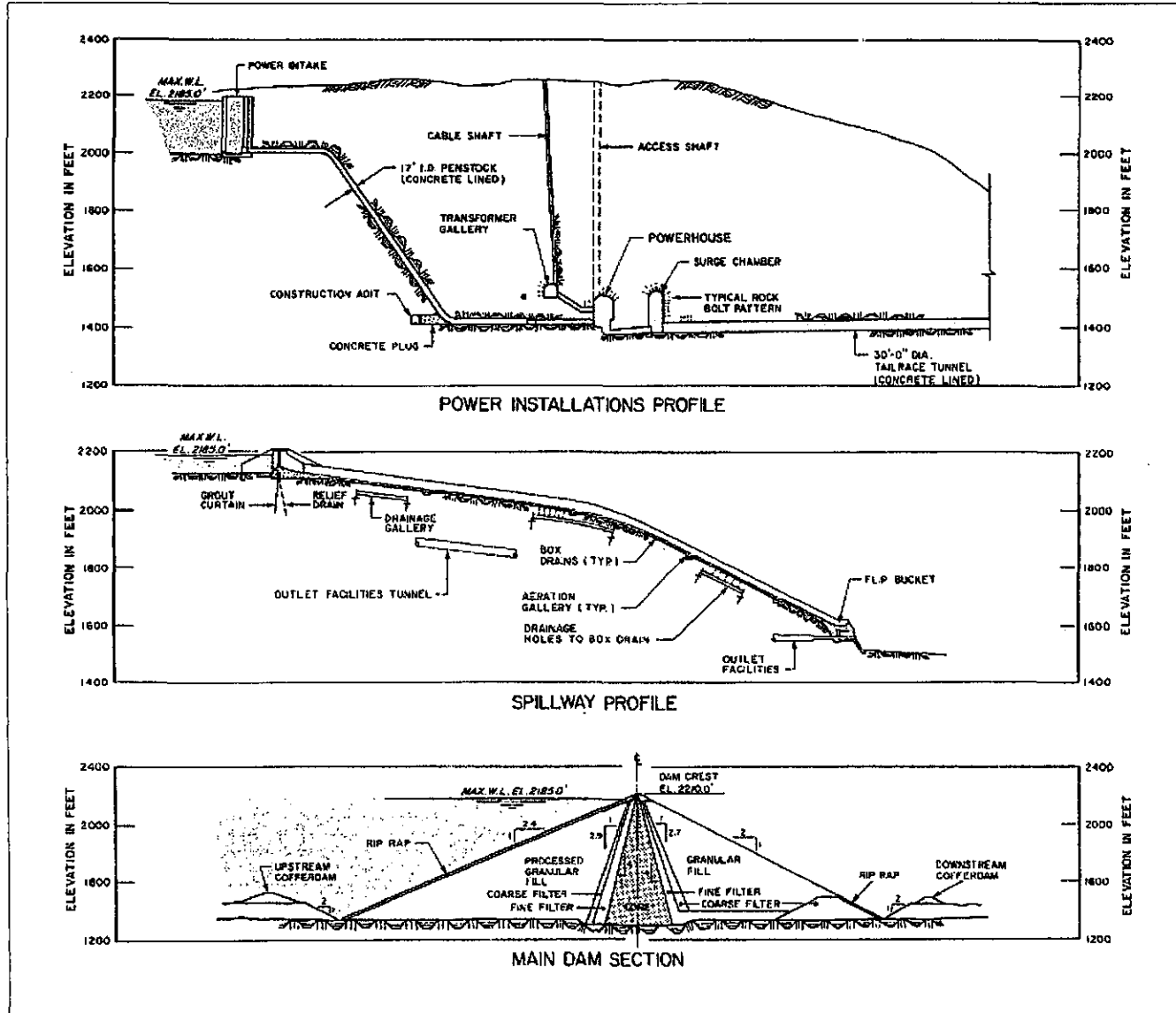


Oroville Dam, California

Project Layout: Watana

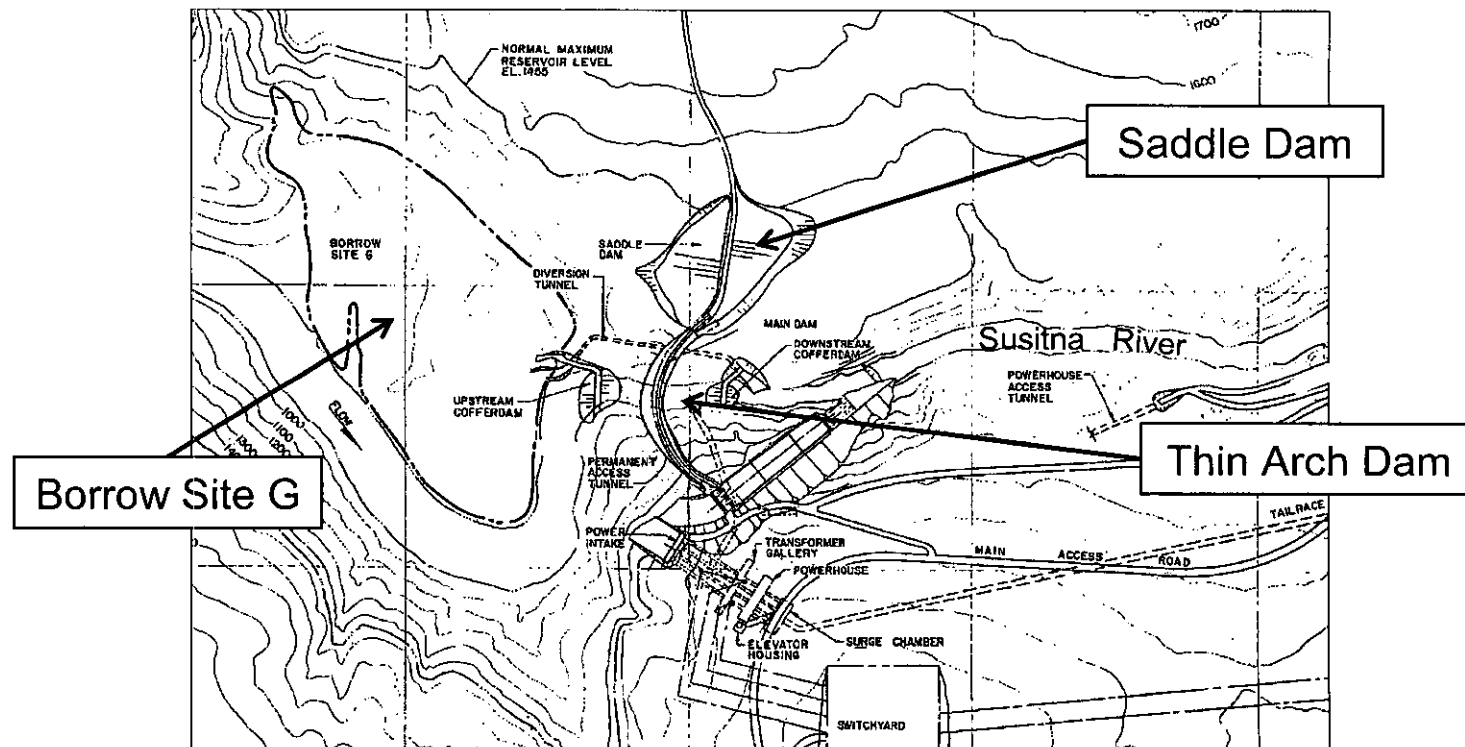


Watana Details

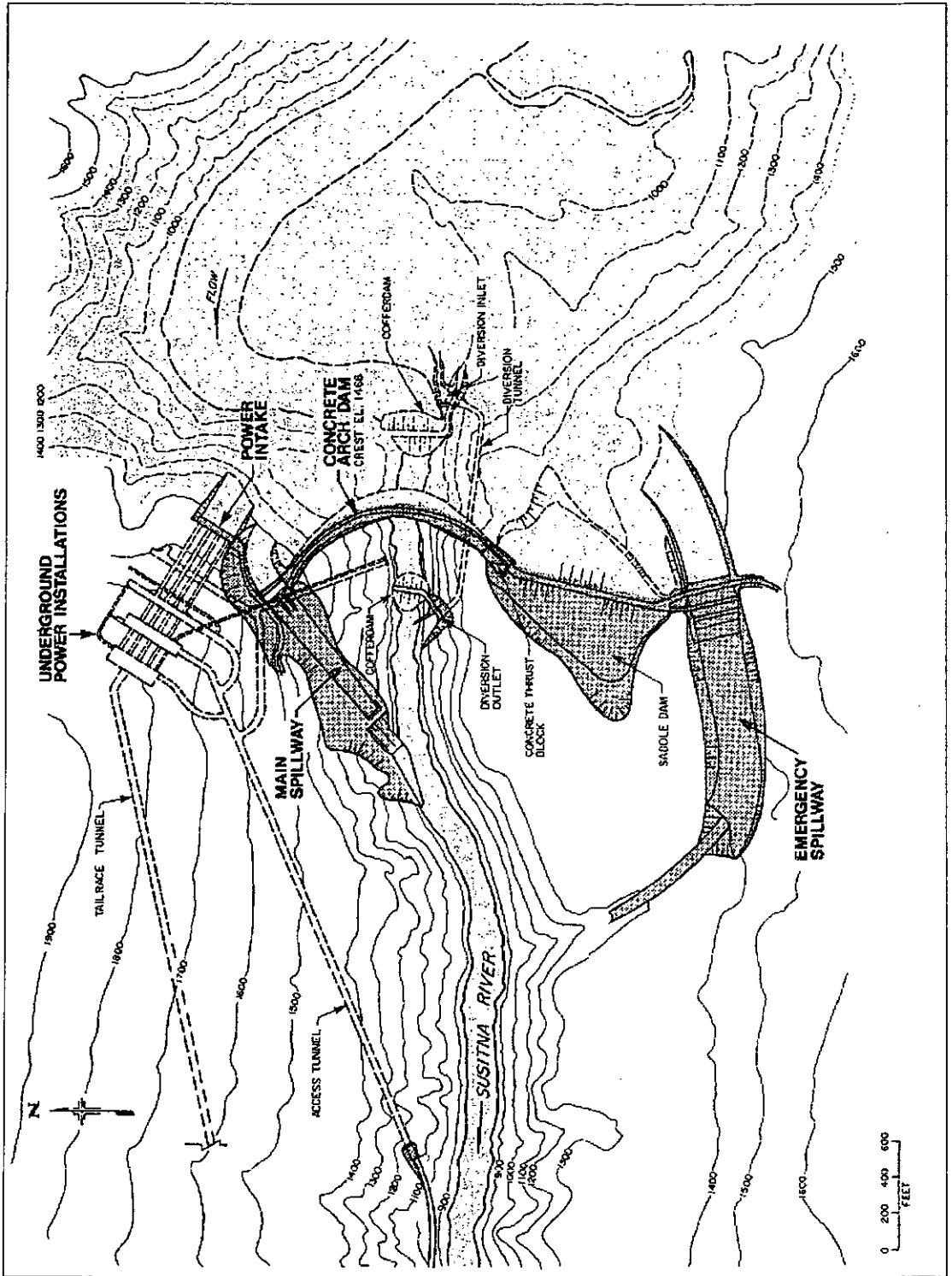


Devil Canyon Dam

- Arch concrete dam
 - 646 feet tall above foundation
 - 1,260-foot crest length
- Earth and rockfill saddle dam
 - 245 feet tall
 - 950-foot crest length
- Located in a V-shaped canyon
- Acceptable abutment and foundation geology
- Borrow site G to provide granular material for filters and concrete aggregate.



Devil Canyon General Arrangement

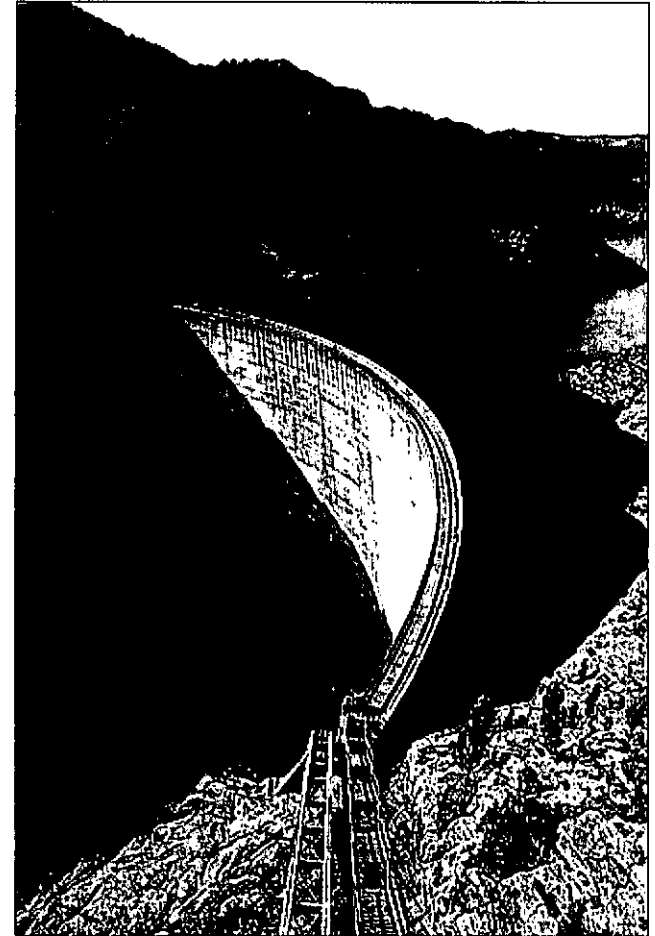


Arch Concrete Dams

- Reduced material volume to construct
- Loads transferred to abutments
- Structurally efficient, visually appealing structures

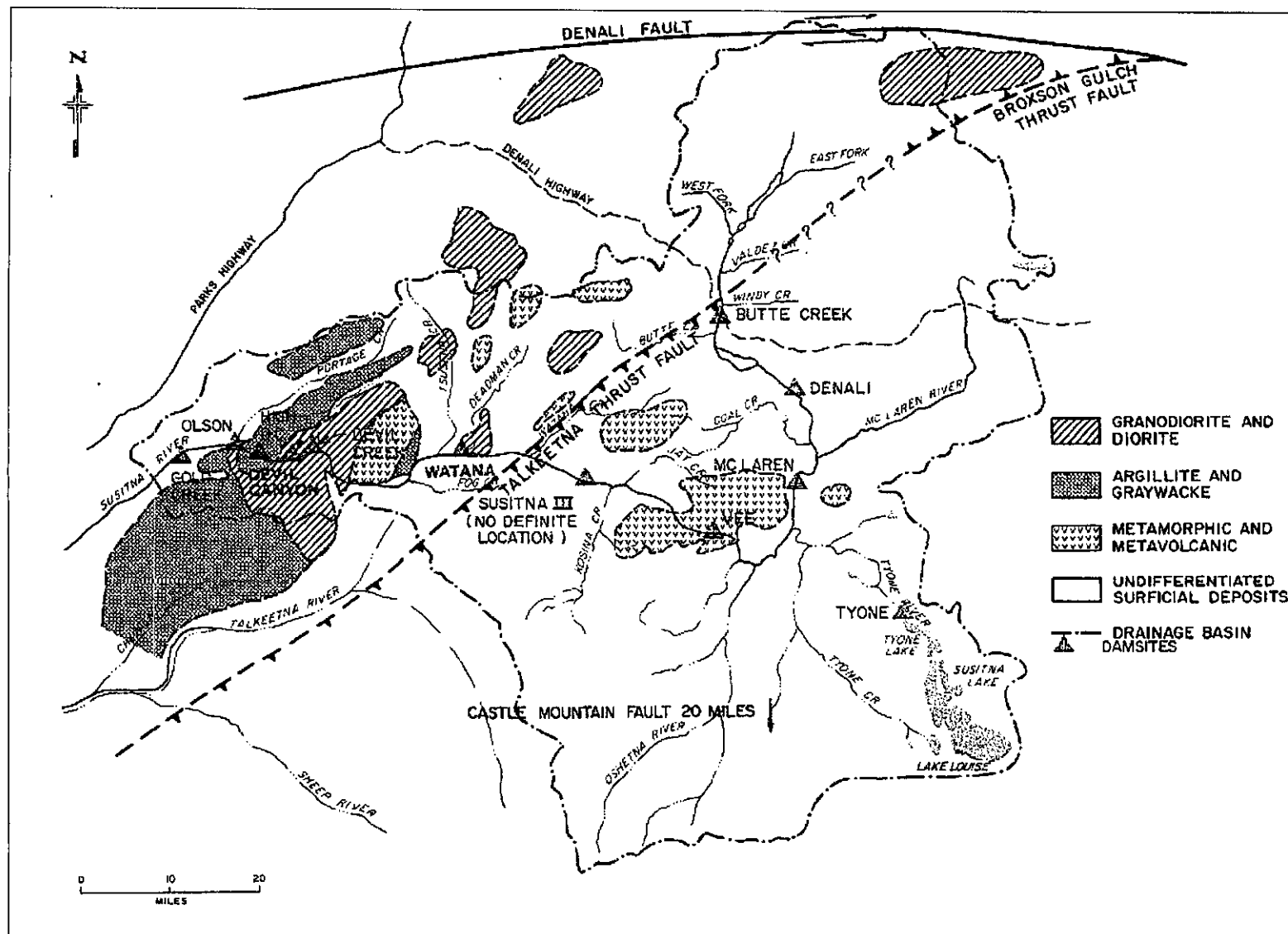


Mauvoisin Dam, Switzerland

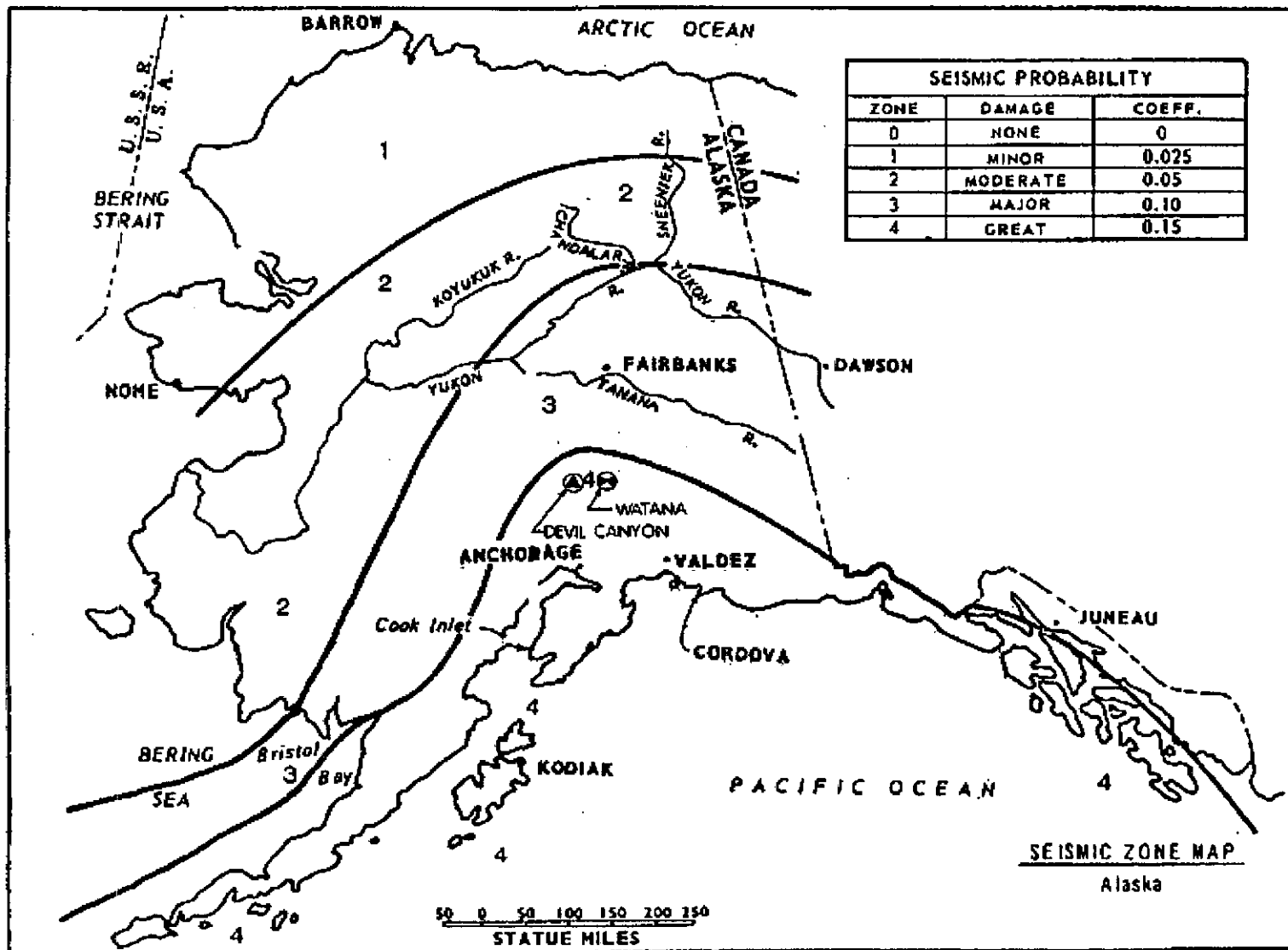


Gordon Dam, Australia

Upper Susitna Basin Geology

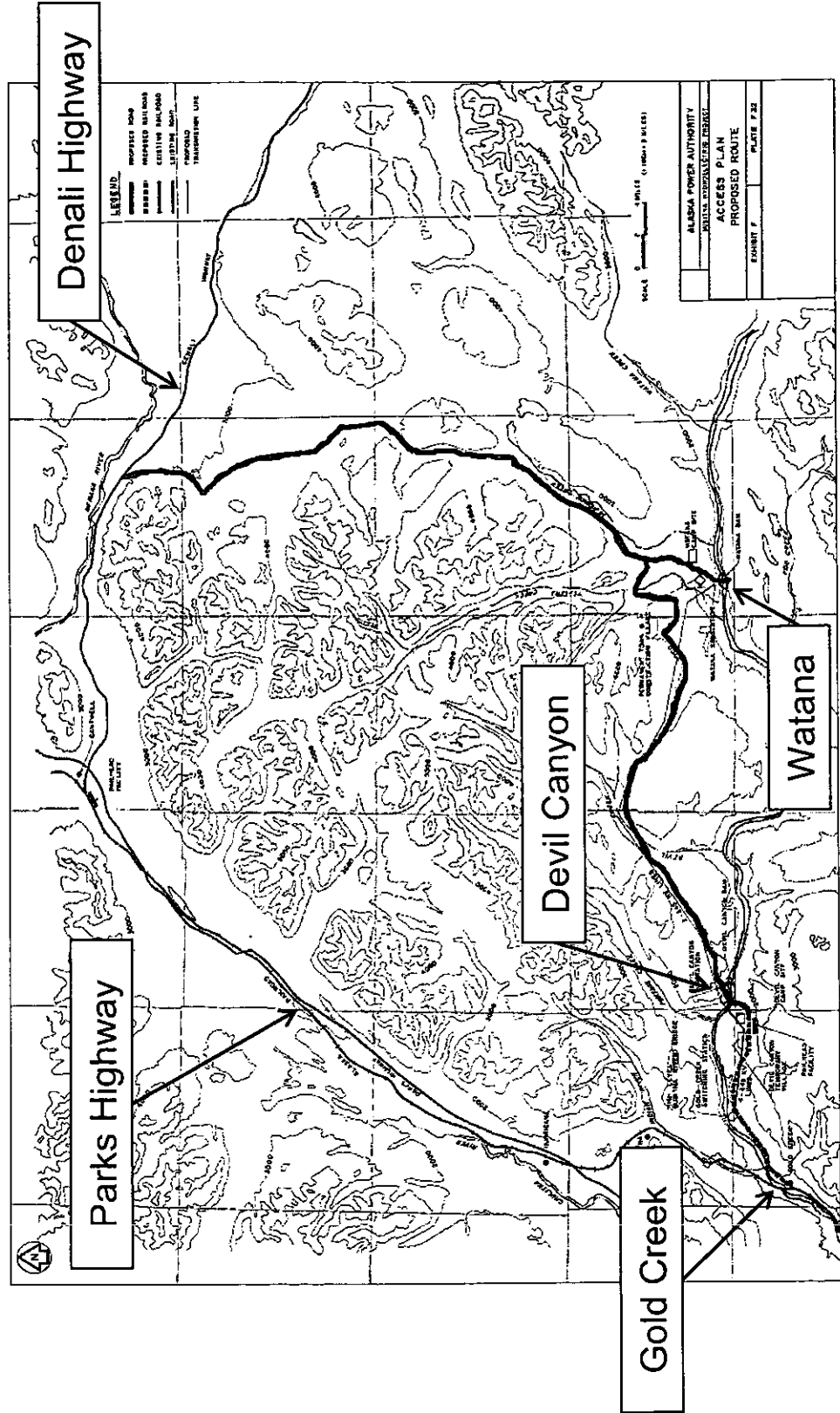


Seismicity



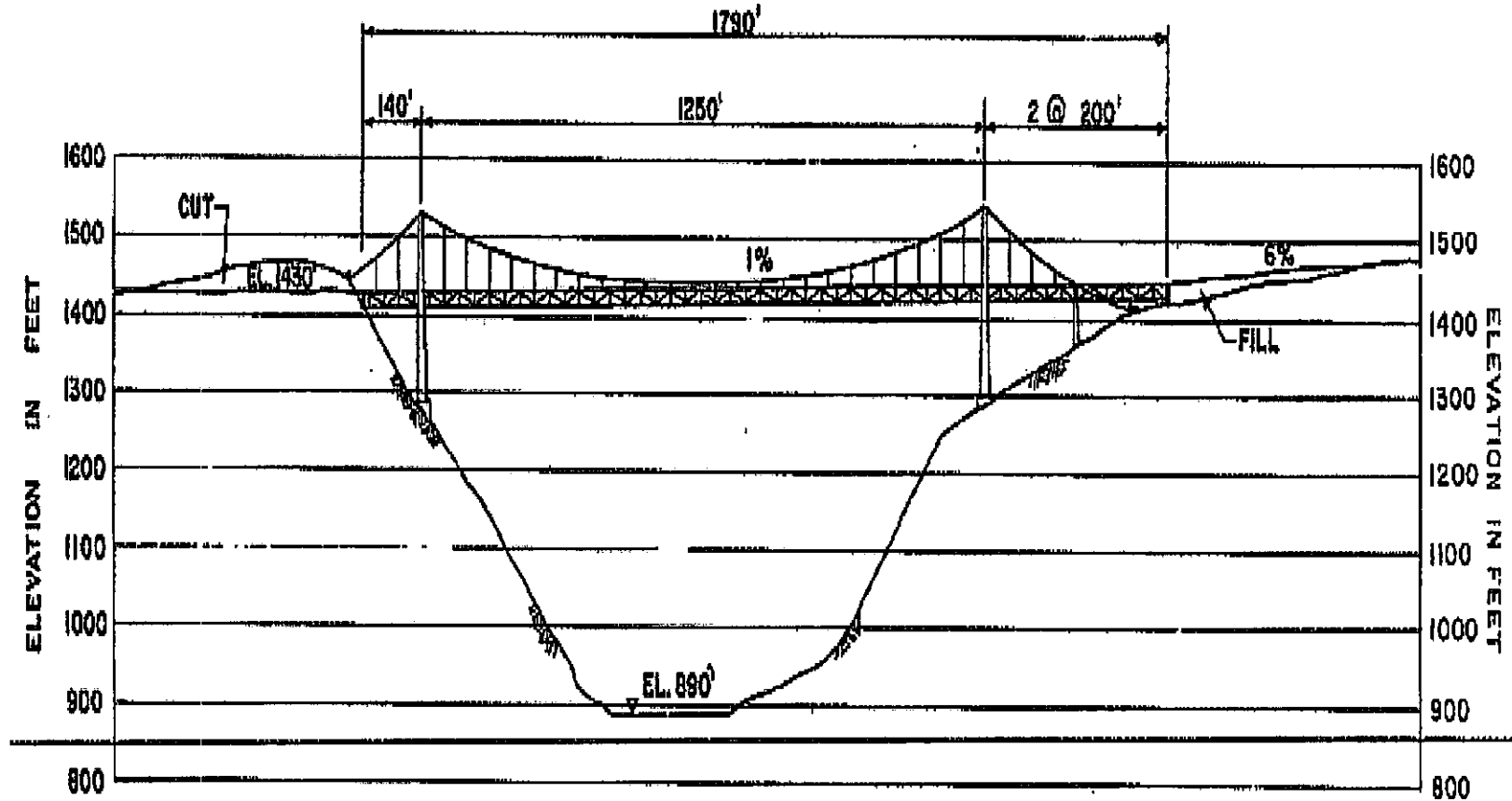
Roads

- 21 miles of road improvements along Denali Highway
- 81 miles of new permanent roadway were planned
- Additional temporary local area construction access roads necessary



Susitna River Bridge

Substantial, new long-span suspension bridge required for project

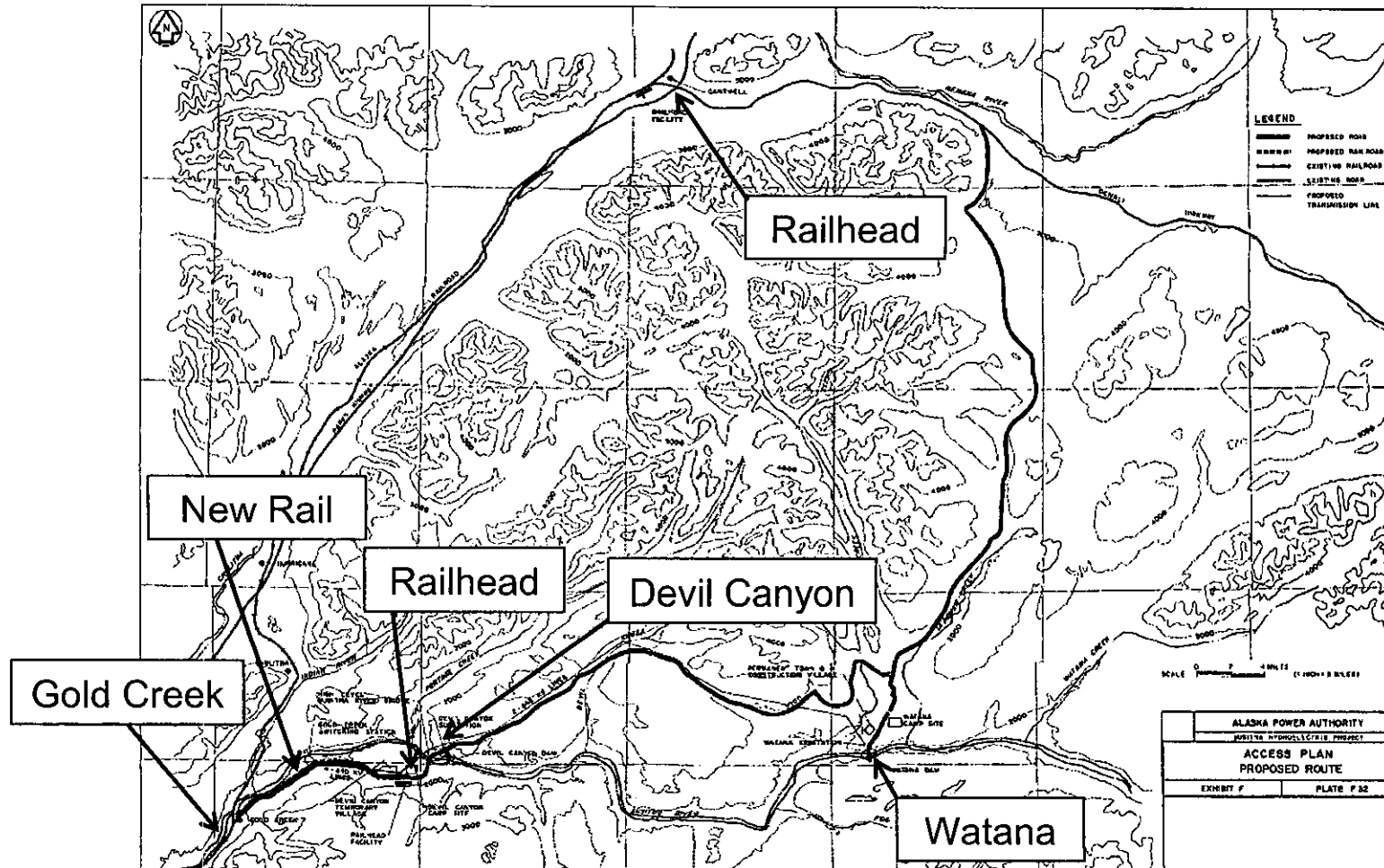


HIGH LEVEL SUSITNA RIVER BRIDGE

SCALE C

Rail

- 12-mile spur from Gold Creek to Devil Canyon
- Railhead facilities at Cantwell and Devil Canyon



Conclusions

- Remote location and large dam configurations require extensive civil works
- Large scale project, but all of these elements have been successfully done elsewhere
- Project is suited to staged construction
- Site access is particularly challenging
 - 81 miles of new road
 - 12 miles of new railroad
 - 1,200' span suspension bridge
- Technical challenges are all manageable
- Logistics and local material suitability and availability are important constructability factors

Back-up
document
only

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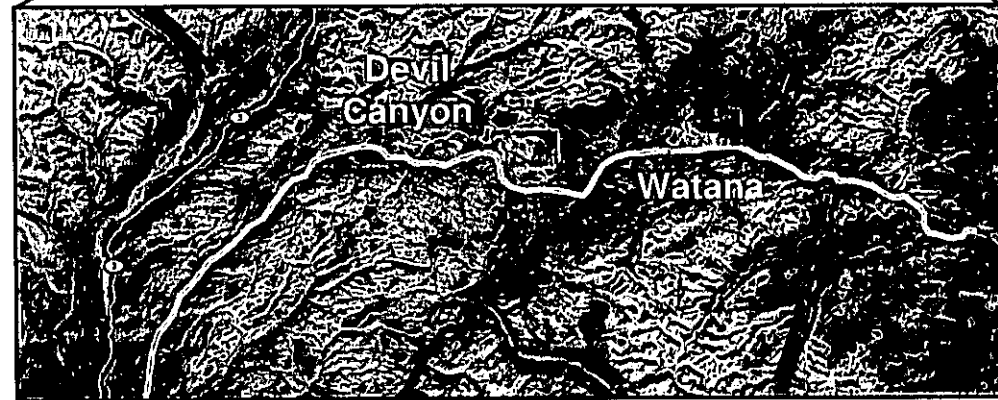
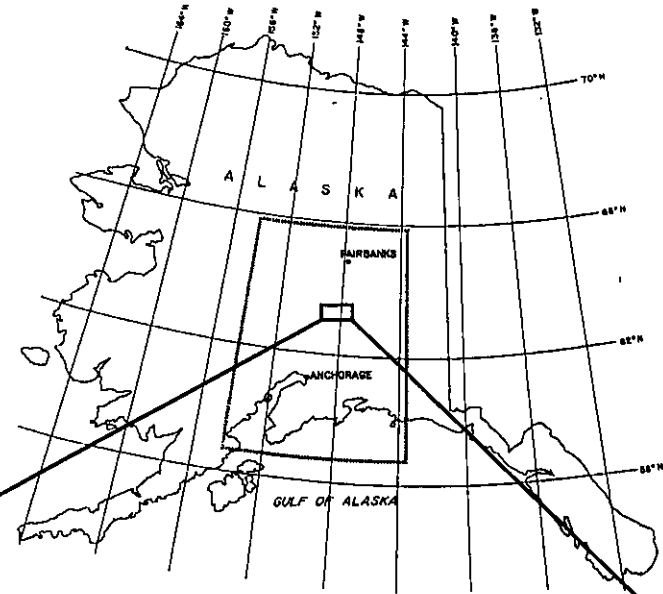
November 2008



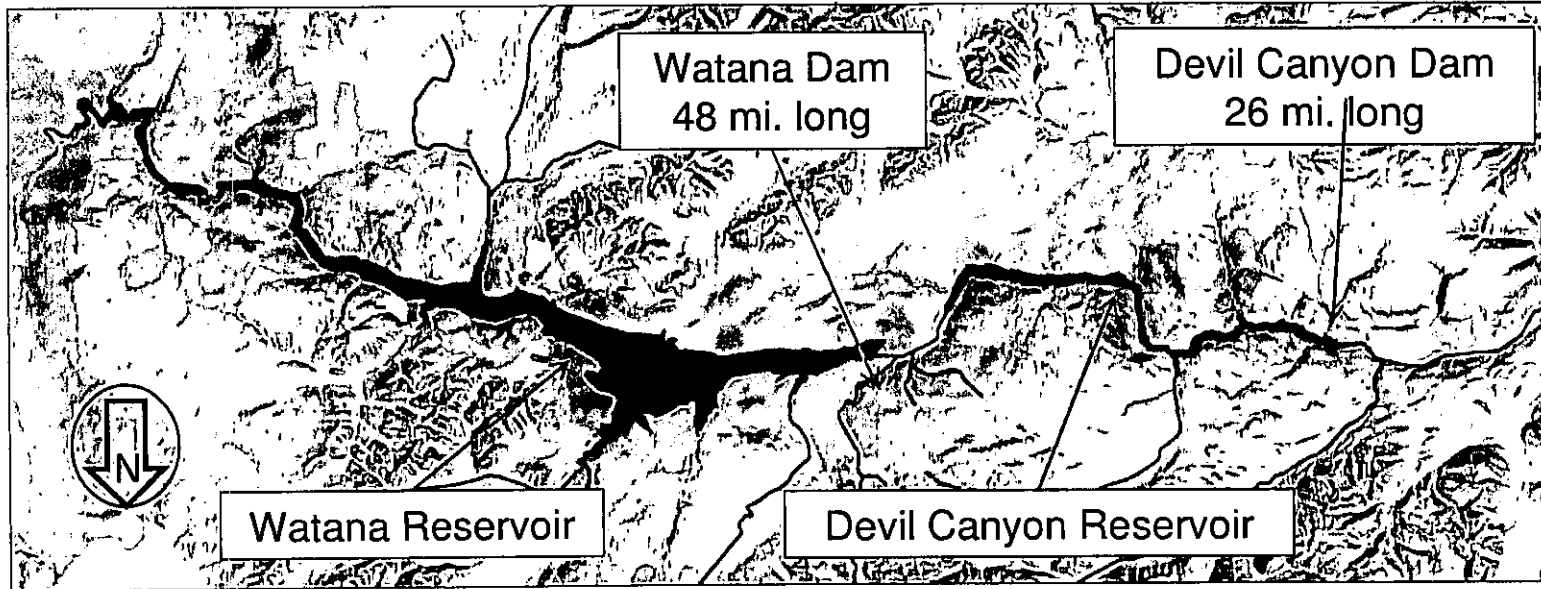
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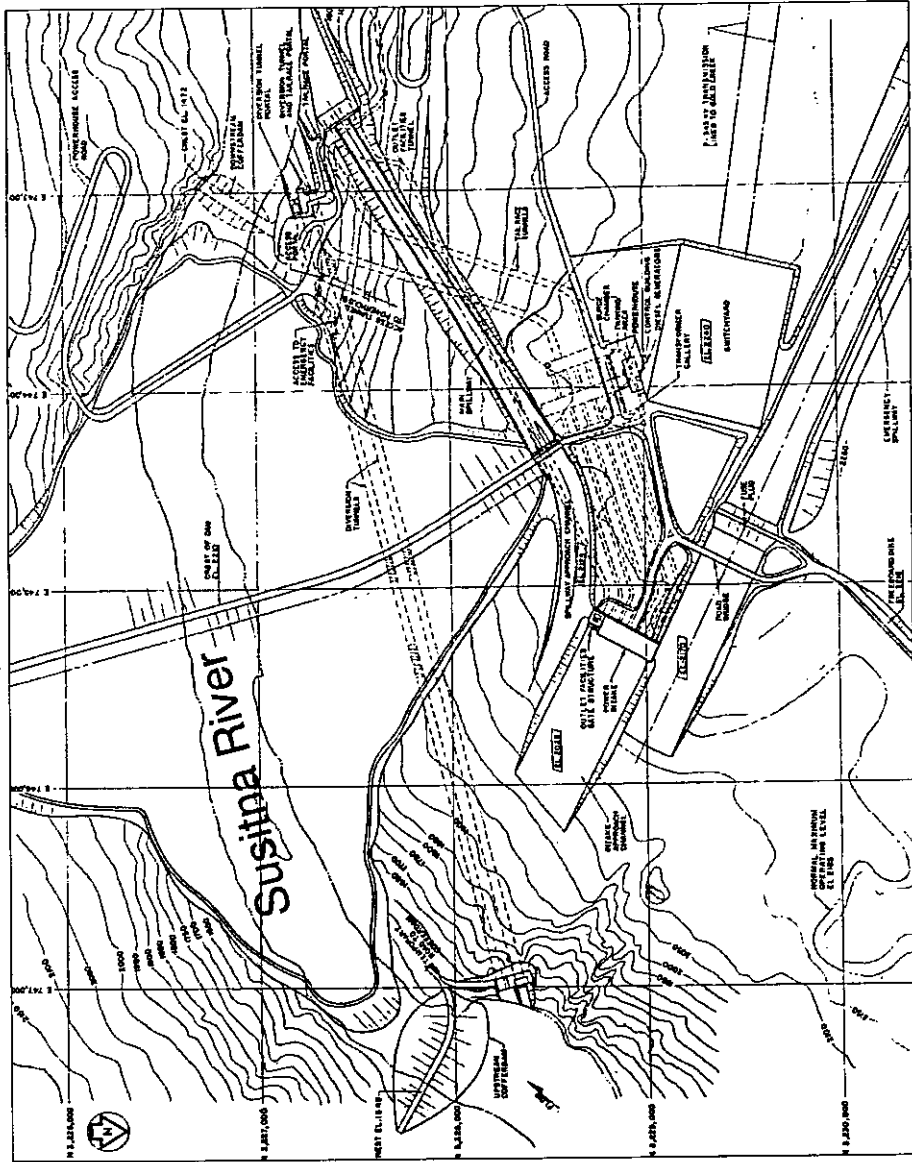


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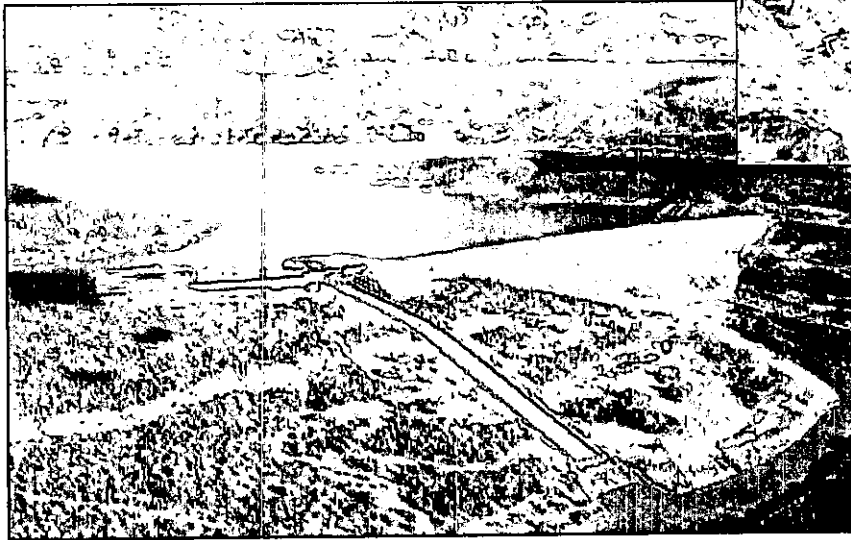


Watana Project Characteristics

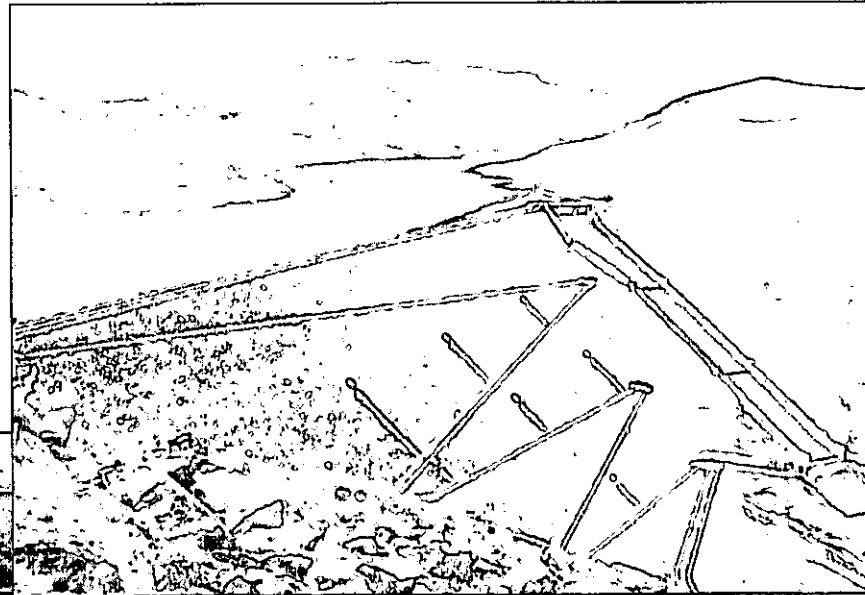
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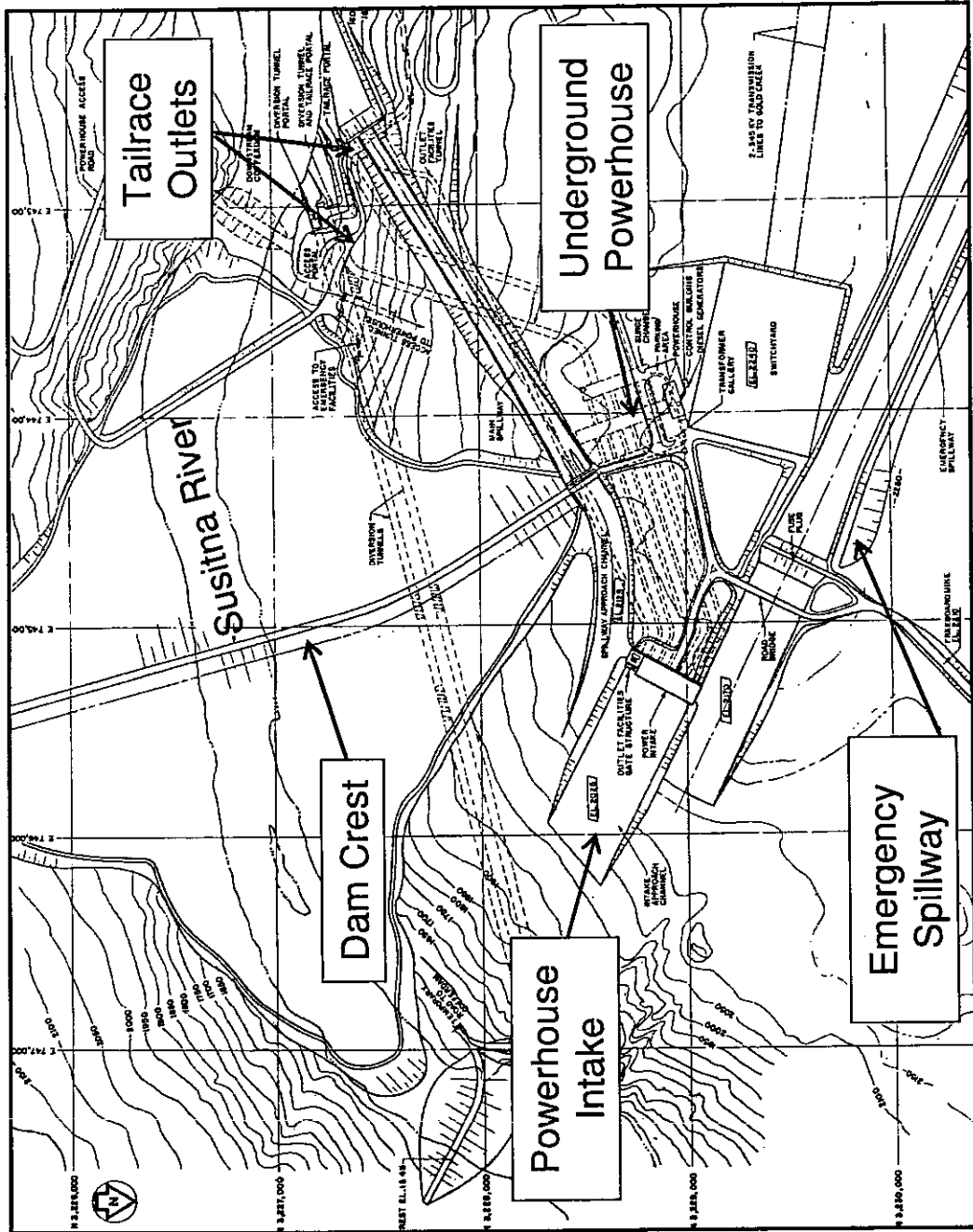


Oroville Dam, California

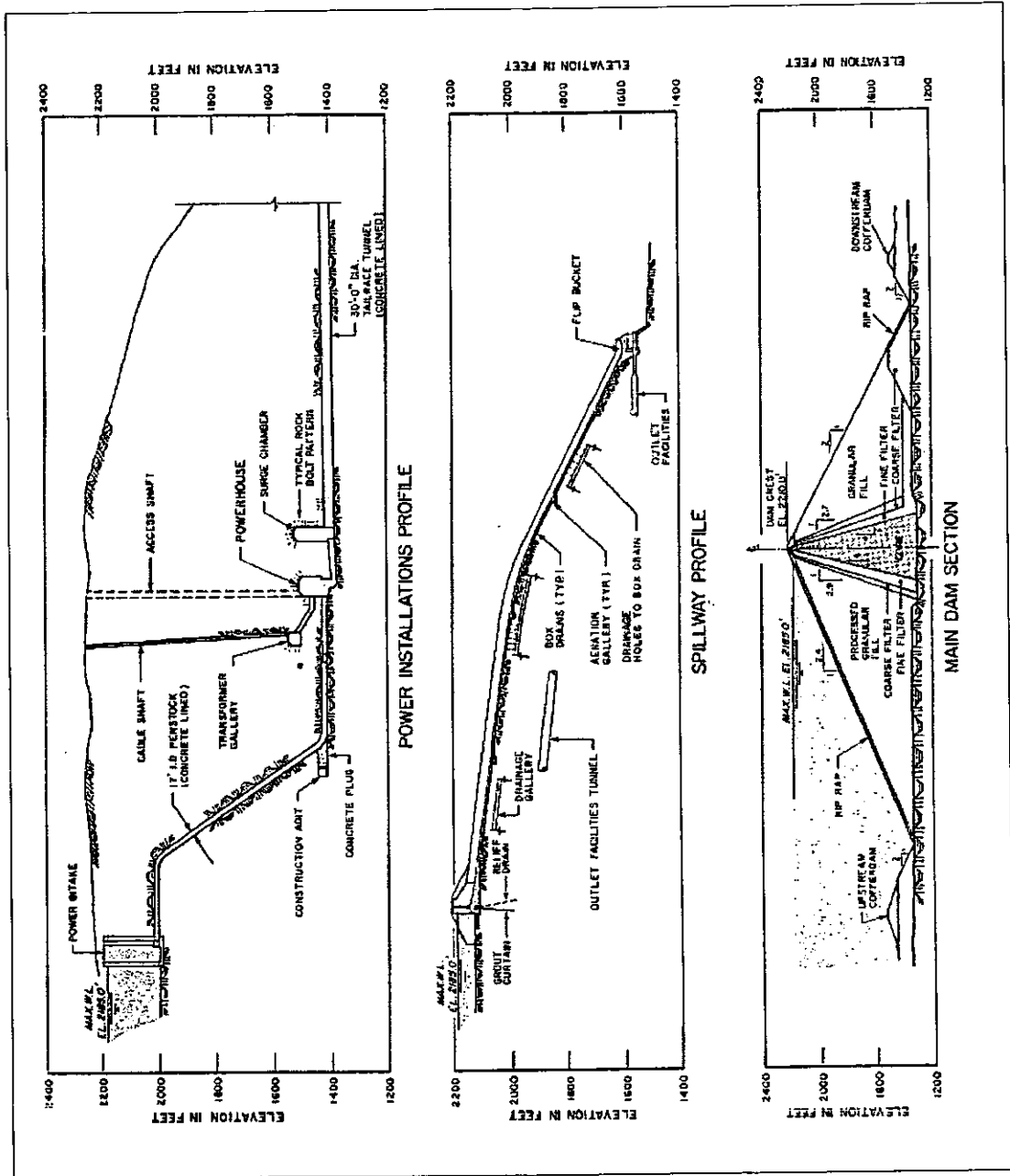


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Project Layout: Watana

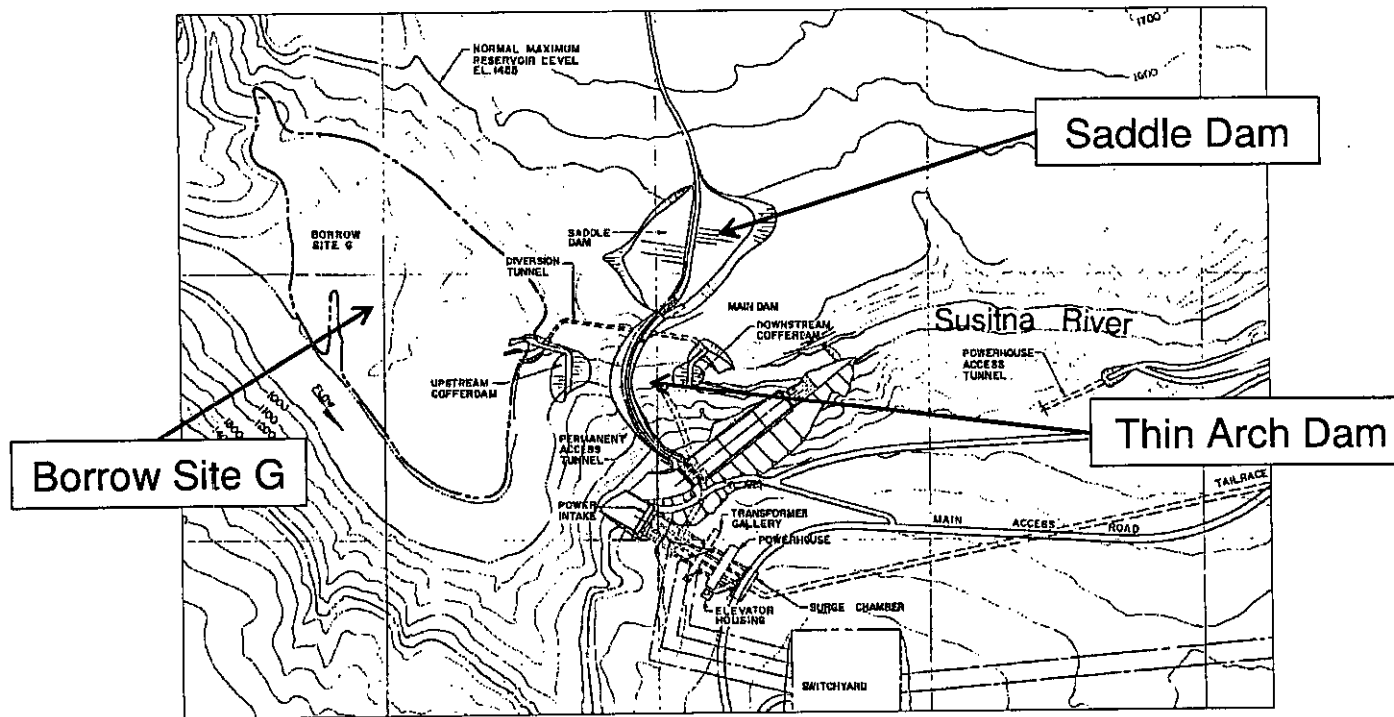


Watana Details

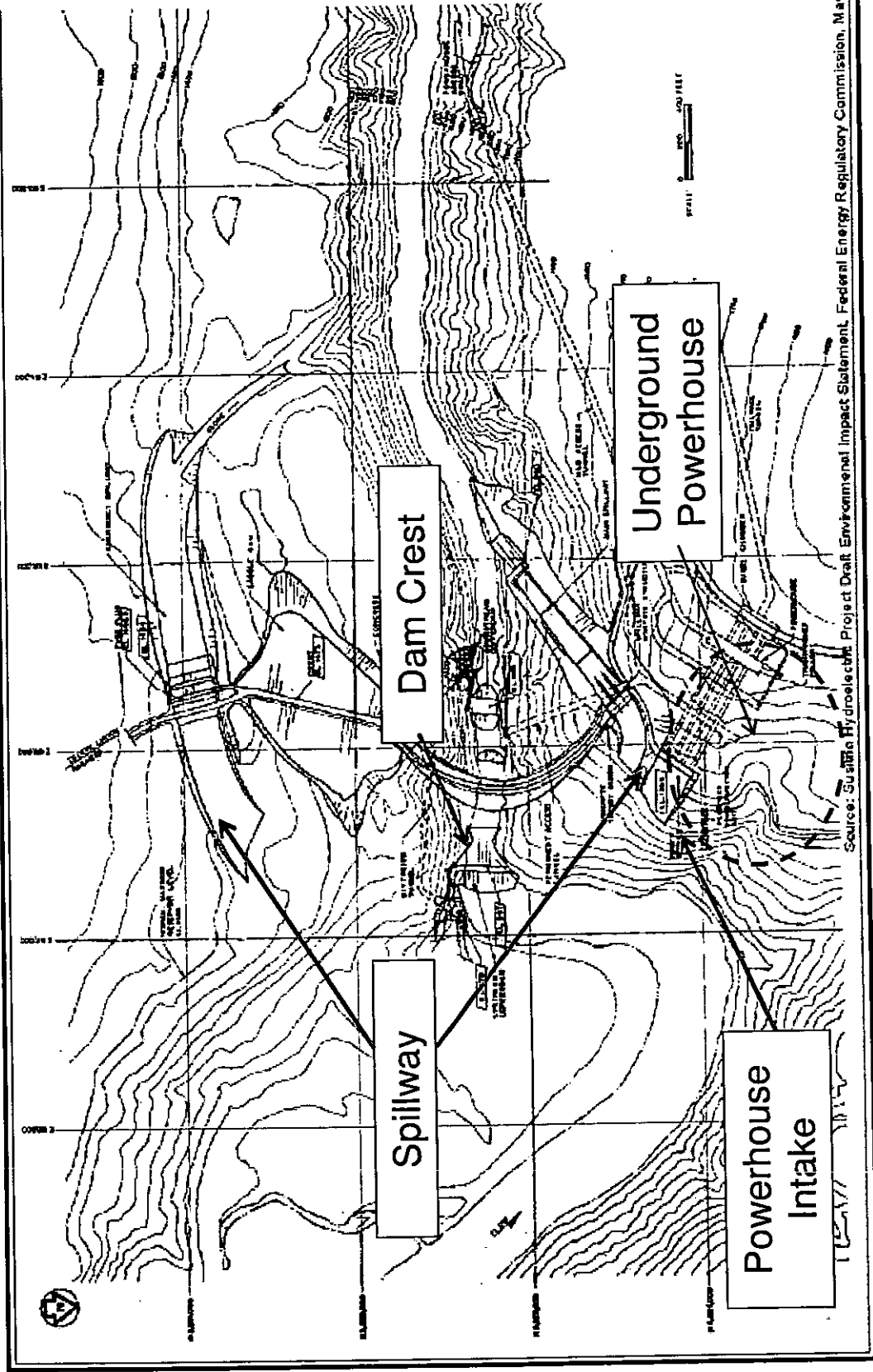


Devil Canyon Dam

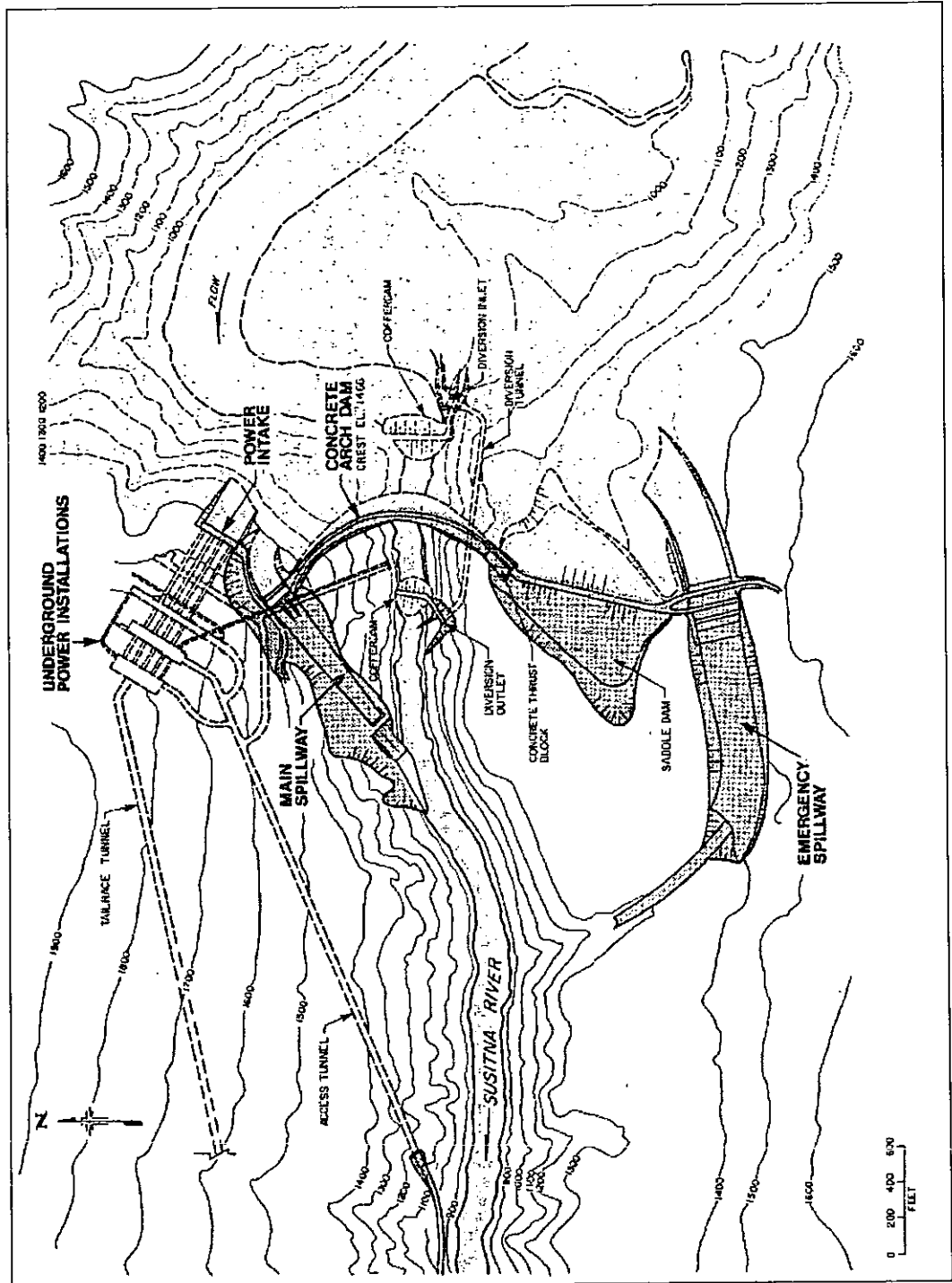
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Devil Canyon Hydropower Plan



Devil Canyon General Arrangement



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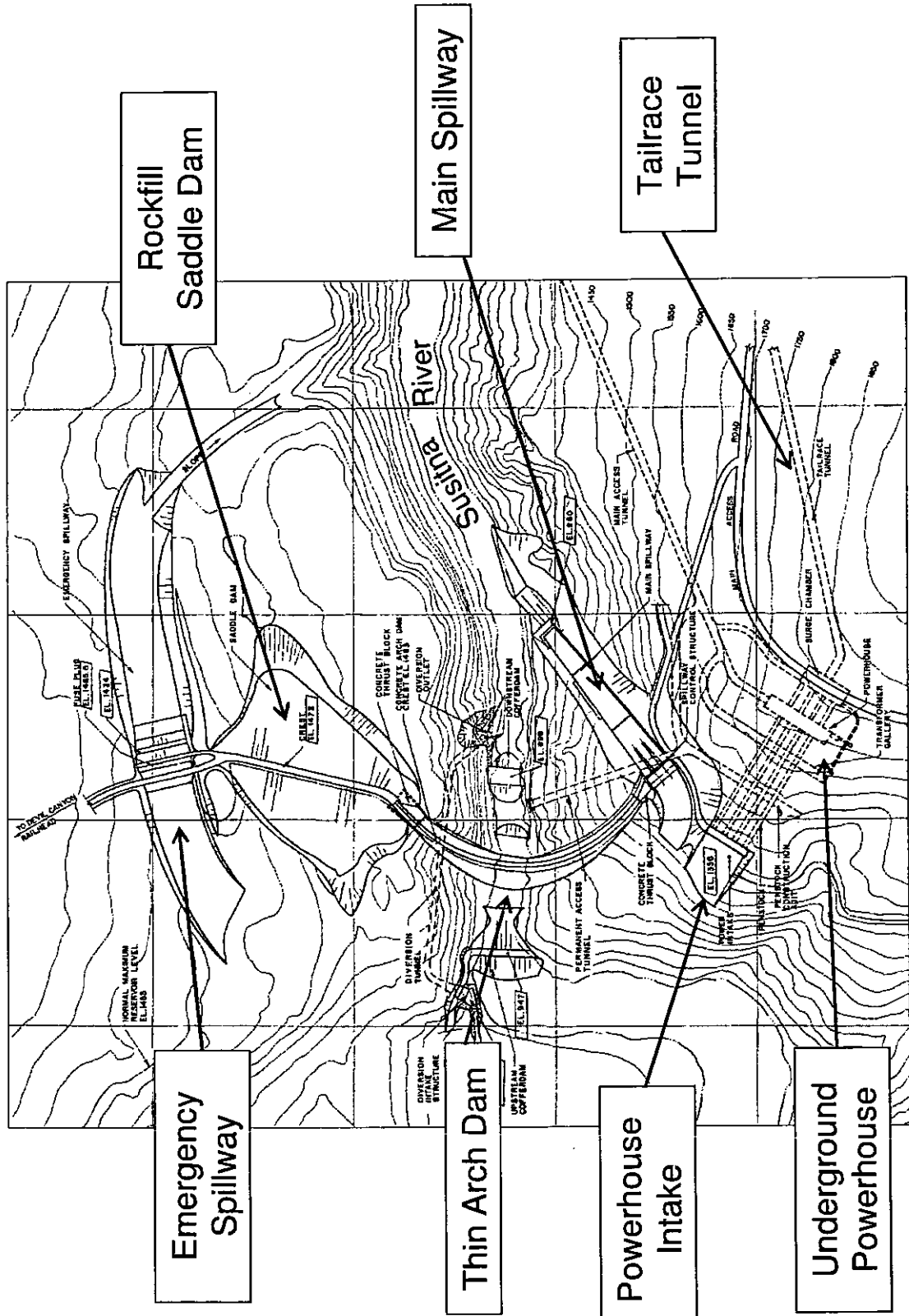


Mauvoisin Dam, Switzerland

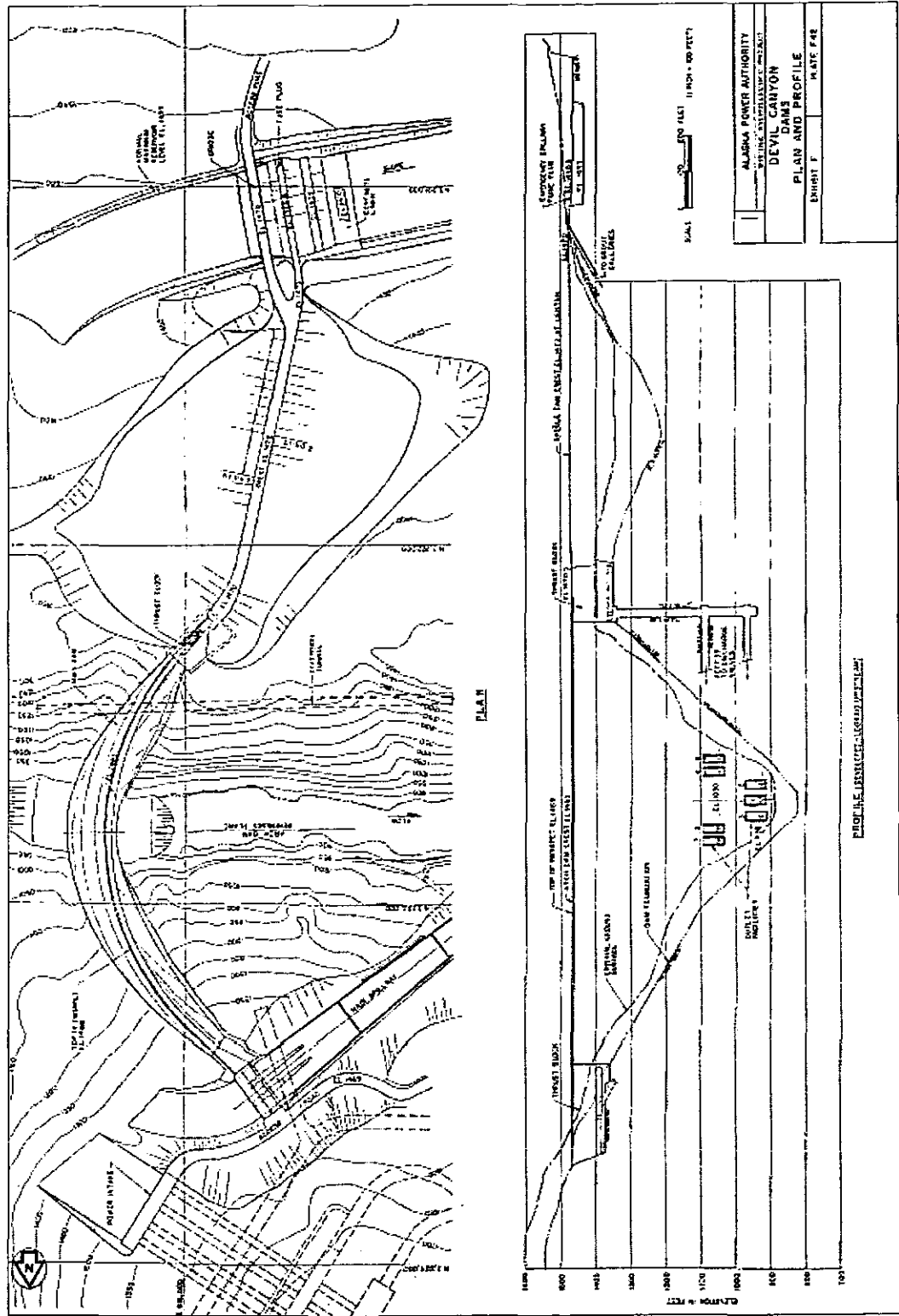


Gordon Dam, Australia

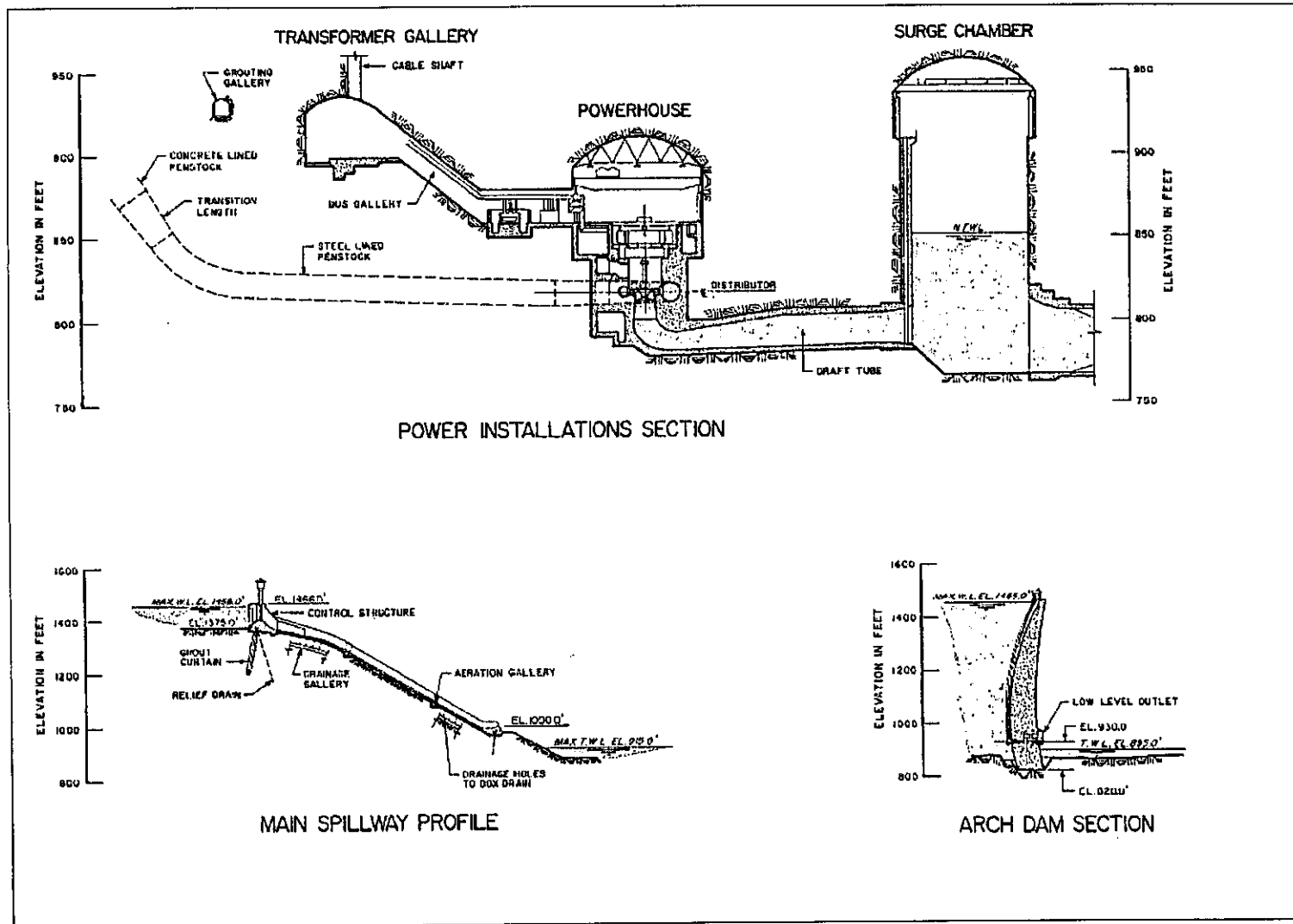
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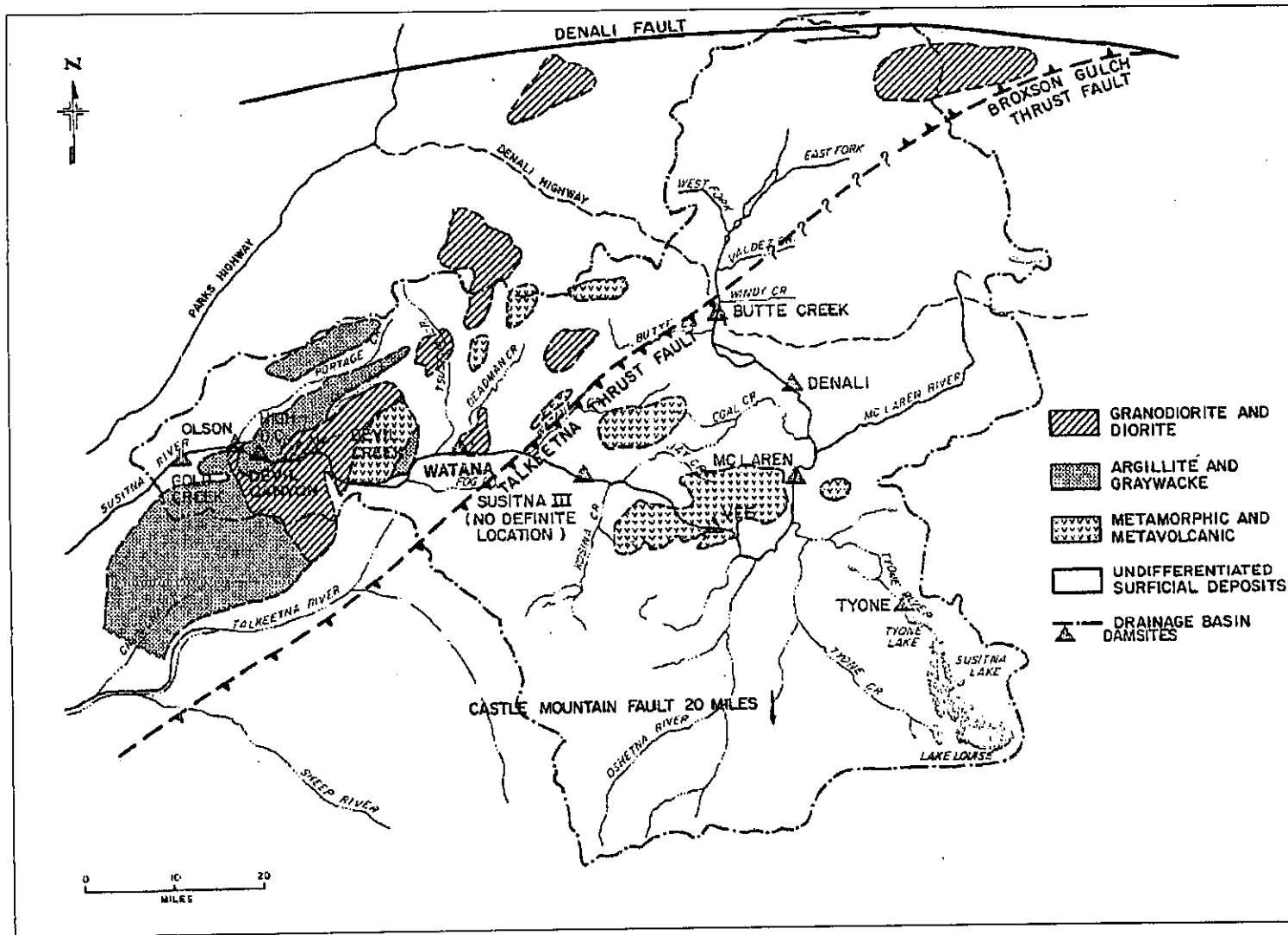
Devil Canyon Dams Plan and Profile



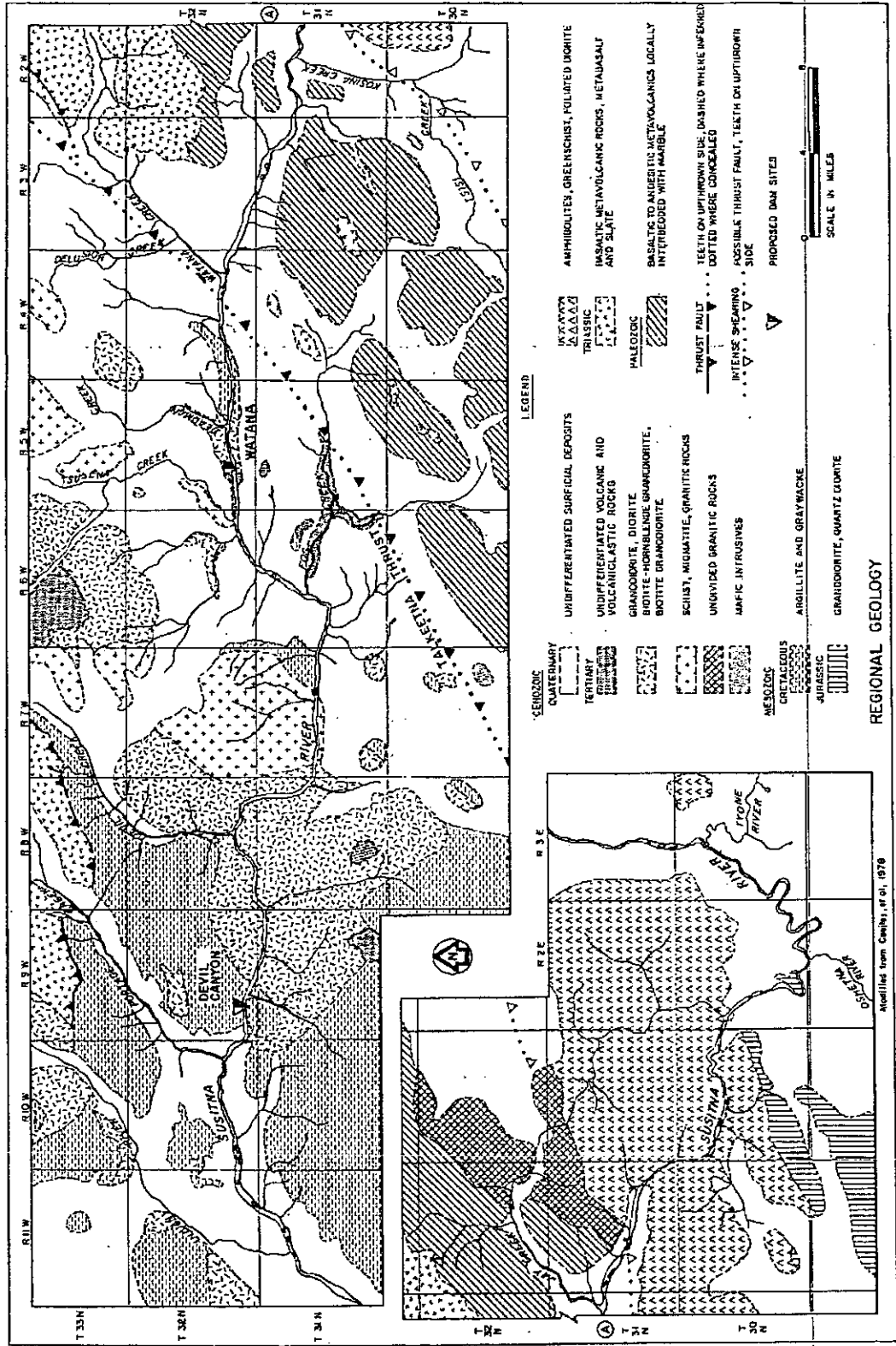
Devil Canyon Details



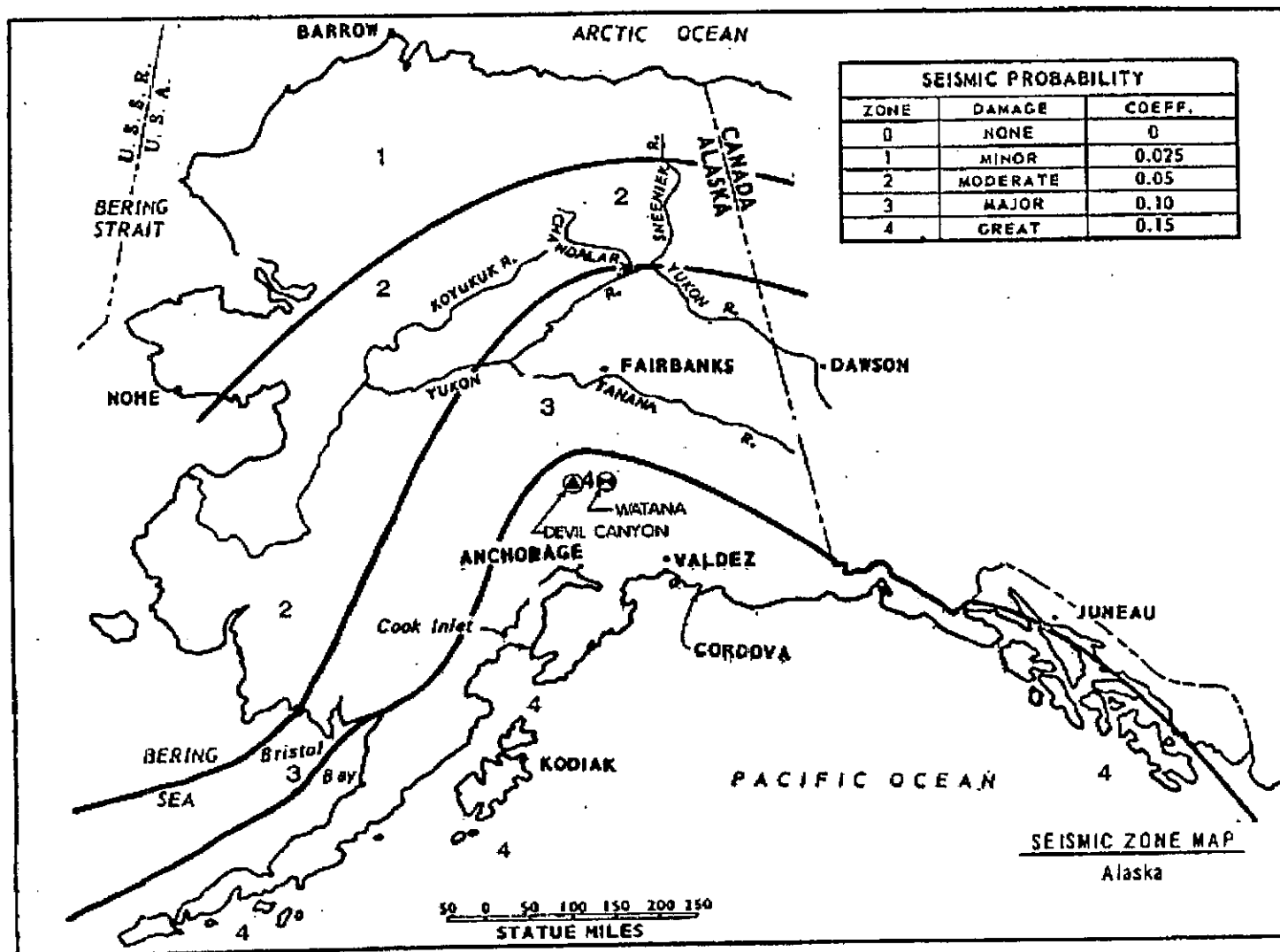
Upper Susitna Basin Geology



Regional Geology

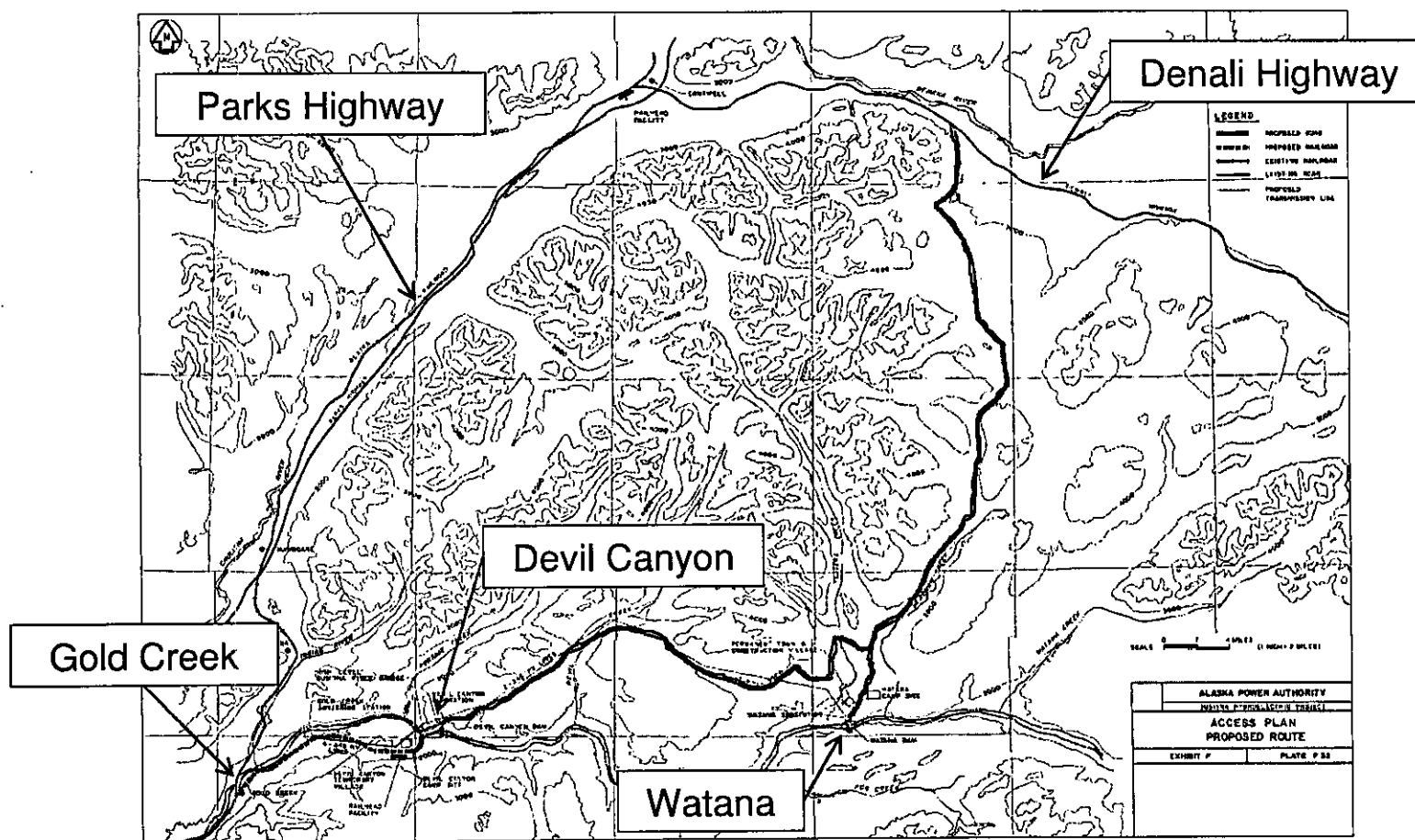


Seismicity



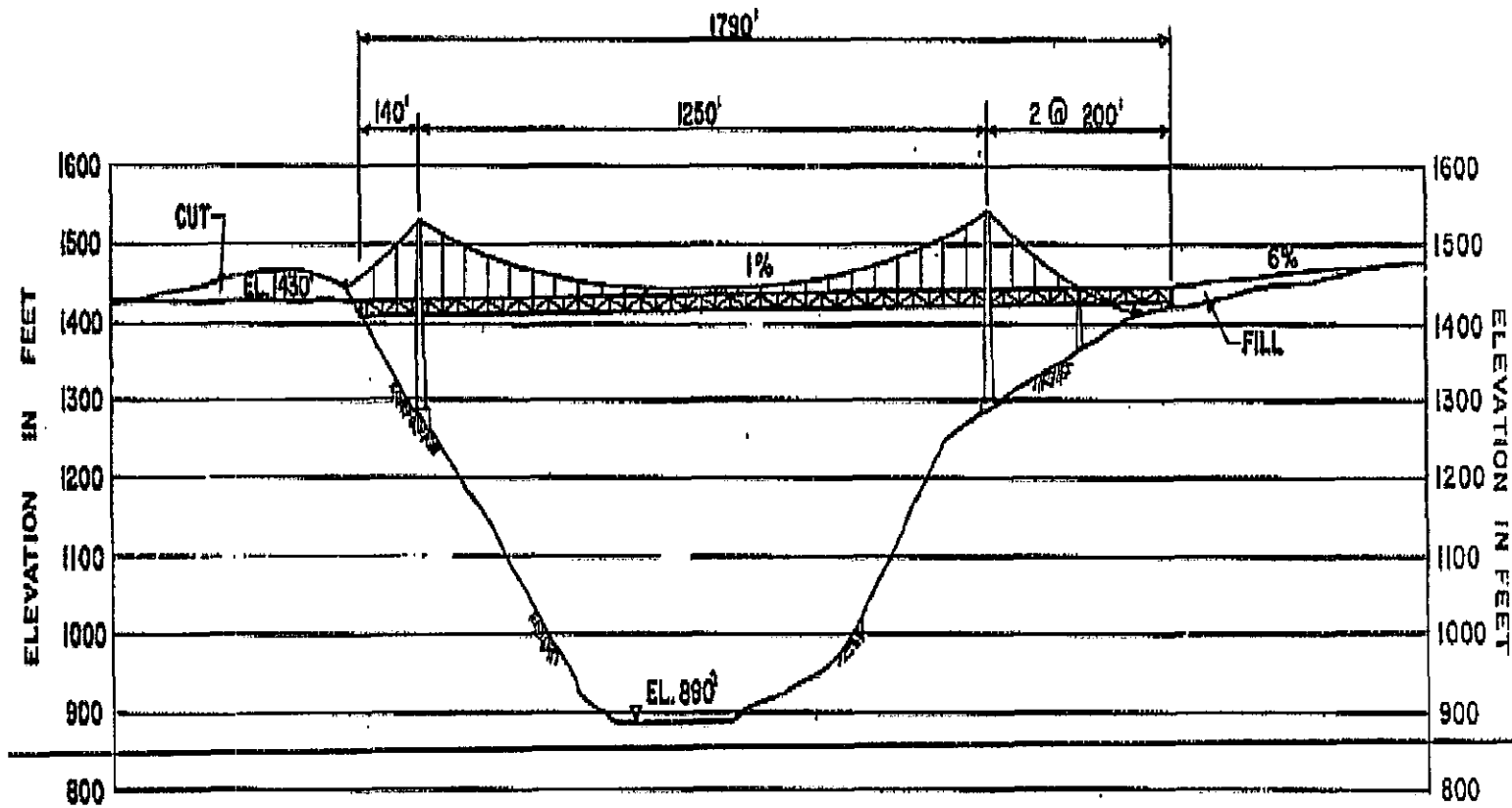
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Susitna River Bridge

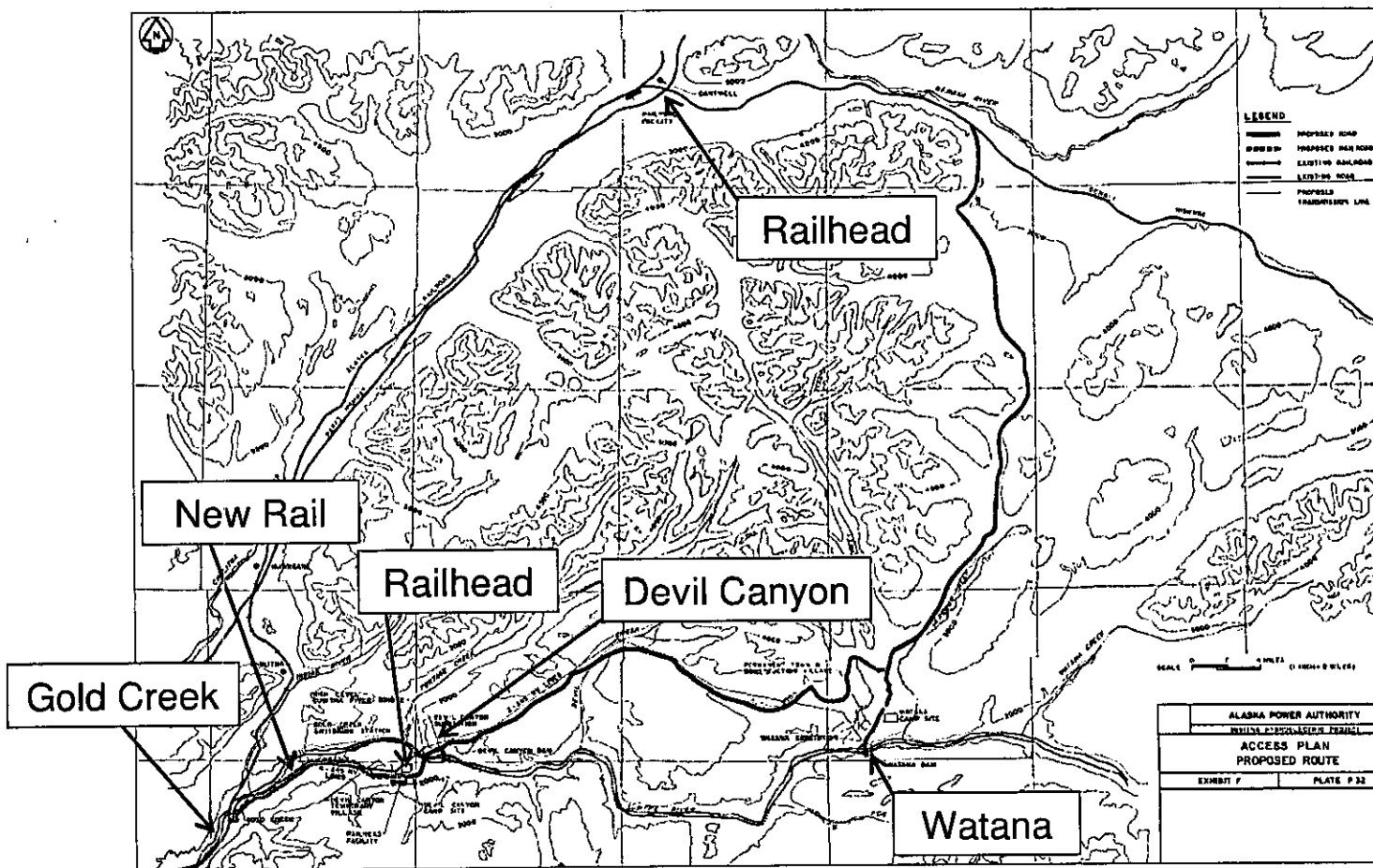
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HIGH LEVEL SUSITNA RIVER BRIDGE
SCALE C

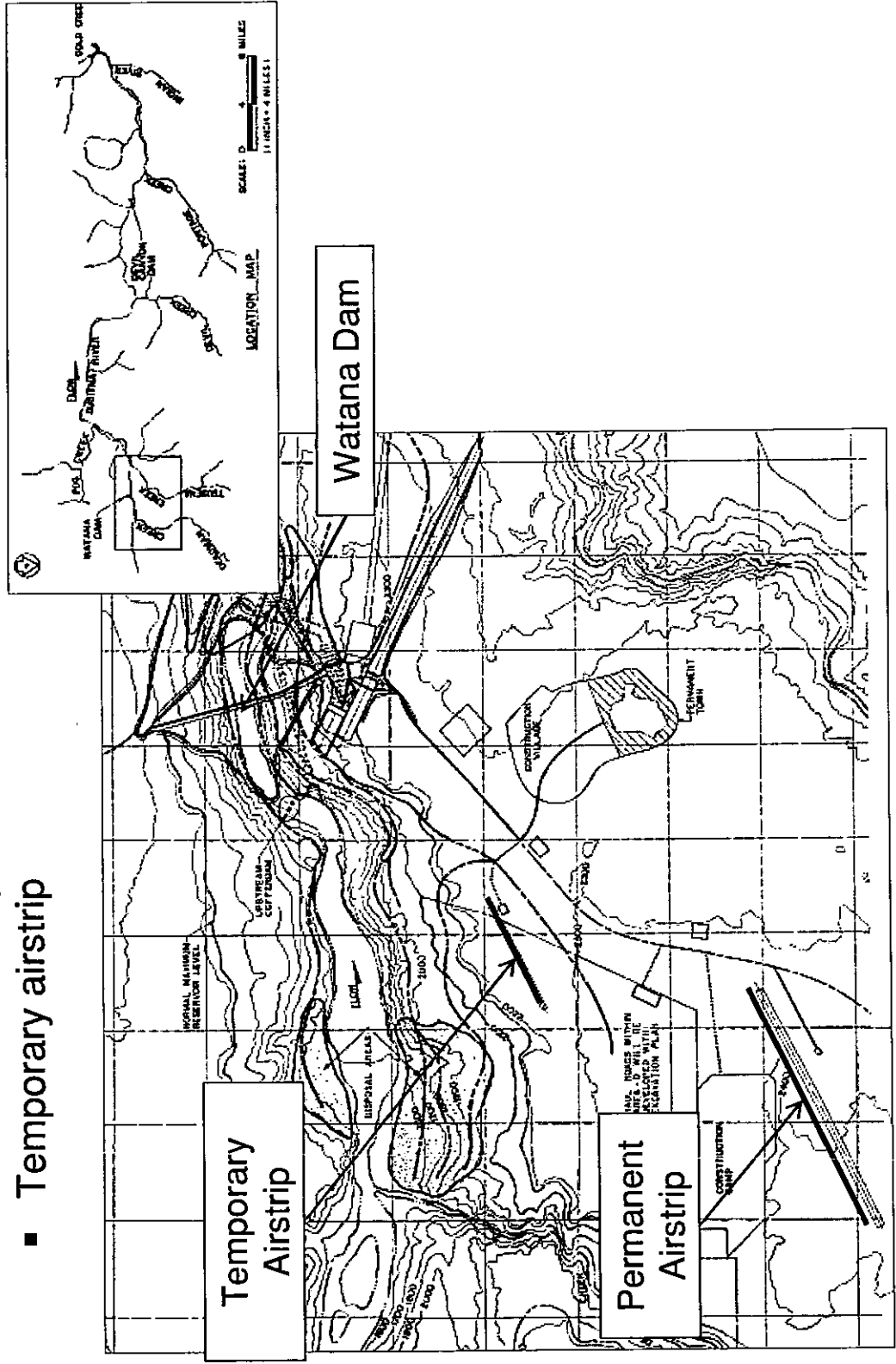
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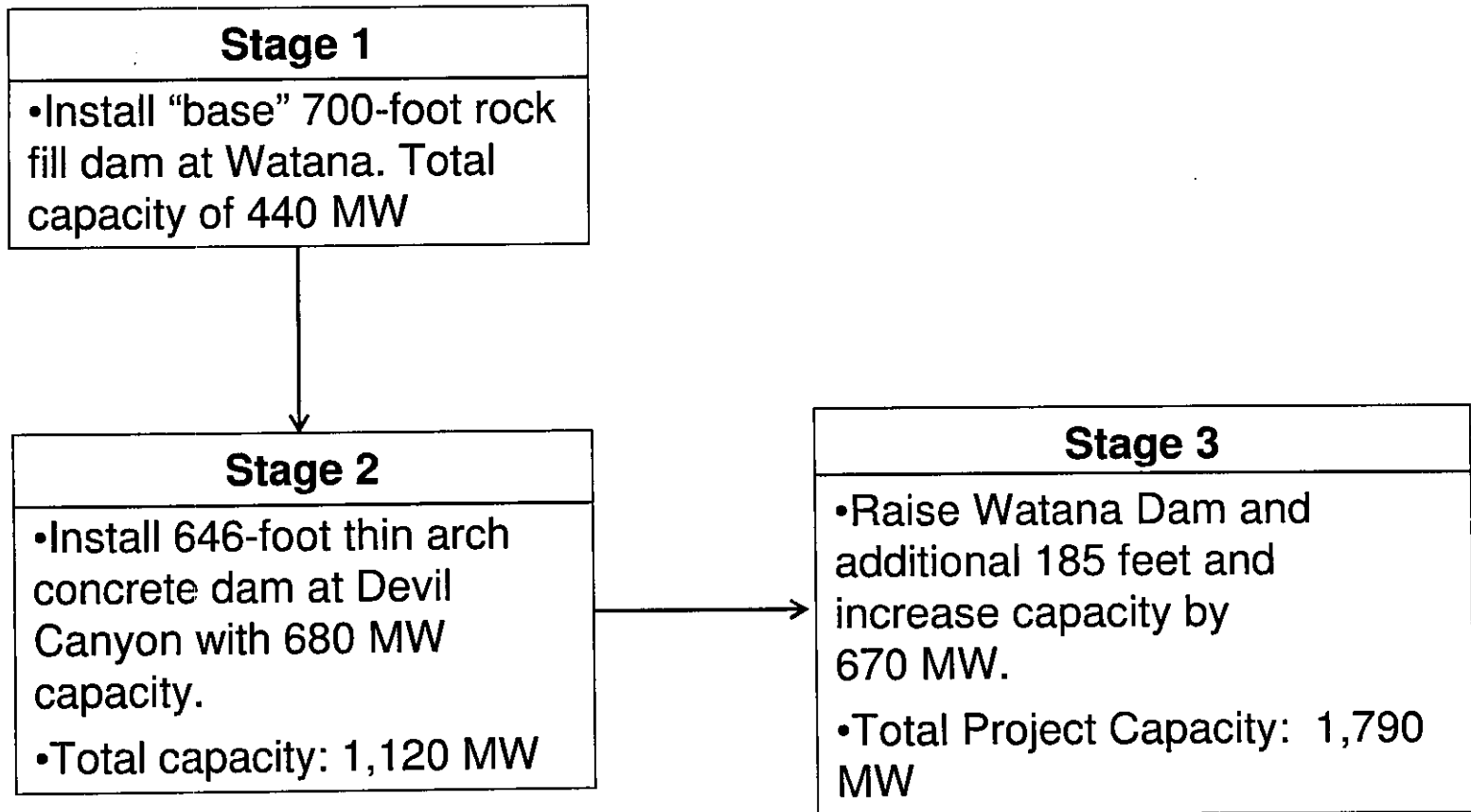


Airports

- Permanent airstrip
- Temporary airstrip



Staged Development Plan

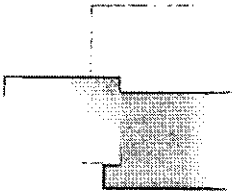


Options Considered for Staged Development

- Option 1 – Full-scale Watana only
- Option 2 – Full-scale Watana and full Devil Canyon in stages
 - Dam, powerhouse and other features built to full-scale plans
 - Stage 1 - Install two 150-MW units, penstocks and tailraces
Install foundations for two future 150-MW units
 - Stage 2 - Install two 150-MW units, penstocks and tailraces
- Option 3 – Watana Stage 1 only
 - Initial dam 200 feet lower than final stage
 - Powerhouse excavated to final size
 - Three 150- MW units installed initially with a foundation for one more unit
- Option 4 – Full-scale Devil Canyon only

Conclusions


- Remote location and large dam configurations require extensive civil works
- Large scale project, but all of these elements have been successfully done elsewhere
- Project is suited to staged construction
- Site access is particularly challenging
 - 81 miles of new road
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- Technical challenges are all manageable
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Chakachamna Hydropower

TDX Power
Nicholas Goodman
Eric Yould

Senate Resources Committee
February 24, 2009



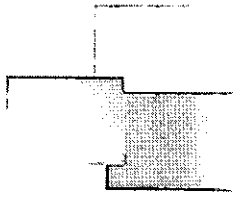
Chakachamna Hydropower

- Statewide hydro Resources
- Susitna project
- Chakachamna project



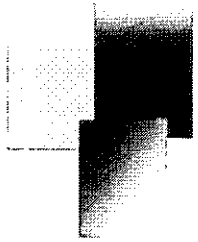
Cook Inlet Natural Gas

- 1968 Price \$0.16/MMBTU
- 2008 Utility Price \$4.00/MMBTU
- Present Henry Hub \$7.50/MMBTU
- Existing Know Reserves Limited
- Future Cost Uncertain
- North Slope Price/Availability Uncertain
- Half the Carbon Footprint of Coal



Cook Inlet Coal Generation

- Present day price \$2.00/MMBTU
- Conventional has environmental issues
- IGCC is Expensive and no good sequestration solutions
- Future Carbon Tax
- Some potential for EOR
- Cook Inlet mining issues



Cook Inlet Renewable

- Wind
- Geothermal
- Tidal
- Solar
- Hydropower



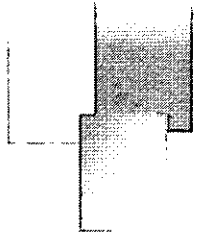
Inventory of Alaska Hydropower Potential

- U.S. Bureau of Reclamation
- U.S. Army Corps of Engineers
- 256 sites with continuous power greater than 2500 KW
- 192 billion KWH energy potential*
- 40% of the U. S. untapped hydropower
- * Railbelt energy demand 5 billion KWH

Potential Major Alaska Hydropower Projects

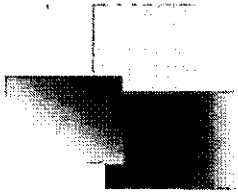
Project Name	River System	Installed Capacity (Megawatts)	Energy (Million KWH/yr)
Holy Cross	Yukon	2,800	12,300
Ruby	Yukon	1,460	6,400
Rampart	Yukon	6,000	34,200
Porcupine	Porcupine	530	2,320
Woodchopper	Yukon	2,160	14,200
Yukon-Tayia	Yukon	3,200	21,000
Susitna	Susitna	1,500	6,500
Chakachamna	Chakachatna	320	1,600
Wood Canyon	Copper	3,600	21,900
Stikine	Stikine	2,260	9,900

Note: Railbelt energy demand is presently 5,000 Million KWH/yr



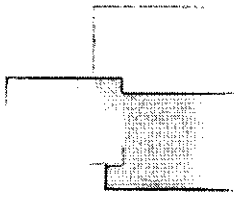
Existing Hydropower Statewide

- 40 projects
- Most located in Southeast
- Inexpensive Electricity



Existing Hydropower Southcentral

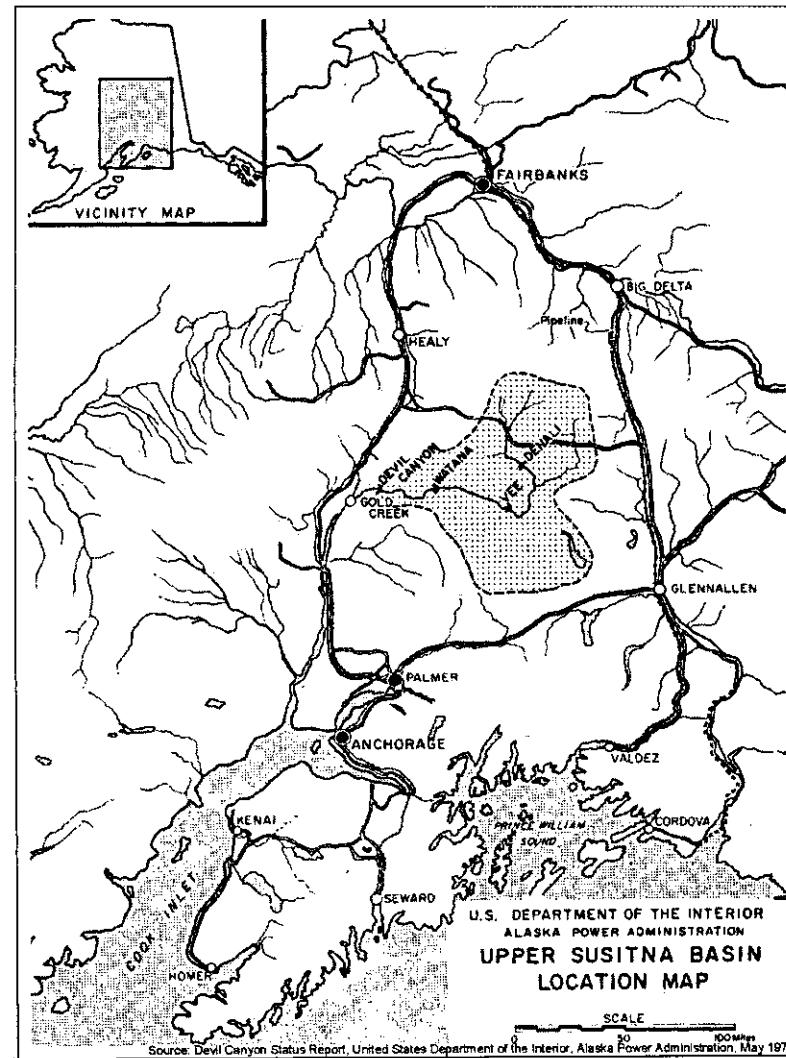
- Eklutna 37.5 MW
- Bradley Lake 115 MW
- Cooper Lake 20 MW



Susitna Hydropower Project

- Two high head dams on the upper Susitna river located 30 miles upstream from Talkeetna
- Total Cost \$5.3 Billion (1985 dollars)
- 1,400 MW installed capacity and 6.5 billion KWH of energy
- Watana built first -- 870 foot high earth fill dam
- Devil Canyon built second -- 650 foot high concrete thin arch dam
- State expenditures for exploration and FERC licensing: \$160 million, through the Alaska Power Authority
- License application withdrawn in 1985 when price of oil plummeted

Susitna Project Location



Upper Susitna Dam Sites

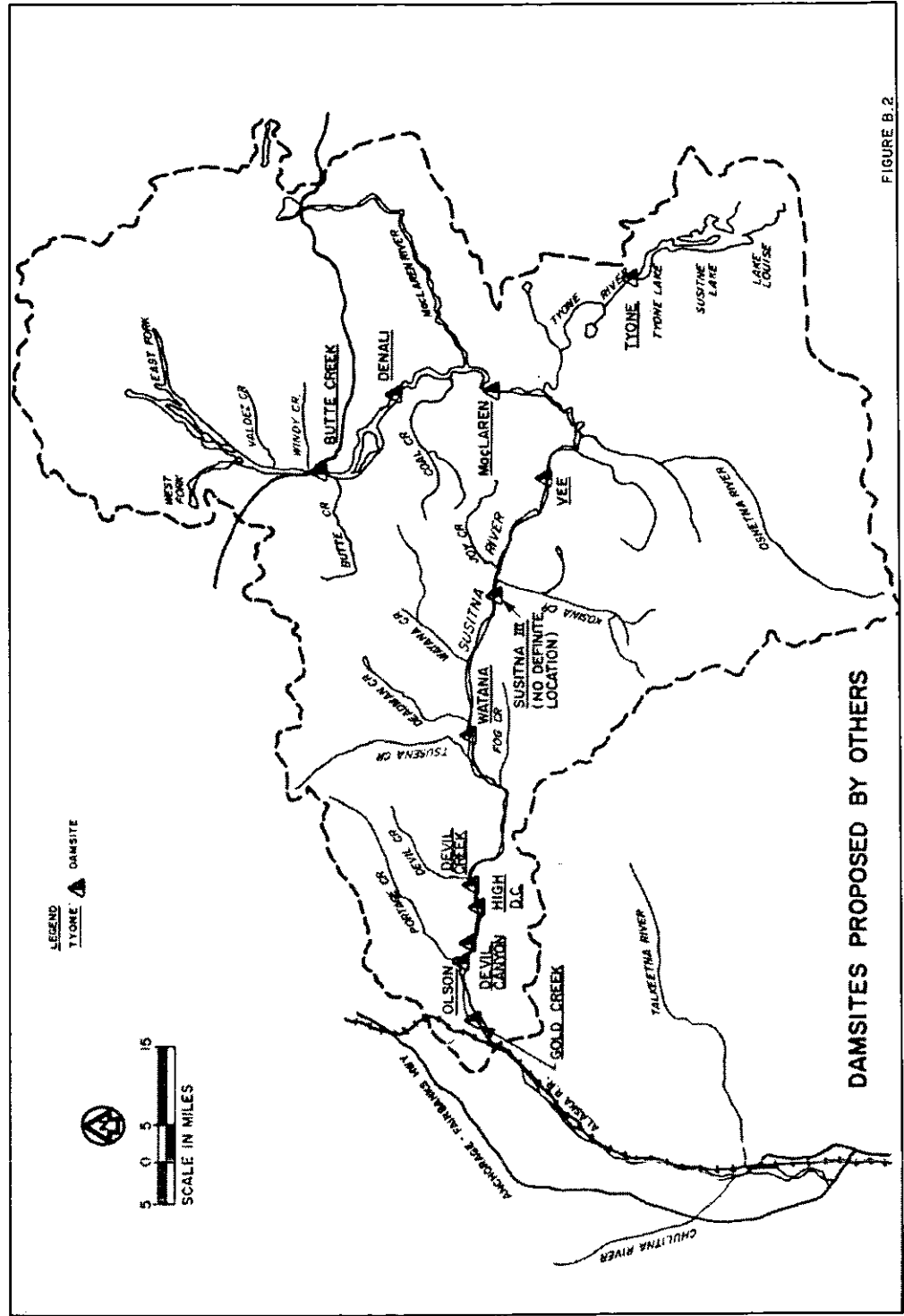
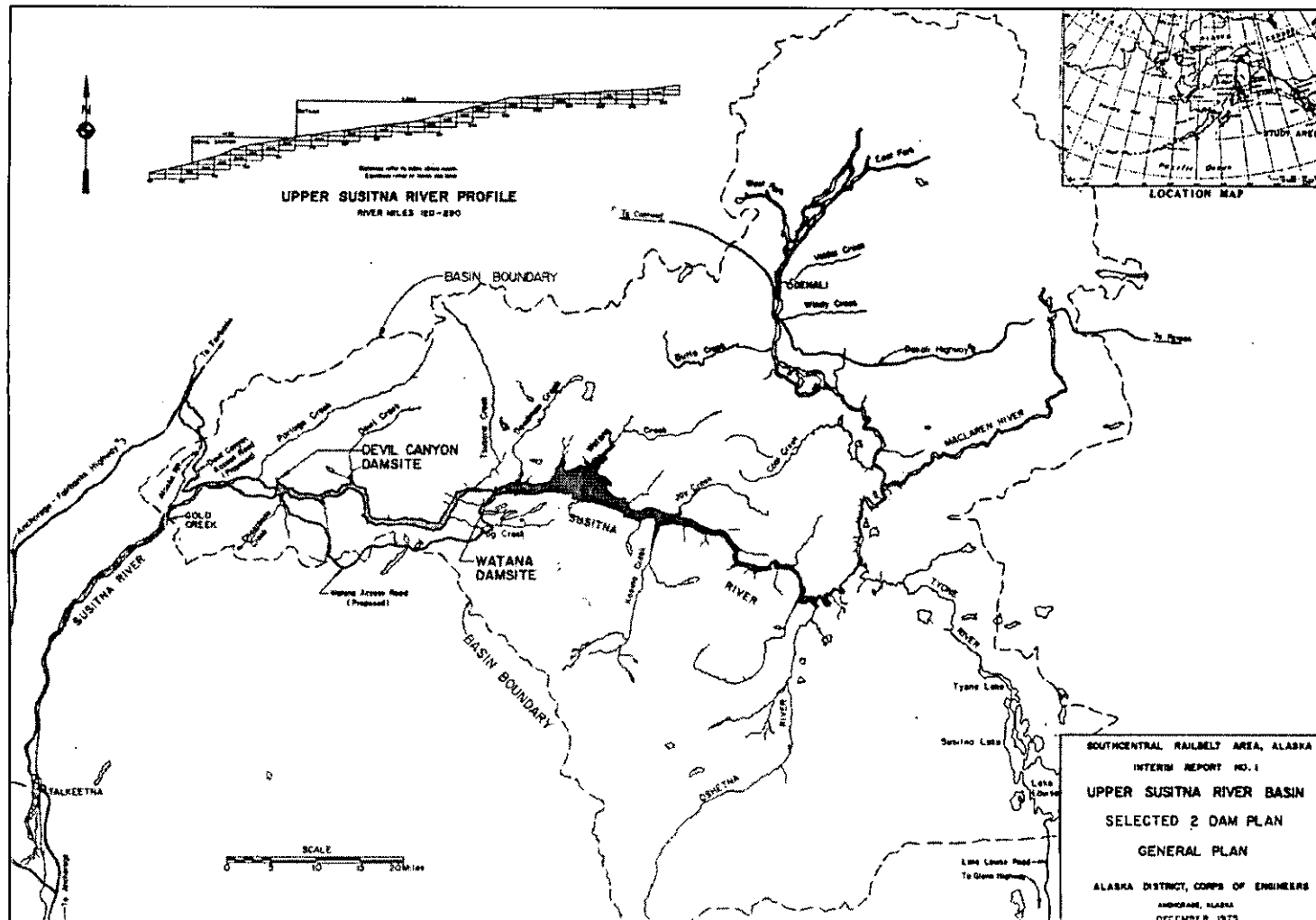


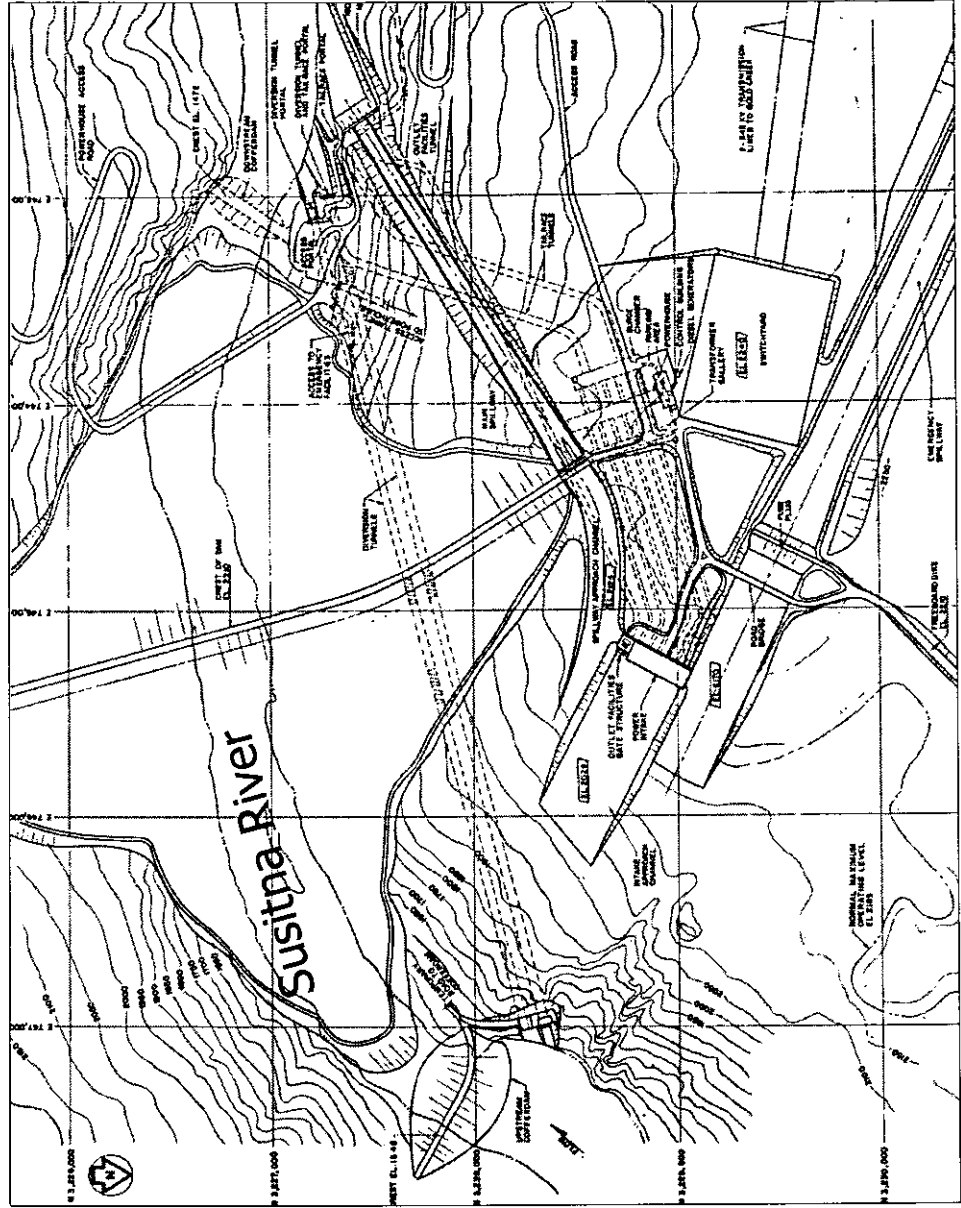
FIGURE B.2

Devil Canyon & Watana

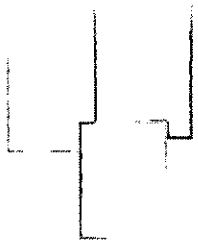


Watana Dam

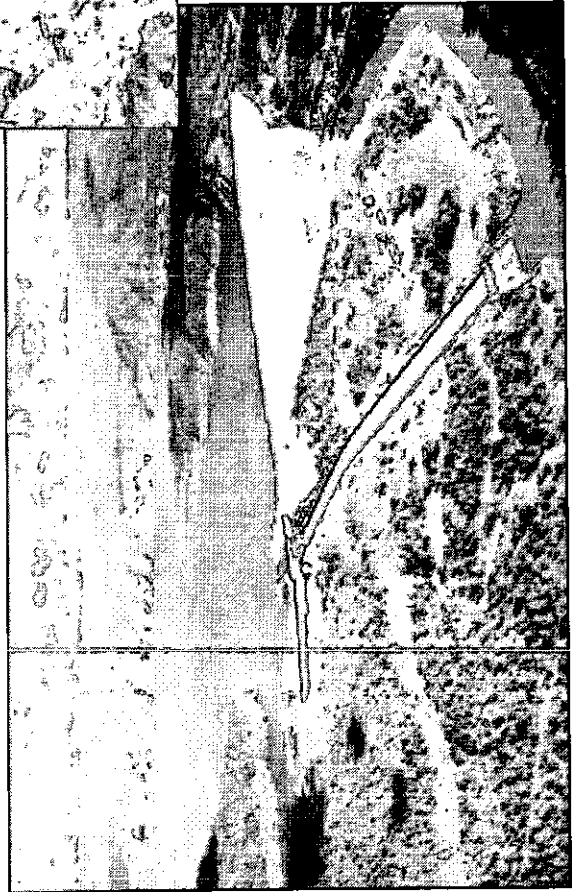
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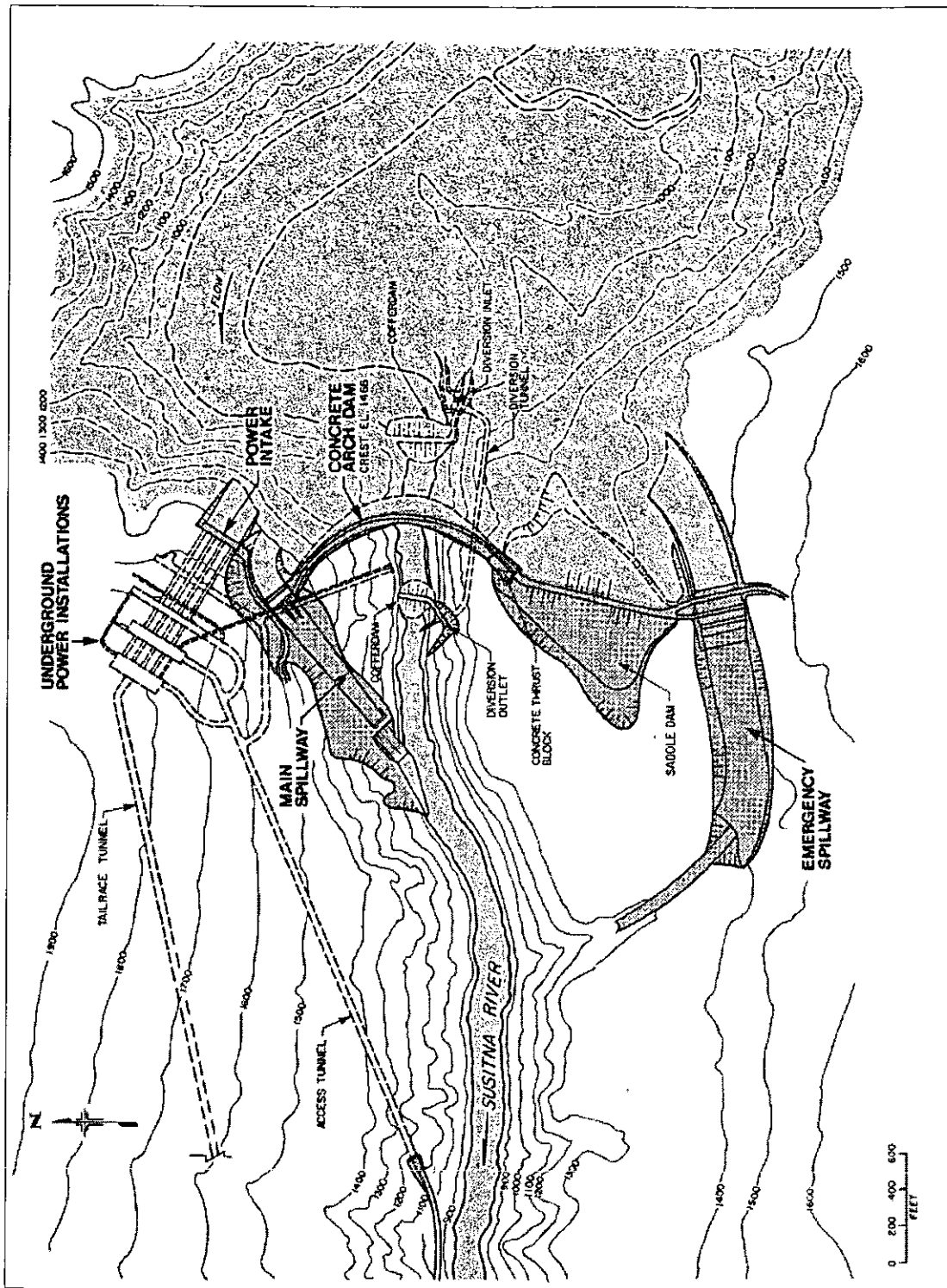


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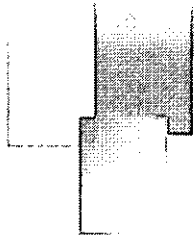


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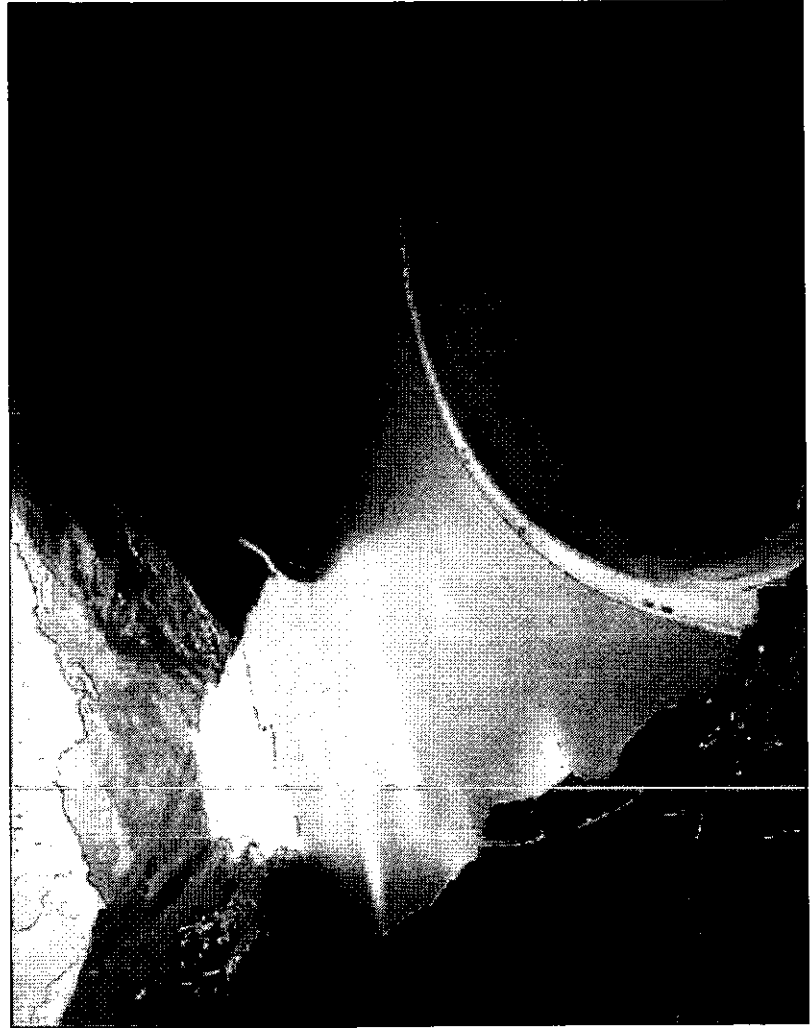
Devil Canyon General Arrangement



Arch Concrete Dams



Gordon Dam, Australia



Mauvoisin Dam, Switzerland

Alternatives Outside the Susitna Basin

Alternative Investigated	Estimated Total Cost of Project (\$ million 1982)	Total Installed Capacity of Alternative (MW)	Average Annual Energy of Alternative (GWh)
Johnson	319	210	920
Chakachamna	905	333	1,300
Snow	305	100	375
Keetna	519	100	420
Browne	681	100	418

Hydro Alternatives

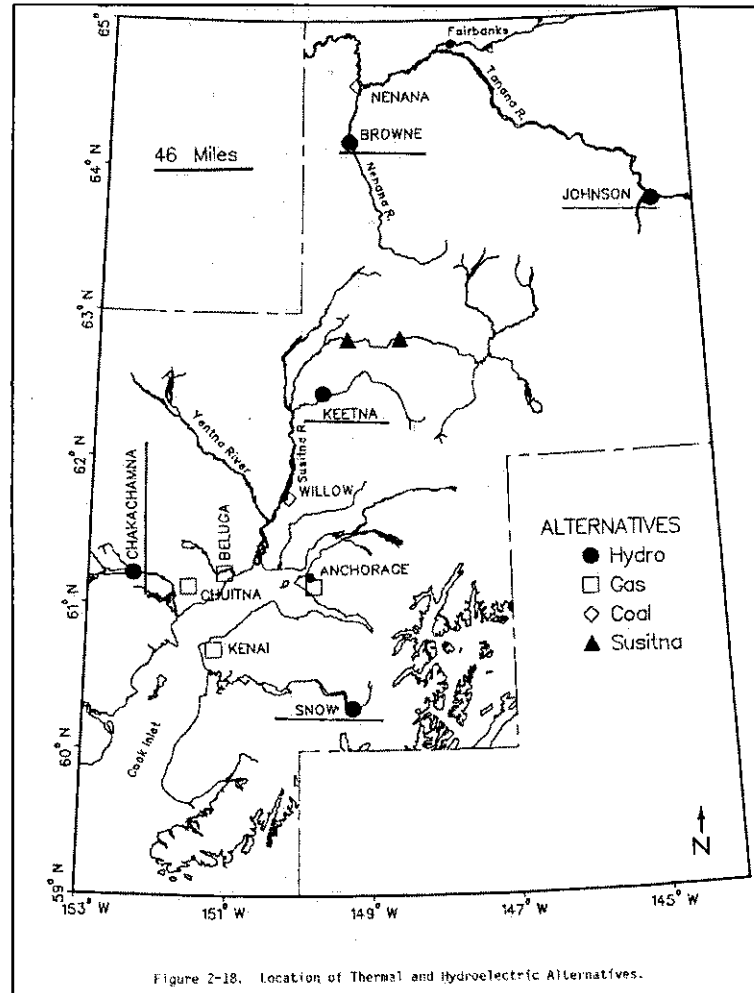
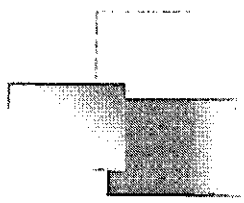
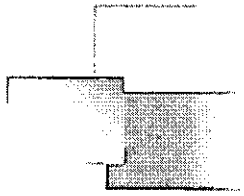


Figure 2-18. Location of Thermal and Hydroelectric Alternatives.



Chakachamna Hydropower Investigations

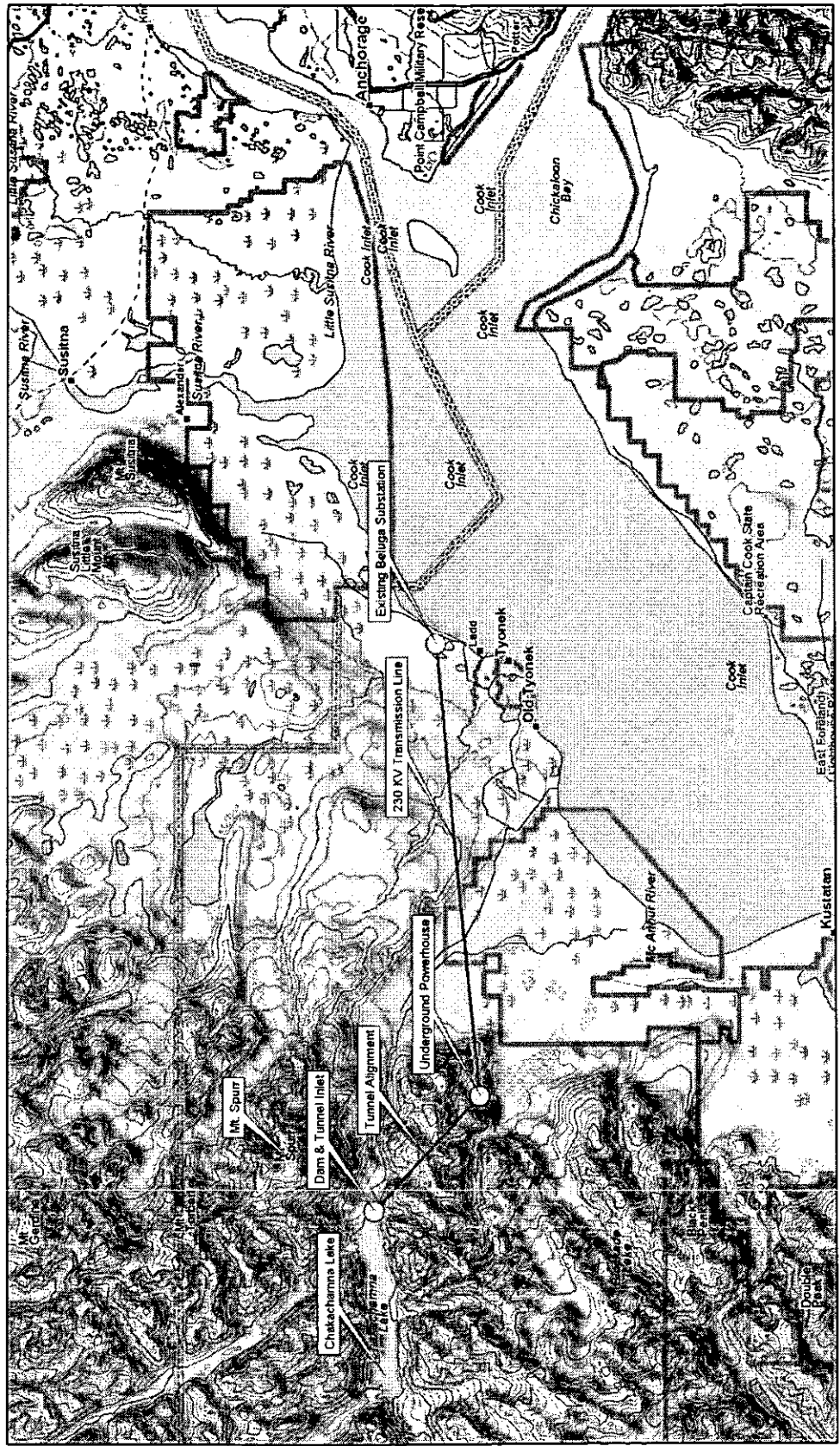
- | | | |
|--------------------------------|-------------|-----------------|
| ▪ Department of Interior | Late 1940s | Reconnaissance |
| ▪ U.S. Army Corps of Engineers | 1970s | Reconnaissance |
| ▪ Alaska Power Authority | Early 1980s | Pre-feasibility |
| ▪ TDX Power | 2006 | FERC permit |



Chakachamna Hydro Power

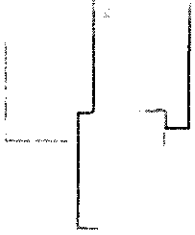
- Studied by Alaska Power Authority in early 1980's
- Being evaluated by TDX Power for Railbelt Utilities
- High head lake tap – 12 mile power tunnel
- No dam
- 330 MW creating 1.6 billion KWH annually
- Total cost of project in 2008 dollars = \$1.7 billion
- Project is 40 miles from Chugach T-line at Beluga

Chakachamna Project Location



Chakachamna Aerial View



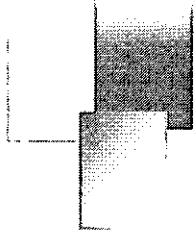


Chakachamna Dam Site

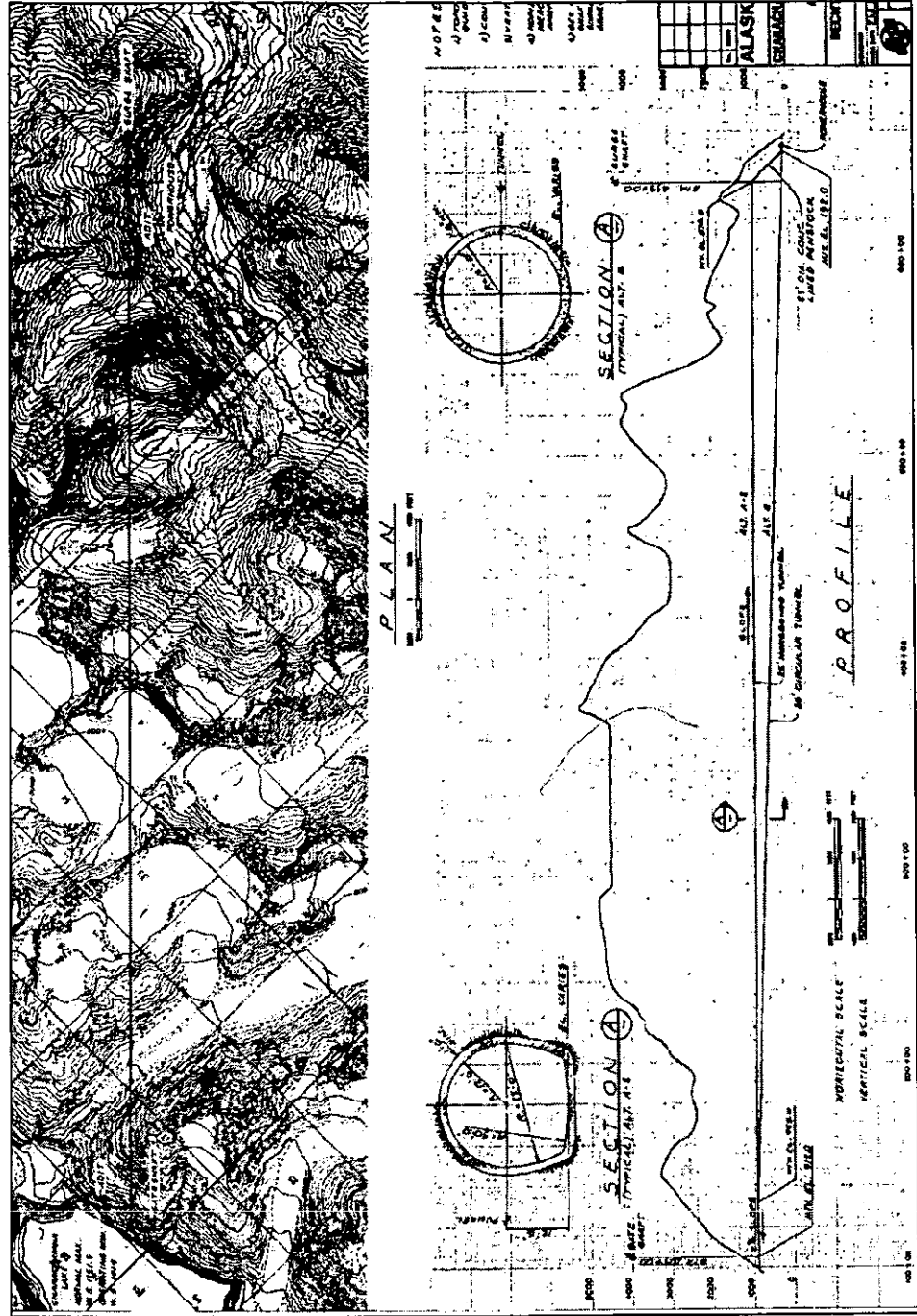


Power Plant Site

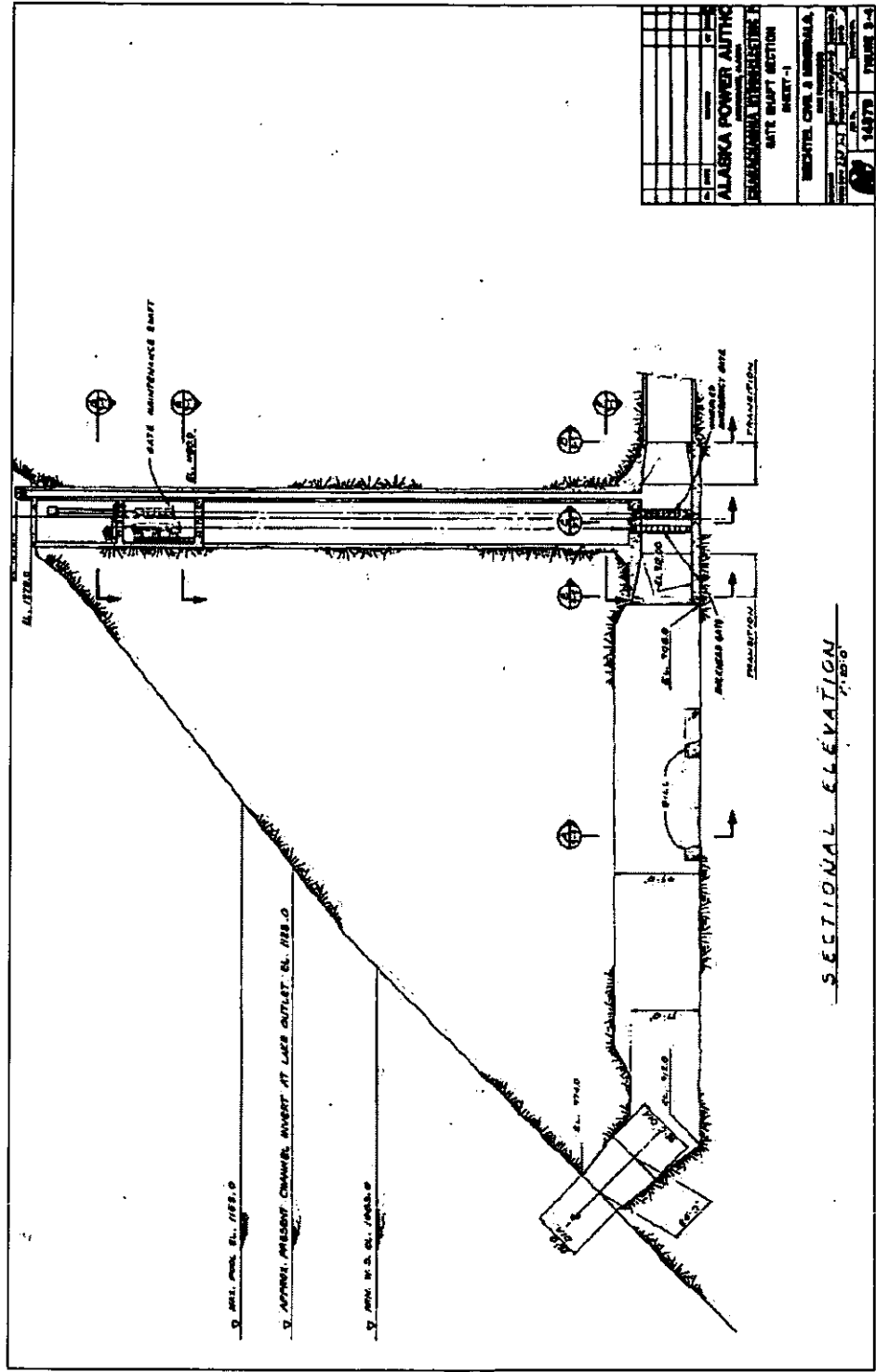




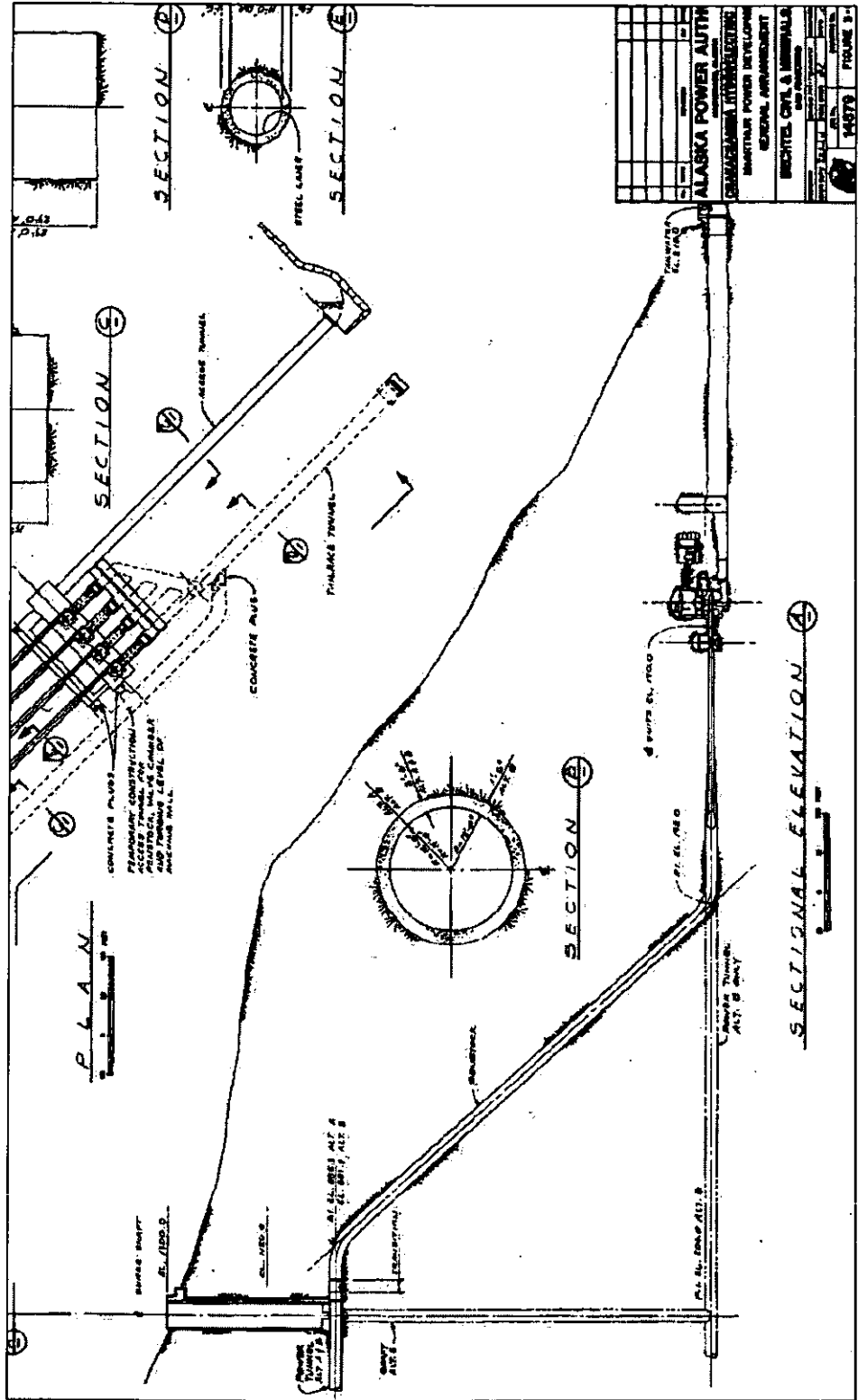
Chakachamna Selected Plan



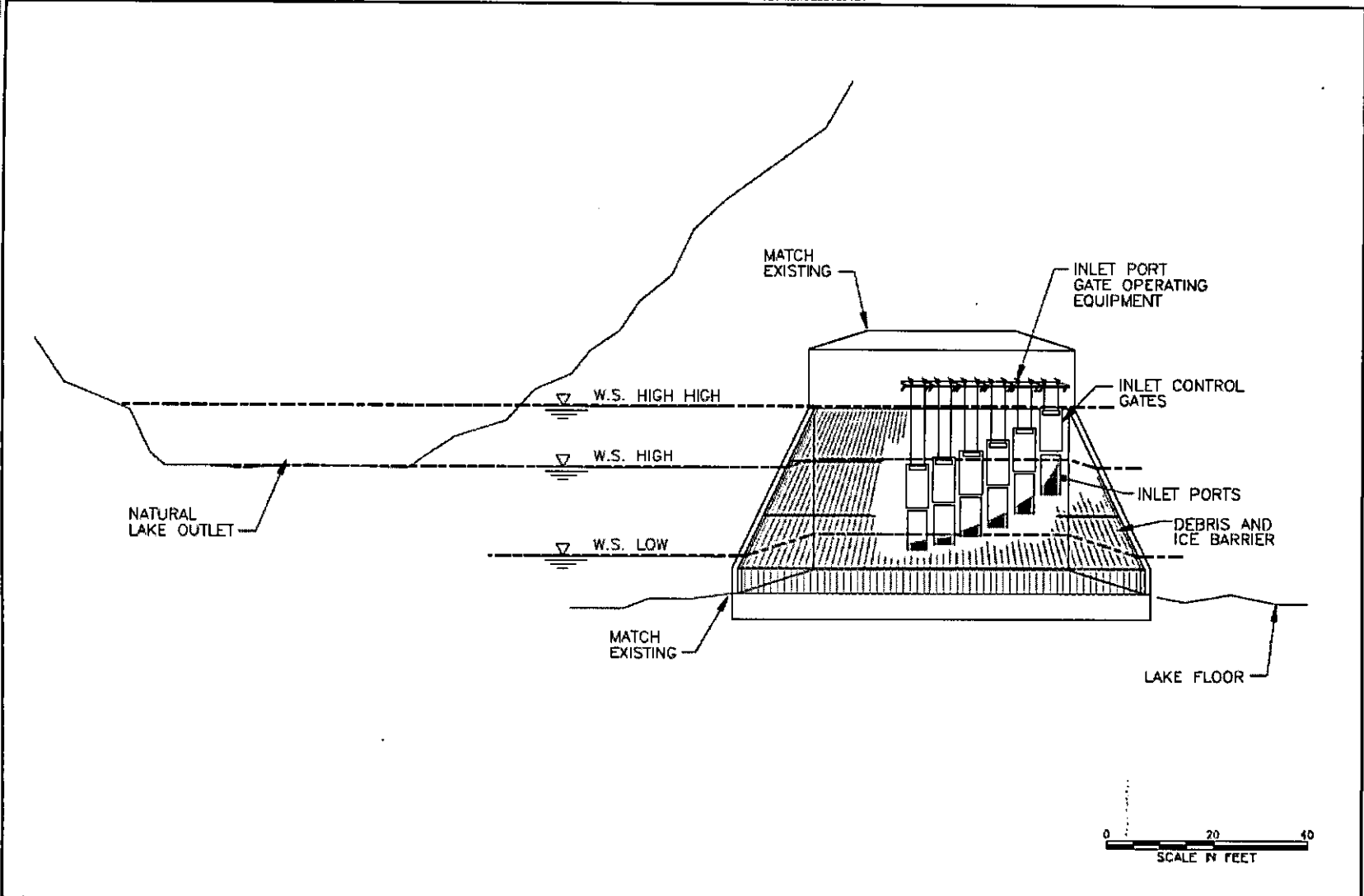
Chakachamna Lake Tap Gate Shaft Inflow to Power Tunnel



McArthur River Underground Powerhouse (Chakachamna)

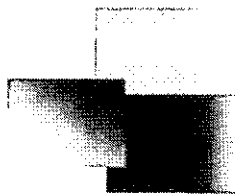


Fish Passage Concepts



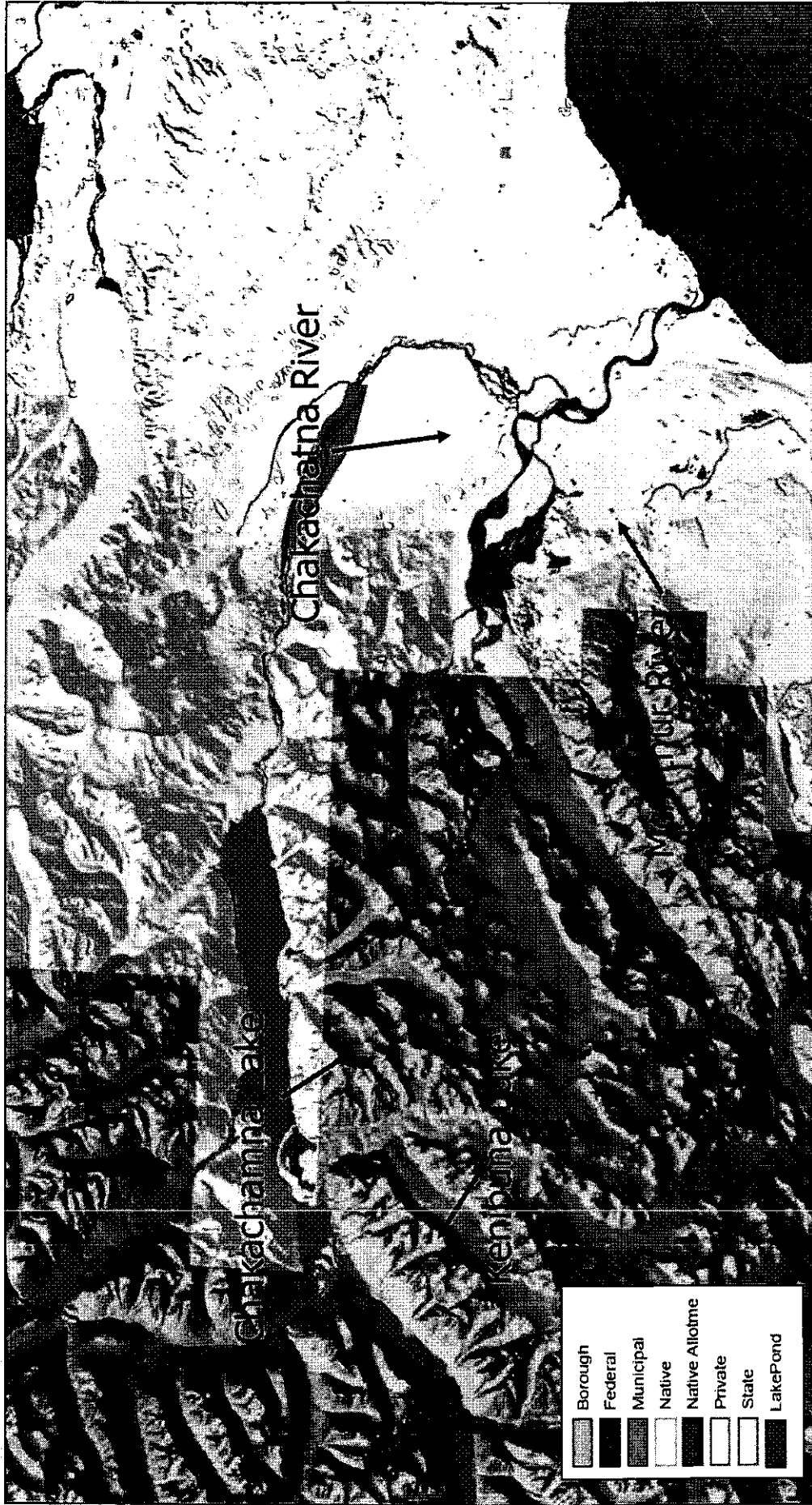
	<p>Chakachamna Fish Bypass Structure ELEVATION</p>	<p>FIGURE 2</p>
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DATE: October 2008



Land Status

- State
- Federal
- Borough
- Tribal
- Other Land Designations
 - Kenai Peninsula Borough
 - Trading Bay State Wildlife Refuge
 - Lake Clark National Park and Preserve



Project Area Landownership



CHAKACHAMNA FISHERIES

- 5 species of salmon use the basin
- Sockeye the main salmon species
- Dolly Varden ubiquitous in the streams
- Lake trout observed in lake
- Not a large anadromous fishery but worthy of protecting
- Fish passage at lake outlet required
- Possible temperature enhancement to river



1982 FISH INVESTIGATIONS

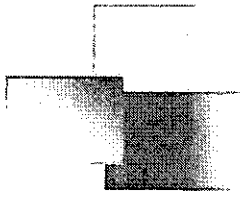
Chakachatna Drainage Basin	
Sockeye	43,637
Chinook	1,422
Pink	8,263
Chum	1,920
Coho	2,599

McArthur Drainage Basin	
Sockeye	34,933
Chinook	2,167
Pink	19,777
Chum	29
Coho	4,729



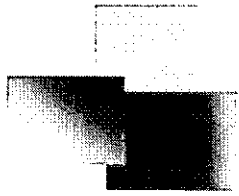
Cook Inlet Sockeye 2007 Fish Runs

	<u>Run</u>	
<u>System</u>	<u>Run</u>	
Crescent River	109,000	
Fish Creek	37,000	
Kasilof River	1,247,000	
Kenai River	2,411,000	
Susitna River	487,000	
Minor Systems	644,000	
*Chakachamna (1982)	78,000	



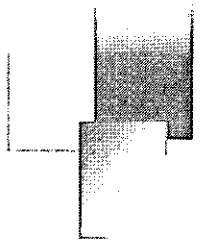
CHAKACHAMNA WILDLIFE

- 56 species of birds
- 16 species of mammals
- Moose, wolves, lynx, bear, wolverine, other fur bearers
- None on the endangered species list
- Less impact than other hydro projects of similar size

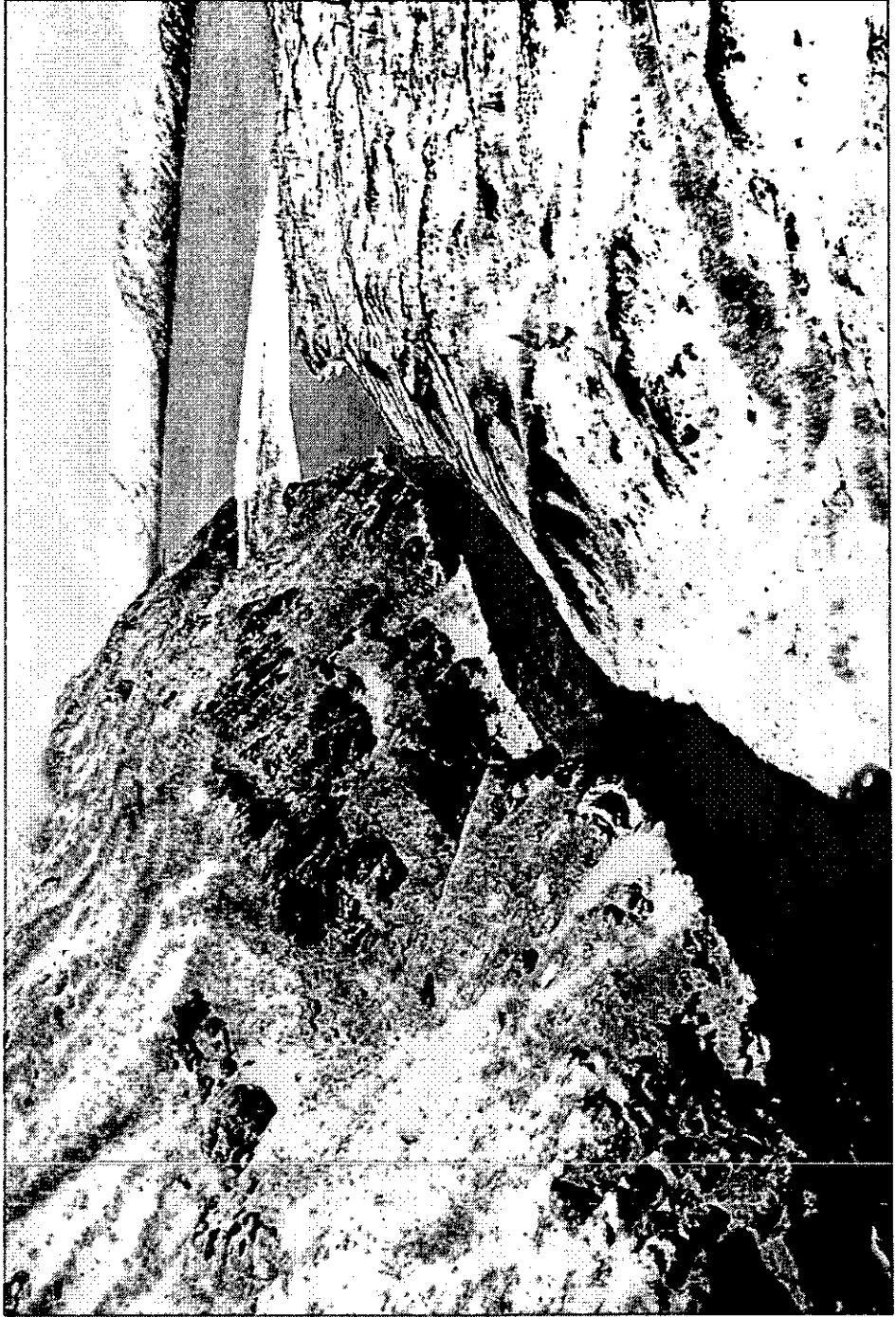


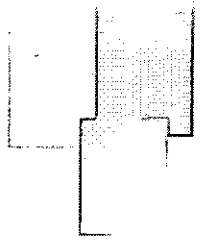
Geotechnical Considerations

- Seismic – Castle Mountain Fault
- Volcanic – Mount Spurr (1992 & 1953 eruptions)
- Glacial – Barrier, Blockade, McArthur, Shamrock

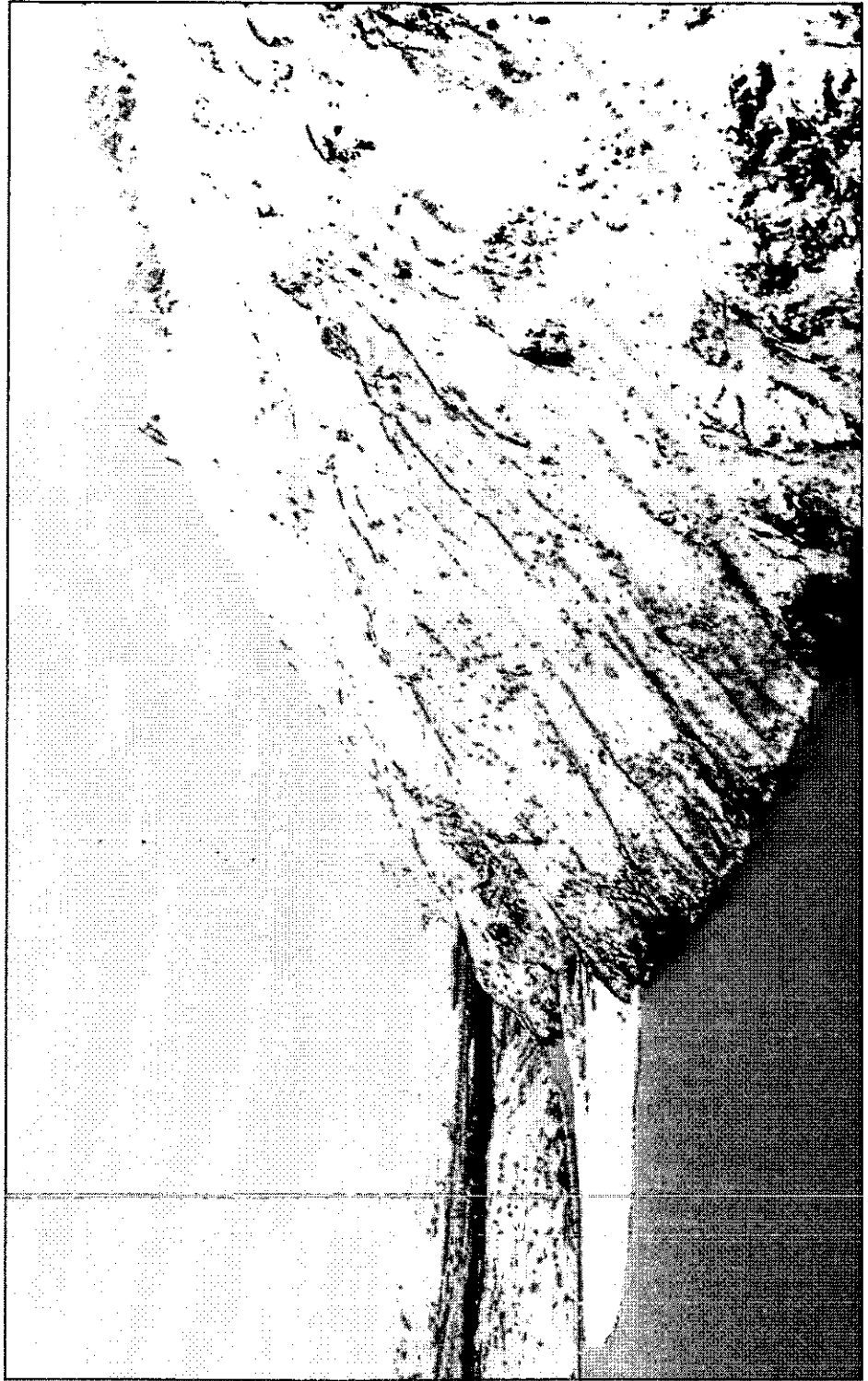


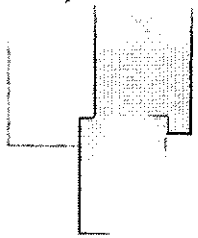
CHAKACHAMNA LAKE OUTLET



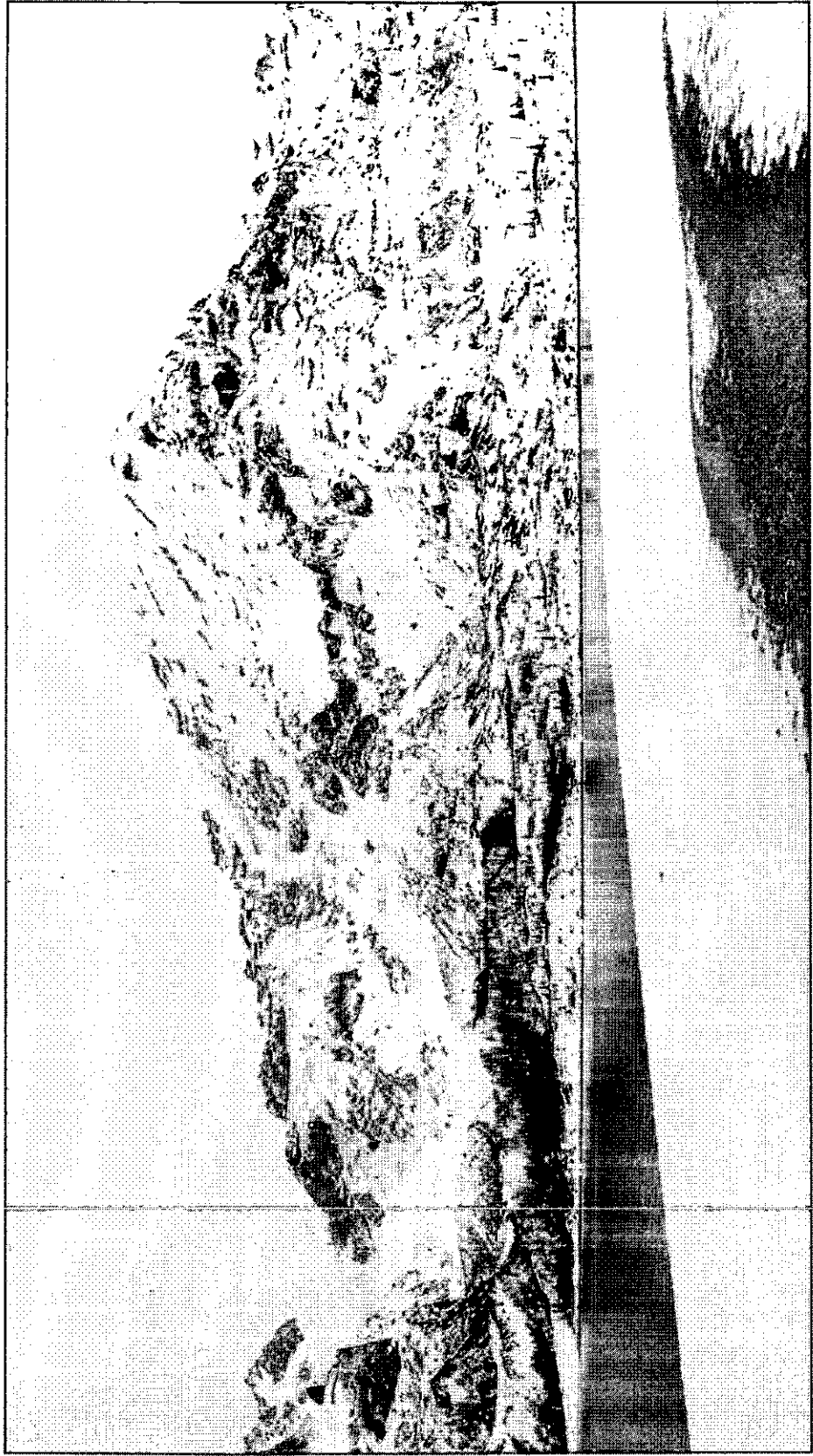


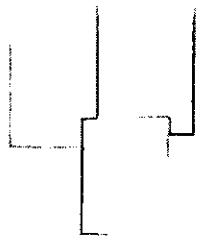
CHAKACHAMNA LAKE OUTLET





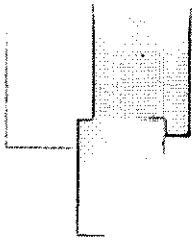
MT. SPURR GEOTHERMAL



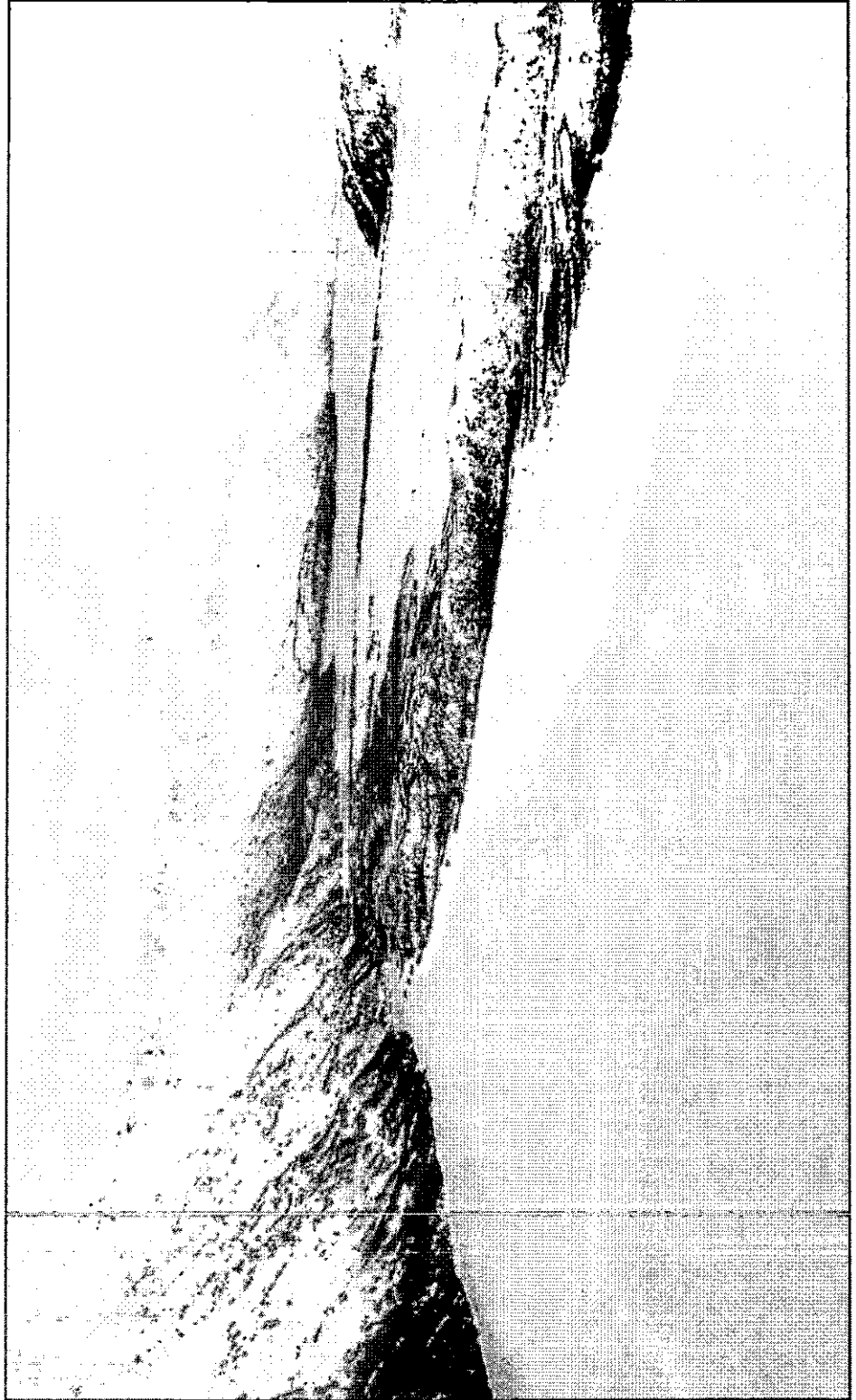


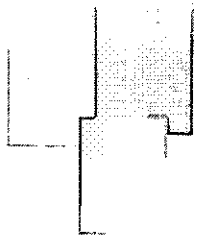
BARRIER GLACIER





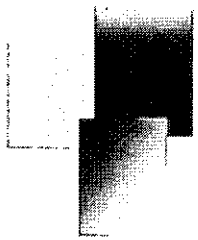
KENIBUNA LAKE





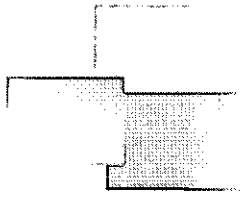
MCARTHUR RIVER POWERHOUSE SITE





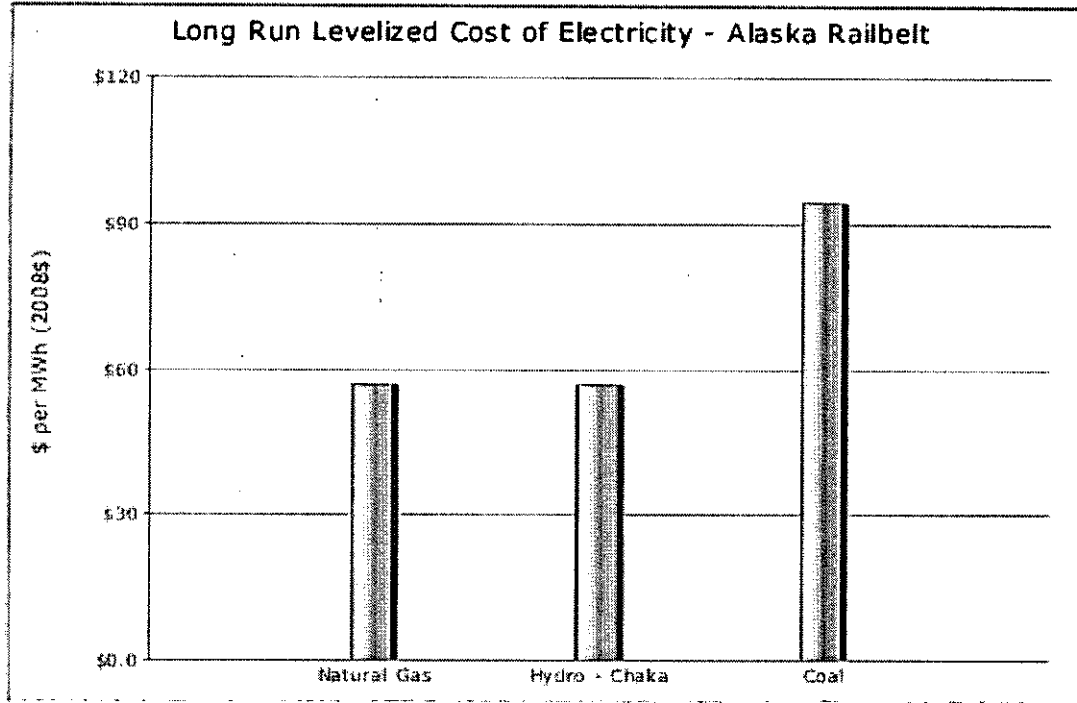
MCARTHUR RIVER UNDERGROUND POWERHOUSE





Economic/Financial

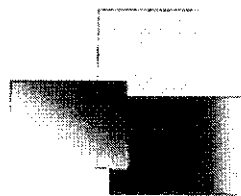
- 1.6 Bkwh annual power production
- One third of the present Railbelt demand
- \$1.7 Billion – 2008 dollars
- Debt Financing
- State Equity



Real Discount Rate
3%

Long Run Natural Gas Price (\$/MMbtu)
\$5.00

CO2 Emissions Cost (\$/tonne)
\$12.00



Next Steps

- Preliminary permit investigations 36 months
- FERC licensing 18-36 months
- Project construction 54 months
- Power on line 2017

SUSITNA & CHAKACHAMNA COMPARED

Susitna

Chakachamna

6.5 billion KWH energy	1.6 billion KWH
\$5.4 billion construction cost (1985\$)	\$1.7 billion construction cost (2008\$)
880 foot dam at Watana 664 foot dam at Devil Canyon \$1 billion for new transmission lines	No Dam 12 mile power tunnel \$90 million for new transmission lines
Power on line 2024	Power on line 2018
Reservoirs floods 45,500 acres 90 miles of stream channel	Existing lake--no additional land flooded



Hydropower Summary

- Significant Hydropower Potential
- State of Alaska Studying Susitna
- TDX Power Pursuing Chakachamna
 - Expensive
 - Long lead time
 - Requires utility support