

第7章

協力のニーズ

7.1 ニーズ評価のアプローチ

本調査の協力のニーズ評価は、国家及びプロビンス10年電力開発計画(National and Provincial Ten Year Power Development Plan 2009-2018, PNG Power Ltd, November 2009) に含まれる次の4つの構成要素の内、ポートモレスビー(Port Moresby)とラム(Ramu)系統の電源開発と同系統の送配電施設を対象にしている。

- 1) ポートモレスビーとラム系統の電源開発
- 2) 上記系統の送配電施設
- 3) 上記系統外の PPL centers における電源開発、送配電施設
- 4) 農村電化

火力ベースの発電を再生可能エネルギーへの置き換えは、経済的に妥当である限り PNG 電力公社(PPL)の主たる目的である。したがって水力発電開発の可能性がある適切な場所に位置する河川の調査は、PPL の優先事項である。しかし、継続する財務的制約は近年の調査に悪影響を及ぼし、1970年代から1980年代に実施された水力発電事業のF/Sの見直しや新規F/Sの実施がなされなかった。政府による規制緩和と新規発電システムの開発は、再生エネルギー政策と化石燃料の高騰から PPL の民営化プロセスの一貫として、最近数年は経済性の高い新規水力発電事業への投資インセンティブとなっている。

7.2 協力の対象となりうる候補事業

(1) 候補優先事業リスト

第4章で認定した次に示す優先事業は、協力のニーズ検討の対象案件となる。

1. ポートモレスビー系統
 - i. Sirinumu ダムとサドルダムの安定性に関する点検 (Rouna 水力発電)
 - ii. Naoro-Brown 水力発電 (60 MW) 又は Udava 水力発電 (58-145 MW)
 - iii. Lake Kosipe 水力発電 (30 MW)
 - iv. Rouna 1 水力発電所 (8MW)の修復

2. ラム系統
 - i. ラム系統の拡張と修復に関するマスタープラン
 - a. 132 kV 送電線 1 回線 (cct) の建設 (Sing Sing – Erap - Taraka) 又は 220 kV で設計した 2 回線の送電線の建設 (132 kV で運転開始)
 - b. 関連する他の送配電システムの拡張と修復
 - ii. 運転・維持・管理の能力強化
 - iii. Ramu 2 水力発電 (60-240 MW)
3. その他
 - i. Wabo 水力発電 (1,800 MW)

(2) ポートモレスビー系統

Port Moresby 系統の主力水力発電システムである 4 箇所の Rouna 水力発電所の水源である Sirinumu ダムとサドルダムの漏水に起因するダムの安定性に関する点検については、PPL から日本の技術による診断の要請を受けた。調査団は現地調査を行っていないため技術的判断はできないが、問題の性質を考慮してその要請を取り上げた (第 4.2.2(2)参照)。

PNG 政府の再生可能エネルギー政策を踏まえ、5 年後に倍増すると予測される Port Moresby 系統の電力需要を満たす優先発電事業として、Naoro-Brown 水力発電 (60 MW) が有力である。Naoro-Brown 水力と DPE が最優先事業と評価した Udava 水力発電 (58-145 MW) との優劣は、2010 年末に完了する予定の Naoro-Brown 水力の F/S の結果を待つ必要がある。Lake Kosipe 水力発電 (30 MW) は、Udava 水力の後になる。(第 4.2.1 節参照)。

Rouna 1 水力発電所 (8MW) の修復は効率の高い事業であるが、円借の対象になる規模ではなく、また自己資金で実施できる可能性がある (第 4.2.2 (1) 節参照)。

(3) ラム系統

PPL、ADB や世銀は、Ramu 系統では、将来の電力需要を満たすために、Ramu 2 水力発電所の投入が優先度の高い事業として取り上げている。しかし現在の Ramu 系統における頻繁で継続時間の長い停電を含めた供給不安定の主たる原因が、送配電系統の不安定さに起因することから、Ramu 送配電系統の拡張と修復を実施しなければ、新規の水力発電施設を投入しても電力の安定供給は実現しない。また Ramu 2 水力発電所を投入しても需要家には安定した電力が供給されず、投資資金が回収できないリスクがある。調査団のこの指摘を PPL は緊急の課題と認めた。現在この系統に関する詳細な調査結果や具体的拡張修復計画が存在しないことから、抜本的対策を調査・立案し、具体的に実施計画を立案する包括的マスタープランの実施を提案した (第 3.7.1 節参照)。また発電施設および送配電系統の維持管理の弱さが Ramu 系統と Port Moresby 系統に共通する電力供給不安定の一因になっていることから、運転・維持・管理の能力強化の重要性を取り上げた (第 3.7.2 節参照)。

上記水力発電事業の内、入手できた概略経済評価指標を次に示す。

表 7.2.1 計画される水力発電事業の概略経済評価指標

水力事業	最大設備出力	資本コスト 百万 US\$	財務的電力単価	EIRR
Rauna 1 発電機の取替	8 MW			

Udava	145 MW	390	US\$ 0.069/kWh	14.3%
Lake Kosipe	30-55 MW	220 - 283		12.4%
Naoro-Brown	60 MW	240 - 320 (PGK 600- 800)		
Ramu 2	60 - 211 MW	339 (PGK 847) 送電線費用を含まない		
Wabo (to Hall Sound)	1,800 MW	1,020 (1976 価格、送電線費用を含む)	US\$ 0.0121/kWh	
Note: 複合サイクル US\$ 0.096/kWh; ディーゼル US\$ 0.197/kWh				

出典: The Papua New Guinea: Power Sector Development Plan, ADB, April 2009 (PSDP 2009) and the data compiled by JICA Study Team

(4) その他

Wabo 水力発電事業は、ポートモレスビー系統とラム系統の将来の電力需要を満たす代替水力発電事業の位置づけにはない。天然ガス開発が PNG 国内の需要を対象としていないように、Wabo 地点で開発される大規模水力エネルギー資源は、国際的な電力多消費型産業の需要を対象にしている（第 4.4.1 節参照）。このクリーンエネルギーを輸出資源として位置づけるか、PNG 国内に国際的な大規模電力消費型産業を誘致し、当国の雇用創出を含めた経済開発の枠組みに位置づけるかは今後の課題である。

7.3 他のドナー機関の支援政策

7.3.1 ADB、世界銀行、オーストラリア政府などによる支援動向の把握

(1) アジア開発銀行の動向

アジア開発銀行(ADB)は、2010年4月5日から16日までPNGにミッションを派遣した。その目的は、(i) TA 7113-PNG: Town Electrification Project のプロジェクト形成のための中期のレビューと、(ii) 提案される Japanese Fund for Poverty Reduction (JFPR) grant (US\$ 2 million) for “Improved Power Supply to Pool Communities”のデザインミッションである。当ミッションは、関連ステークホルダーとの会議、West New Britain の現地調査、PPTA Midterm Report に関し、PNG Power LTD (PPL)、SADB、Consultants と三者会議を行い、Memorandum of Understanding (MOU)の記録を作成した¹。また Country Strategy Program の件で、IPBC、DNPM、PPL、Western Power Ltd などとの協議を行った。調査団は、ADB Energy Specialist, Mr. Anthony Maxwell と情報交換の機会を得た。

Town Electrification Project のプロジェクトの Scope of Work は、6つの水力発電地点の評価を含んでいる。

- Subproject 1. Gumini River Hydropower, Alatou Mine Bay Province
- Subproject 2. Kimadan River Hydropower, Kavieng, New Ireland Province
- Subproject 3. Divune River Hydropower, Popondeta, Oro Province
- Subproject 4. Ru Creek 2 Hydropower, Kimbe, West New Britain Province, or alternatively Kimbe-Bialla interconnection project
- Subproject 5. Ramazon River Hydropower, Buka, Autonomous Region of Bougainville (ABG)

¹ ADB Memorandum of Understanding, PPTA 7113-PNG: Preparing the Town Electrification Project 参照。

Subproject 6. Sowam River Hydropower, Wewak, East Sepik Province

6 箇所の小水力発電事業地点の内、Sowam River Hydropower は事業費が高すぎ、Ru Creek 2 Hydropower は水がなく 4 箇所に絞られている。トランシェ 1（6-10 年）で、4 箇所のいくつかに 1 億米ドル程度を分配する予定。この 6 箇所の小水力発電所は、Port Moresby Grid と Ramu Grid の外側の Off Grid 地域に位置する。

ADB は、Ramu 2 水力発電 などへの JICA との Co-financing に関心を示している。また、Wabo Power Project の情報収集も行っている。

5 月 14 日に ADB の PNG 事務所と ADB Manila との TV 会議で、Country Director Mr. Charles T. Andrew と Mr. Anthony Maxwell を交え、意見交換を行った。ADB は、Ramu 2 水力発電、Udava 水力発電、Wabo 水力発電などの融資の可能性を検討中であるが、現在、ADB の電力セクターへの支援の優先順位は、大型水力発電案件ではなく、Off Grid の小水力発電案件であるとの説明があった。また今後 PNG の電力セクターに関する ADB と JICA との密接な情報交換を確認した。

(2) 世界銀行の動向

世銀(the World Bank)は、2010 年 3 月 29 から 31 日まで PNG にエネルギーセクターミッションを派遣した。その目的は、エネルギーセクターミッションが 2009 年 10 月に提案した IDA TA Project の可能性に関する議論と Sustainable Energy Financing Project (SEFP)の進捗評価である。当ミッションが会った機関は、DNPM、DPE、IPB、PPL、PNGSDP、Western Power、ADB PNG である。

PNG 政府と世銀が 2008 年から 2010 年の期間に対して合意した 3 年間の Country Assistance Strategy では、エネルギーセクターのプロジェクトが支援の対象になっていた。世銀が提案するエネルギーセクタープロジェクトのスクールの可能性に関する議論が行われたが、その内容は不明である。議題として取り上げられた項目は、PNG の水力発電開発（ポートモレスビーとレイ系統へ給電する大規模から中規模の事業、系統外で孤立する町村への小規模水力事業）、都市部以外の電化の課題、ポートモレスビー系統の 5 年後の 200MW への電力需要増対策、再生可能エネルギーと農村電化に焦点を当てた政策と戦略援助、DPE のエネルギーセクター政策への技術援助(Renewable Energy Policy, Rural Electrification Policy, National Energy Policy)、PPL への援助（環境社会配慮を含めたポートモレスビーへの次期水力事業の準備、電力料金を含めた PPL の効率化への援助、次期水力発電事業の早期形成への援助）、大規模水力発電事業の開発の可能性の検討に関する技術援助（Wabo Power Project, 1,800 MW の検討と社会環境配慮調査）などである²。

この広範な議案には Ramu 2 水力発電、Naoro-Brown 水力発電、Udava 水力発電、Wabo 水力発電が含まれているが、世銀の融資対象になるには民間単独ではなく、これらの事業を政府管轄事業と認定することを求めている。

² World Bank Energy Sector Mission, March 29-31, 2010, Aid Memoire, Draft 参照。

(3) 他の融資機関

PPLは世銀、ADB、JICAの他に、水力発電事業の融資機関のオプションとして European Investment Bank (EIB)と中国政府を候補に上げている。EIBの金利は、世銀やADBより高いものの、PPLの事業に政府保証が求められない長所があるとしている。中国政府の Ramu 2 水力発電事業への融資合意期限が切れたため、PPLはその延長を中国政府に依頼する予定である。

(4) オーストラリア政府の動向

Mr. Lawrence Duguma, Assistant Secretary-Bilateral Branch, Foreign Aid Division, Department of National Planning and Monitoring の説明によれば、オーストラリア政府は、電力セクターへの大掛かりな援助活動は行っていない。現在オーストラリア政府の援助は、政府のガバナンスへの教育が中心である。対象となる分野は、(i)制度、法律、(ii)能力強化（資金の適切な管理、調和の取れた政策など）、(iii)社会的見地からのガバナンスである。ニュージーランドも同様な分野への援助が中心である。

7.3.2 協力のニーズに関する基礎情報収集

PPL や DNPM は、融資機関、関連政府機関との情報の共有と役割分担などを効率的に調整する電力セクターの合同会議が必要と認識し、5月13日（木）に Power Sector Round Table の開催を試みたが、関係機関の足並みが揃わず断念された。実施機関として PPL と IPBC が、政府監督機関として DNPM と DPE が、援助融資機関として ADB、JICA、世銀などが同じテーブルに着くことを目指す試みは今後も続けられるだろう。中国政府や、European Investment Bank も融資機関の候補である。主要援助融資機関との合同会議が実現すれば、協力のニーズと役割分担が明確になる可能性がある。しかしこの試みは、電力セクターの援助で先行する ADB や世銀が歓迎するとは限らず今後の動向を見守る必要がある。

第 8 章

協力のアプローチ

8.1 電力セクターの包括的援助戦略の枠組み

世界銀行が提案するエネルギーセクターの援助スコープ¹を参考に、包括的援助戦略の枠組みを次のように検討した。

1. PNG の水力発電開発の対象は、ポートモレスビーとレイ系統へ給電する大規模から中規模の事業、および系統外で孤立する町村への小規模水力事業とする
2. 都市部以外の電化の課題
3. ポートモレスビー系統の 5 年後の 200MW への電力需要増対策
4. 再生可能エネルギーと農村電化に焦点を当てた政策と戦略への援助
5. DPE のエネルギーセクター政策への技術援助(Renewable Energy Policy, Rural Electrification Policy, National Energy Policy)
6. PPL への援助（環境社会配慮を含めたポートモレスビーへの次期水力事業の準備）
7. 電力料金を含めた PPL の効率化への援助、次期水力発電事業の早期形成への援助
8. 大規模水力発電事業の開発の可能性の検討に関する技術援助（Wabo Power Project, 1,800 MW の検討と社会環境配慮調査）
9. ポートモレスビーとレイ系統の送配電施設の修復と拡張
10. 上記系統外の PPL centers における電源開発、送配電施設
11. 水力発電関連ダム施設の運転・維持・管理

ADB の重点課題、Off Grid の小水力発電案件は項目 2 と 4 に相当し、Udava 水力発電と Ramu 2 水力発電は、項目 1、3、6 に相当する。Wabo 水力発電は、項目 8 に相当する。PPL が注力する Naoro-Brown 水力は、項目 3 と 6 に相当する。項目 9 から 11 は、世銀の援助の枠組みには含まれていないが、国家及びプロビンス 10 年電力開発計画(TYPDP 2009-2018)に含まれる 4 つの構成要素²と、調査団の現地調査結果を踏まえ追加した。調査団は、この 11 項目を PNG 政府が企画する監督機関、実施機関、ドナーを招いた電力セクターに関するラウンドテーブルの議論の対象となる JICA の援助戦略のたたき台として検討した。

¹ World Bank Energy Sector Mission, March 29-31, 2010, Aid Memoire, Draft 参照。

² 第 7.1 節参照。

8.2 候補事業の優先度及び協力形態の検討

前節の 11 項目の内、第 7 章に取り上げた優先事業の優先度と協力形態の可能性を以下に検討する。

優先度	優先事業	協力の形態
ポートモレスビー系統		
緊急	Sirinumu ダムとサドルダムの安定性に関する点検	緊急診断が可能な方法
高	Naoro-Brown 水力発電又は Udava 水力発電	F/S に基づく有償資金協力
低	Lake Kosipe 水力発電	有償資金協力
低	Rouna 1 水力発電所の修復	無償資金協力
ラム系統		
高	132 kV ラム系統送電線および関連送配電システムの拡張と修復に関するマスタープラン	協力準備調査（有償）又は開発調査
高	運転・維持・管理の能力強化	技術協力
中	Ramu 2 水力発電 (60-240 MW)	F/S に基づく有償資金協力
その他		
低	Wabo 水力発電 (1,800 MW)	環境社会配慮は世銀の支援、F/S レビュー後 PPP への投融資、民間資金との協調融資

ポートモレスビー系統の緊急課題は、Sirinumu ダム関連サドルダムの基礎鞍部下流面の漏水の安全性点検である。サドルダムの破堤リスクがあるため、ドナー間で情報を共有、早急に専門家を派遣し、緊急対策を検討する必要がある。

F/S を実施中の Naoro-Brown 水力発電 (60 MW) は、投資効率が高いと推定され、ADB が融資を検討している Udava 水力発電(58-145 MW)に先行する可能性が高く、優先円借款案件として有望である。F/S の結果は 2010 年 10 月末に予定されているが、12 月末になる可能性がある。Rouna 1 水力発電所 (8MW)の修復は効率の高い事業であるが、円借款の対象になる規模ではなく、また自己資金で実施できる可能性がある。

ラム系統の最優先課題は、132 kV ラム系統送電線および関連送配電システムの拡張と修復である。この送配電システムの拡張と修復を実施しなければ、新規の水力発電施設を投入しても電力の安定供給は実現しない。この系統に関する詳細な調査結果や具体的拡張修復計画が存在しないことから、抜本的対策を調査・立案し、具体的に実施計画を立案する包括的マスタープランの実施が必要である。マスタープラン後の F/S は不要で、協力準備調査(有償)を経て円借款案件として有望である。

F/S レビューを実施中の Ramu 2 水力発電所は投資効率が高いと推定されるが、PNG Energy Development Ltd に付与された開発権の内容と動向をモニターする必要がある。また発電施設および送配電システムの維持管理の弱さが Ramu 系統と Port Moresby 系統に共通する電力供給不安定の一因になっていることから、運転・維持・管理の能力強化対策と役割分担

もドナー間で話し合う必要がある。

Wabo 水力発電は民間投資事業として推進され始めているが、巨大事業に伴う環境社会配慮、土地取得問題、さらに国家開発計画、雇用政策と関連し、世銀は国の監督下で事業を推進することを提案している。電力需要調査、および環境社会影響調査、土地信託などを考慮した土地取得計画の検討を先行させることが事業推進の前提となる。

付属資料—1 面談者リスト

Asian Development Bank

Mr. Anthony Maxwell	Energy Specialist, ADB(Manila)
Mr. Charles T. Andrews	Country Director, PNG Resident Mission
Mr. Mahfuz Ahmed	Principal Natural Resources Economist

Japan International Cooperation

Mr. Kyoji MIZUTANI	Resident representative, Papua New Guinea Office
Mr. Takahira YOKOTA	Assistant Resident Representative, PNG Office
Mr. Shun NEZAKI	Assistant Resident Representative, PNG Office
Ms. Hikari MIYAHARA	Project Formulation Advisor, PNG Office
Mr. Masahiro ITO	Assistant Director, Pacific Division, Southeast Asia 1 and Pacific Department, Head Office, Tokyo
Mr. John KOL	Development Officer, PNG Office

Embassy of Japan, Papua New Guinea

Mr. Hajime NISHIYAMA	Ambassador of Japan
Mr. Katsutoshi ITO	First Secretary
Mr. Takeshi FUJIMURA	First Secretary

PNG Power Ltd.

<Head Office>

Mr. Tony Koiri	Chief Executive Officer
Mr. Lawrence Solomon	Deputy Chief Executive Officer
Mr. Togaro Asiba	Manager of Business Marketing & Sales
Mr. Edmond Pereira	Manager Revenue & Customer Services
Mr. Crusoe K. Dili	Team Leader – Civil Maintenance / Planning
Mr. Kone Bulina	Land Officer
Mr. Francis Uratun	Network Planning Engineer
Mr. Jones Pokarop	Substation Design Engineer
Mr. Titus Tsigese	Environmental Officer
Mr. Damien Sonny	Renewable Planning Engineer, Engineering Research & Planning
Mr. Steven Kerowa	Team Leader, Lands Community Relations
Mr. Wabing Mileng Stahl	Network Team Leader-Port Moresby, Network Management Division
Mr. Joseph S. Basse	manager Network Management
Mr. Ephraim Aurete Hau	Senior Electrical Engineer, Hydro Maint. Planning
Mrs. Lillian Sukot	Data & Statistic Coordinator, System Control Center
Mr. Peter Tukau	Revenue & Customer Services

<Lae Office>

Mr. Stanley Gogorea	Generation Team Leader - Lae, Operations Momase
Mr. Ronnie Kopi	Centre Manager - Vanimo, Assistant Manager – Electrical - Lae
Mr. Watson B. Naso	Regional Manager - Momase

<Milford>

Power Station Manager

<Rouna>

Mr. Joseph Buki	Power Station Manager
Mr. Kaiva Warina	Team Leader Operation
Mr. Pkil Sangara	Team Leader Electric
Mr. Eruesp Poyo	Team Leader Civil
Mr. Jim Aru	Team Leader Mechanical

<Yonki/Ram>

Mr. Andrew Magaiye
Mr. Kamilus Wohuifia
Mr. Awa Aporo
Mr. Kenneth Rapudidi
Mr. Andrew Magaire

Center manager – Yonki/Gusap
Ramu Hydropower Station Manager
Regional Manager
Acting Network Team Leader
Center Manager

PNG Taiheiyō Cement Limited

Mr. Sunao SHIOMI
Mr. Makoto KAGAMIDA
Mr. Osamu MIZUI

Former Managing Director
Managing Director
Vice Factory Manager

Western Power Ltd.

Mr. Tony Carbry
Mr. Ben Mehuwa

Chief Operating Officer / Company secretary
Project Development Manager

PNG Energy Development Ltd.

Mr. Ken Baxter
Mr. Ian J Bulmer
Mr. Tony Carbry
Mr. Charles Niecewoudt

Chairman
Chief Executive Officer / Director
Chief Financial Officer / Chief Operating Officer
Director

Origin Energy Ltd.

Hydro Tasmania Consultant

Mr. David Wilson
Mr. Jayson Peterson
Mr. Bruce Taylor

Business Development Manager
Hydrologist
Geologist

Mineral Resources Authority

Mr. Sonick Taguse

GIS Specialist, Information & Marketing Division

Mapping Bureau

Mr. Sebastian Hani

Staff of Air Photo Division

PGS Limited (PNG Geospatial Solution)

Mr. Raymond I. Bure

Director / Partner, GIS / Mapping Specialist

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Mr. Chris Burns
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Chief Operating Officer
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Mr. Alan Lavi

Assistant Director Engineering Services, Policy and Planning Branch, Energy Division

Mr. Nelson Tai

Energy Planner, Policy and Planning Branch, Energy Division

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Mr. Lawrence Duguman

Assistant Secretary-Bilateral Branch, Foreign Aid Division

Mr. Samuel Koney

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Mr. Michio SERIZAWA

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Department of Environment and Conservation

Mr. Dennis Iwawami, Senior Scientific Officer, Environment Protection Wing,
Regulatory Services, Planning Branch,
Mr. Rose Kualke Scingadar, Protected Areas Terrestrial Sustainable Environment
Program Wing
Ms. Grand Natetera, Manager GIS
Ms. Adah Sauke, Senior GIS Officer, special Systems and Data(GIS)
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Department of Land and Physical planning

Mr. Mr. Jacob Waifindo, Regional Manager,

Papua New Guinea Forest Authority, National Forest Service

Mr. Lyall Umbo, Project Manager, Resource Development Office
Mr. Charles Pakuse A/Project Officer, Resource Development Office

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Mr. Andy Agovava Asset Officer, Asset Office,

National Statistic Office, Papua New guinea

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Mr. Nalau Bingeding Research Fellow, Social & Environmental Studies
Division.

Purari River Wabo Hydropower Project

1. Project Features

- (1) Purari River is one of the largest rivers in the Papua New Guinea (PNG) that flows in the middle of the county to the south. The total length of the main stem is about 630 km, while the drainage area of the whole river basin is about 33,000 km².
- (2) Wabo hydroelectric power station is planned at about 200 km from the river mouth the Purari River (Figure 1). The river basin is blessed with abundant annual rainfall of more than 8,000 mm. At the dam site of Wabo Hydropower Project, the basin catchment area is 26,300km², having an average discharge of 2,500m³/s (Figure 2).
- (3) Wabo Hydropower Project is planned as a dam type development scheme with an installed capacity of 1,800 MW, which will generate 11,825 GWh per year.
- (4) Generated power at the Wabo Hydropower Project is transmitted with double-circuit 500 kV transmission line to the town of Hall Sound which is located about 300 km from the Wabo Project site.
- (5) Hall Sound is a natural harbour which has advantages for the development of a port. The area is scheduled to be developed as power consuming industry zones such as aluminium smelter. Hall Sound is also scheduled to be developed as an urban area.

2. Background

- (1) In 1956, New Guinea Resources Prospecting Company asked a British company, Halcrow to survey five rivers in Papua New Guinea for the power development to be used for aluminium smelting purpose. The survey result showed that the Purari River basin was the most prospective one. In 1959, Halcrow surveyed Wabo Project site by the request of Commonwealth Aluminium Corporation.
- (2) During the period from 1971 to 1973, Nippon Koei Co., Ltd. conducted hydropower potential study of the Purari River. Nippon Koei Co., Ltd. presented development schemes of six locations with total capacity of 6,000 MW. In the study, Nippon Koei Co., Ltd. recommended to conduct detailed survey of Wabo Project site.
- (3) The government of Papua New Guinea requested both governments of Japan and Australia to conduct a feasibility study (F/S) of Wabo Project. The Australian government asked SMEC to re-evaluate the report of Nippon Koei Co., Ltd. In the evaluation report of 1974, the Australian government confirmed that Wabo Project was prospective.
- (4) Industrial Bank of Japan, Limited conducted a study for industrial development. In 1975, the study team presented a concept of industrial complex back by the power generated by Wabo Project.
- (5) In 1975, an implementation of feasibility study (F/S) of Wabo Project was agreed among the three governments of PNG, Japan and Australia. The F/S was conducted from 1975 to 1977 by Nippon Koei Co., Ltd. and SMEC with assistance of Japan International Cooperation Agency (JICA). The F/S of Wabo Project included the development components of (i) hydropower, (ii) port, (iii) industry, and (iv) urban.
- (6) During the period from 1977 to 1979, an environmental study of Wabo Hydropower Project was conducted with a technical assistance of UNDP.

- (7) In 1991, Mitsubishi Corporation asked Nippon Koei Co., Ltd. to re-evaluate the construction cost to re-estimate the unit power generation cost of Wabo Project. The re-evaluation works also included the idea of reducing the project size, and the stage wise development.
- (8) In 2008, Nippon Koei Co., Ltd. again conducted an overall review of construction costs and unit generation costs.

3. Plan of Hydropower Development Facilities

- (1) Major components of Wabo Hydropower Project are Main Dam, Saddle Dam, Power Generation Facilities, Spillway, and River Diversion Facilities. Figure 3 shows a general plan of the construction works, and Figure 4 shows the main dam site and related facilities.
- (2) Principal features of the facilities are as shown below (based on JICA F/S)

Wabo Reservoir	Full Supply Level (FSL) Minimum Operation Level (MOL) Gross Storage Volume Effective Storage Volume Reservoir Area Catchment Area Annual Average Inflow	EL. 135 m EL. 110 m 16,600 x 10 ⁶ m ³ 6,490 x 10 ⁶ m ³ 290 km ² 26,300 km ² 79,000 x 10 ⁶ m ³
Main Dam	Type Dam Height Dam Volume	Central earth core fill embankment 160 m 15.9 x 10 ⁶ m ³
Saddle Dam(Including Emergency Spillway)	Number of Dams Type Maximum Height Total Dam Volume	5 locations Fill type dam of various kinds 75 m 7.8 x 10 ⁶ m ³
Spillway	Design Flood Design Outflow Type Chute Width	22,600 m ³ /s 16,570 m ³ /s Chute Type, Ski Jump Type Dissipater 105 m
Intake, Penstock	Height of Intake Structure Penstock	56 m 8 m Diameter x 6 nos.
Power Station	Maximum Output of Generator Generator Output at MOL Number of Generator Rotation Speed Turbine Output Firm Output Annual Firm Energy Output (excl. Secondary Output)	360 MW 300 MW 6 (including one spare) 125 rpm 365 MW (Net Head 98.0 m, Turbine Discharge 427 m ³ /s) 1,350 MW (Load Factor 90%, 5 nos. operation) 11,825 GWh (Generating End) 11,575 GWh (Receiving End at Hall Sound)
Diversion	Number of Tunnel, length Inner Diameter	3 nos., 660 to 1,105 m 14.5 m

4. Plan of Transmission Line

- (1) 500 kV double circuit transmission line with 300 km length is planned from Wabo Power Station to Hall Sound to transmit 1,800 MW of generated power. Transmission line route is as shown in Figure 1.
- (2) It is planned to install a switchyard for relaying the transmission lines. Two lines are carried on separate towers in the mountainous area from the power station to the switchyard. One line is installed in the rest of the route from the switchyard to Hall Sound.
- (3) Another switchyard will be constructed at the receiving end to step down 500 kV to 66 kV.

5. Construction Plan and Schedule

- (1) Construction material for the hydropower station facilities will be transported by sea and by the Purari River to Wabo hydropower project construction site. Transported construction material by sea is once unloaded in the transfer port to be constructed at Pai-a Inlet, and then transported by river along the Purari river up to the port of Wabo site. During the extreme dry period, a jetty will be constructed at Pawaira 1 to enable land transportation using the construction road for transmission lines.
- (2) For the transmission line construction, roads will be constructed along the transmission line route. In the coastal part, it is planned that public roads to be used for construction.
- (3) For the dam construction works, river flow of 2,500m³/s in average discharge will be diverted using three number of diversion tunnels by constructing cofferdams upstream and downstream. It is proposed to construct cofferdams by excavating riverbed with dredger, then mainly by dumping embankment material from both abutments.
- (4) Wabo project site is a high rainfall area without any clear dry period. The core material embankment works for the main dam will be limited to a single shift only.
- (5) 25 months will be required for the detailed design, selection of the contractors including contracting. During the period, preparatory works will be done for land acquisition, preparation of temporary equipment for construction, construction of workers' camp, jetty and dock, construction of road between Pawaia 1 and Wabo site, and procurement of dredging boat. The river will be diverted 30 months after the contract of main construction works, and the impounding works will start 62 months after the contract. The commencement of the power generation will be 68 months after the contract, which is 93 months (7 years and 9 months) after the commencement of design works.

6. Construction Cost

(1) Estimated construction cost for power generation and transmission facilities are 1,023 million US dollar (568 US dollar/kW) according to the JICA Feasibility Study Report in 1976.

(2) A summary of the costs are as shown below:

Item	Cost (million US dollar)
1 Civil works	423.9
2 Power plant	155.3
3 Transmission line and terminal substation	198.8
4 Construction facilities	30.0
5 Land acquisition and resettlement (Wabo site only)	0.8
Sub-total	808.8
6 Engineering (10% of items 1 to 4)	80.8
7 PNG government Administration (5% of items 1 to 5)	40.4
Sub-total	930.0
8 Project contingency (10%)	93.0
Total	<u>1,023.0</u>

7. Power Cost

(1) Result of analysis in 1976 F/S shows several estimates for power cost. The following table shows the power cost for different interest rates by project periods. In case the project period is 30 years, the power cost at Hall Sound receiving end will be 0.02 to 0.03 US dollar per kilo watt hour.

Interest Rate	Project Period		
	20 yrs	30 yrs	40 yrs
7%	25.6	19.1	17.8
8%	27.4	20.8	19.5
9%	29.4	22.7	21.4

- (Note) i Unit: (10⁻³US\$/kWh)
 ii Price Escalation: 8% per annum
 iii Power cost at Hall Sound receiving end
 iv Assuming that industrial power demand to be in full swing (1,735 MW) in five years
 v Load Factor: 90%
 vi Source: Purari River Wabo Power Project Feasibility Report (December 1977)

8. Port and Industrial Development

(1) The proposed port development location at Hall Sound is a natural deep port sheltered from the prevailing waves. Little siltation is occurring and it is anticipated that only minor maintenance dredging would be required.

- (2) At Hall Sound, large areas of firm, well drained land exist, which when levelled, are appropriate for industrial development accessible to a port site. Climate of Hall Sound is similar to that of Port Moresby with rather small amount of annual rainfall of 1,200 mm.
- (3) According to the study carried out by the Purari Industrial Survey Mission, the scale of industrial development adopted would be as follows:

Industry	Production (10 ³ ton/year)	Peak Power Requirements (MW)	Plant Site Area (ha)
Aluminum Smelting	580	1,000	150
Ferroalloys (except ferronickel)	384	271	52
Ferronickel	150	105	65
Integrated Steel Mill	100	29	17
Electrolytic Caustic Soda, Ethylene Dichloride	540	120	25
Copper Refining	100	11	35
Zinc Refining	90	45	42
Silicon Carbide	32	32	60
Liquefied Natural Gas	2,140	110	50
Chemical Fertilizer	550	12	20
Total	4,666	1,735	516

9. Environmental Impacts

- (1) To assess the environmental impacts of Wabo project, it is necessary to review the contents of EIA report prepared by UNDP in 1979.
- (2) Expected environmental impacts will be as follows:
- Impacts on inundation of 29,000 ha natural forest and affects to ecology. Possibility of disappearance of endangered/new species.
 - Disappearance of primary forest caused by construction of transmission line construction road and analysis of its impact on ecology
 - Impacts on river and river mouth due to decrease of sediment supply to the downstream area of the dam, especially on erosion of delta, seawater intrusion, and possibility of adverse affects on mangrove.
 - Impacts on fish species in delta and residents living on fishing by decrease of nutrient supplied to the downstream area of the dam.
 - Resettlement of two villages with indigenous people due to inundation.
 - Resettlement of population in Hall Sound (1,800 people, according to JICA F/S in 1976) due to the port, industrial and urban development. It is expected that 900 people would be directly affected and one village would need to move.
 - Air pollution, water contamination from wastewater from factories due to industrial and urban development.

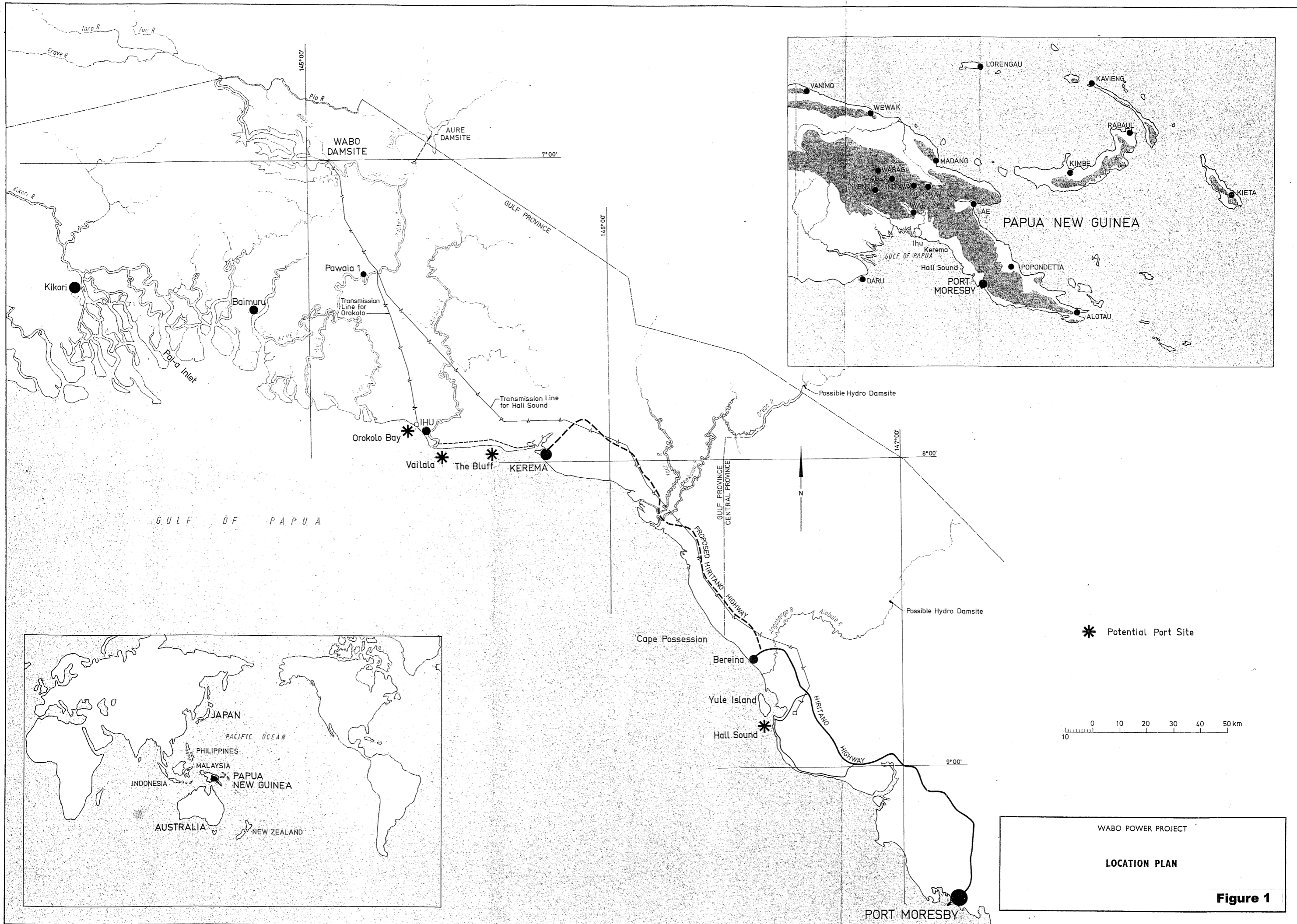
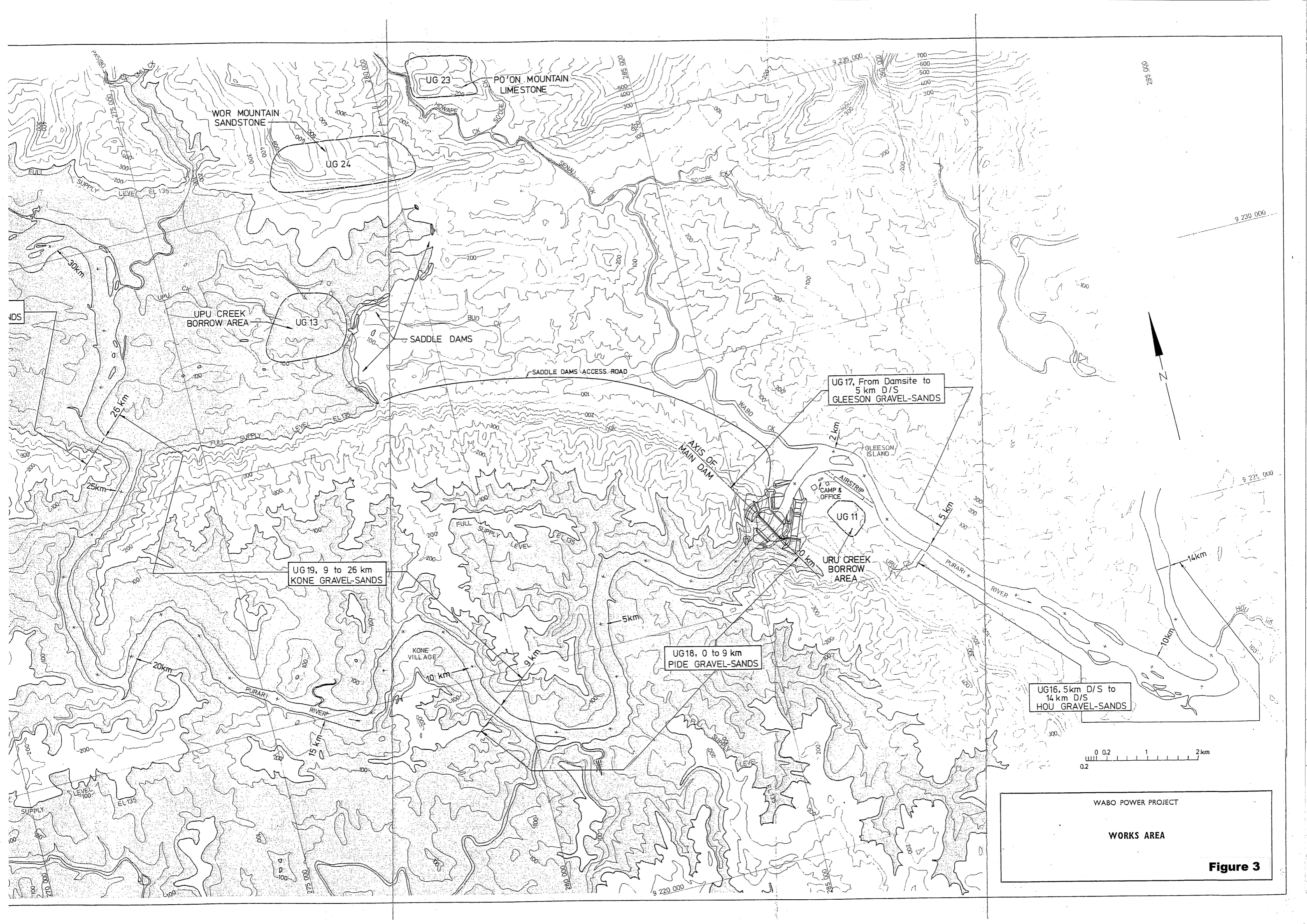


Figure 1



WOR MOUNTAIN SANDSTONE

PO'ON MOUNTAIN LIMESTONE

UPU CREEK BORROW AREA

SADDLE DAMS

SADDLE DAMS ACCESS ROAD

UG 17, From Damsite to 5 km D/S GLEESON GRAVEL-SANDS

GLEESON ISLAND

UG 11

URU CREEK BORROW AREA

UG 19, 9 to 26 km KONE GRAVEL-SANDS

KONE VILLAGE

UG 18, 0 to 9 km PIDE GRAVEL-SANDS

UG 16, 5km D/S to 14 km D/S HOU GRAVEL-SANDS

WABO POWER PROJECT

WORKS AREA

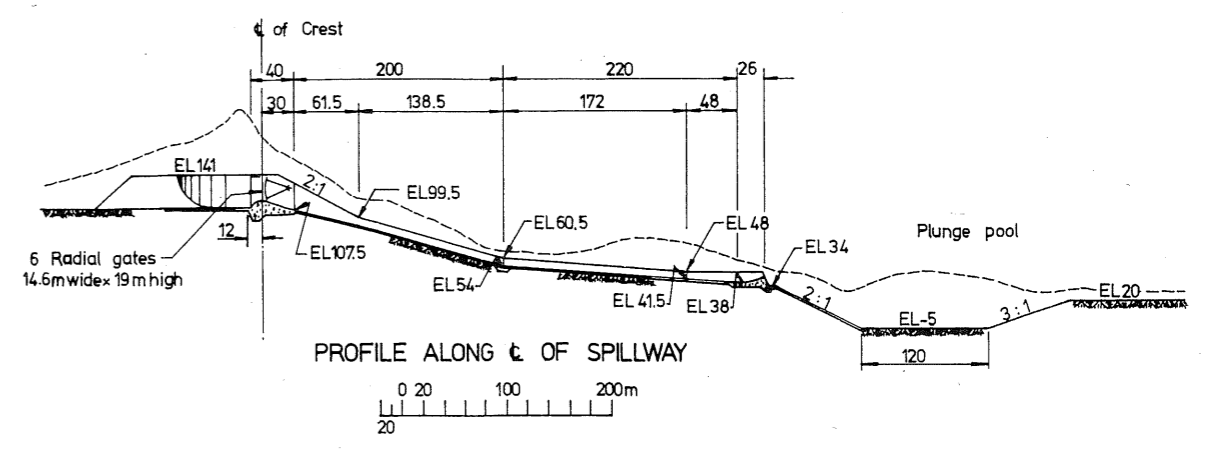
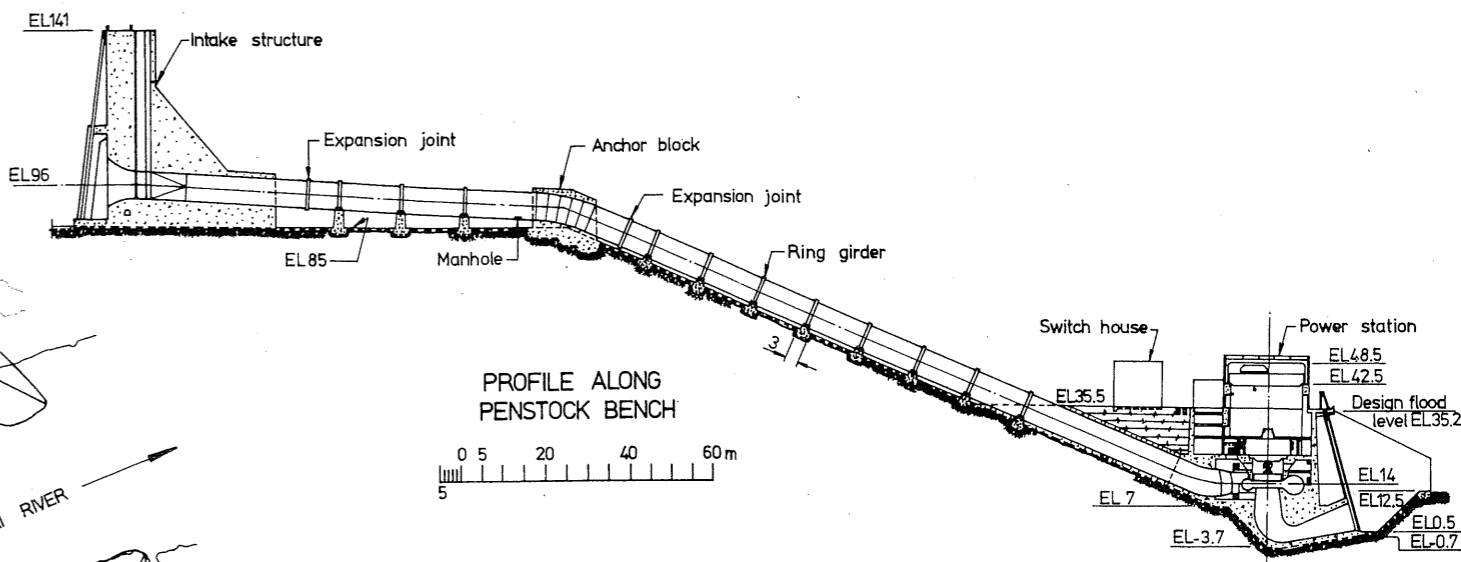
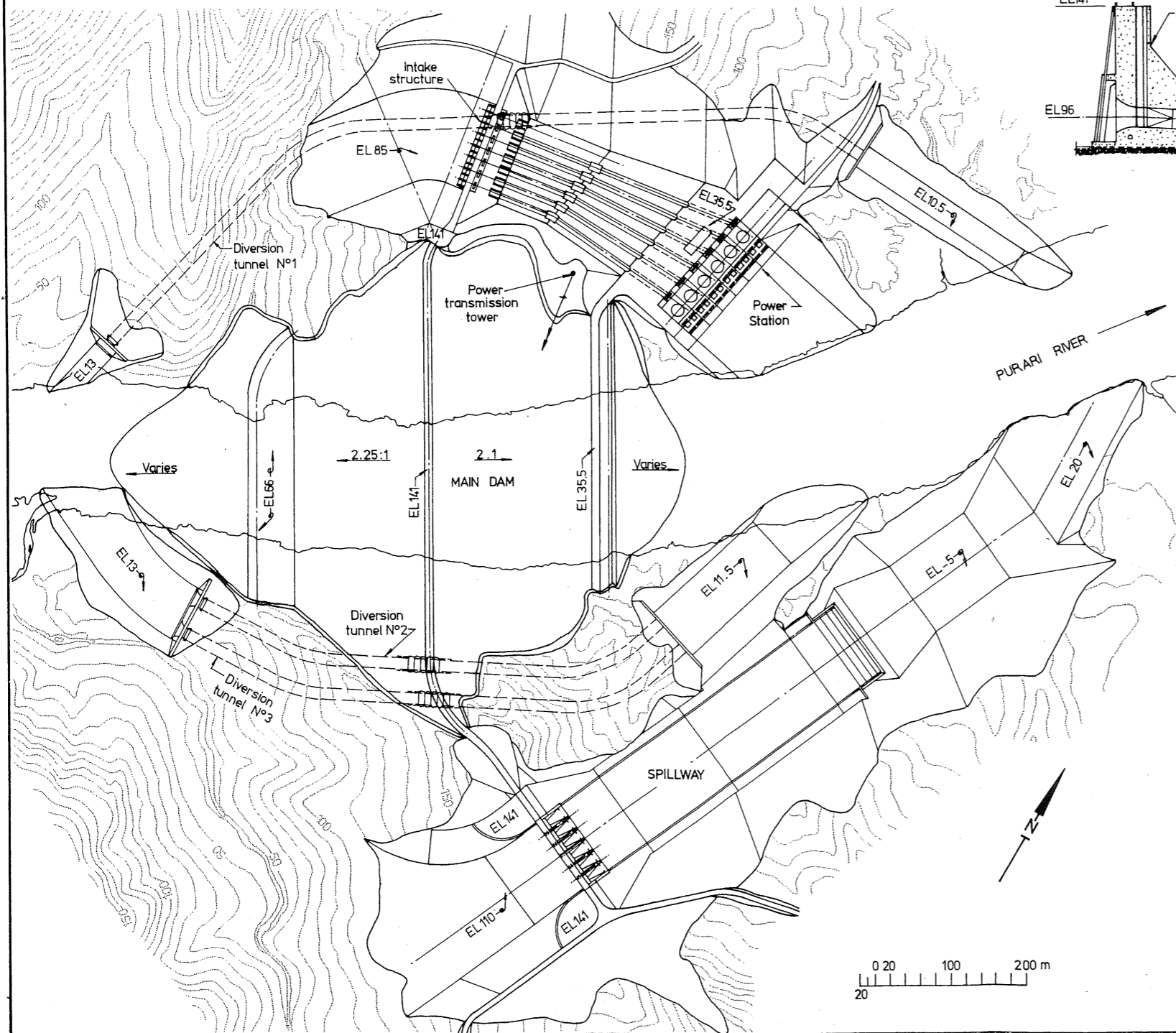
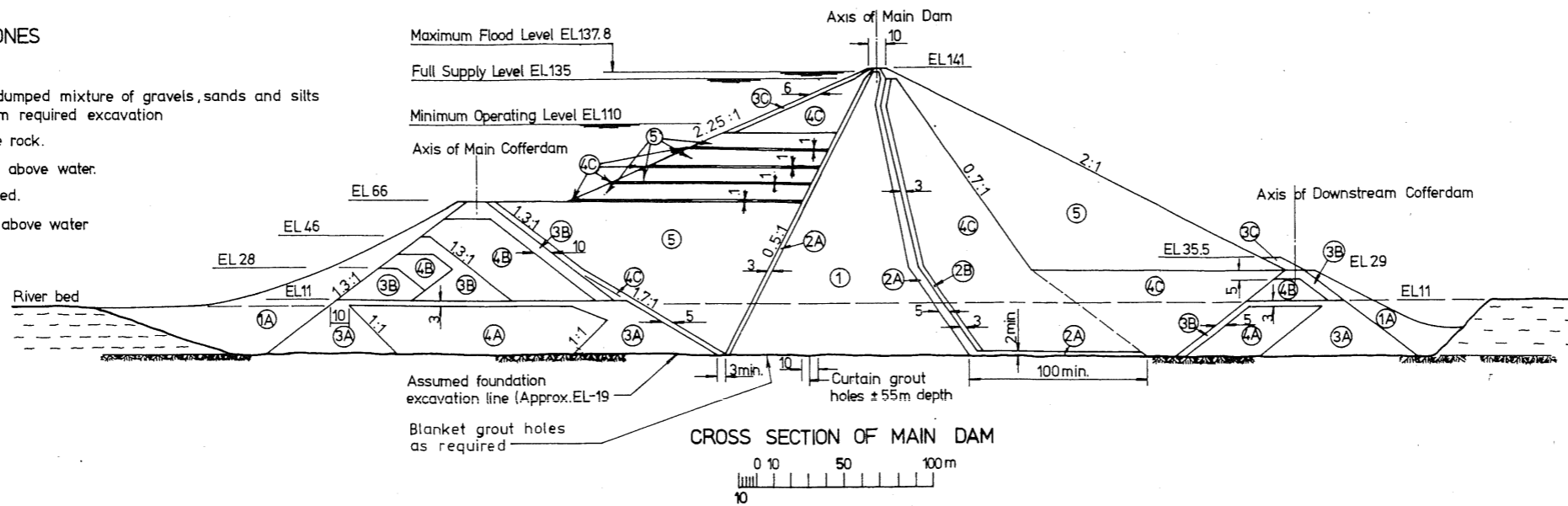
Figure 3

COFFERDAM ZONES

- Zone 1A- Sealing membrane
Below existing riverbed level-barge dumped mixture of gravels,sands and silts
Above riverbed-material stripped from required excavation
- Zone 3A-Quarry run, barge dumped limestone rock.
- Zone 3B-As for Zone 3A except end dumped above water.
- Zone 4A-Dredged gravel-sands, barge dumped.
- Zone 4B-Dredged gravel-sands,end dumped above water

EMBANKMENT ZONES

- Zone 1-Impervious core, mudstone compacted with tamping roller.
- Zone 2A-Fine filter, processed from dredged fine sands and silts.
- Zone 2B-Coarse filter, processed from dredged gravel-sands.
- Zone 3C-Slope protection,quarry run placed limestone rock, maximum size as required for wave action.
- Zone 4C-Dredged gravel-sands, compacted with 10 tonne or heavier vibrating drum roller.
- Zone 5-Random fill from required excavation in Era Bed sandstone.



WABO POWER PROJECT
**MAIN DAM
GENERAL ARRANGEMENT**
Figure 4

付属資料—3 環境関連資料

Legislation related to Environmental Assessment/ Land Protection/ Land Acquisition

	Law/ regulation	Year of issue	description	Note
Related to Environmental Assessment				
1	The Environment Act 2000	2000	The law provides environmental impact assessment process in the country, namely Environmental Impact Statement to obtain Environmental Permit. This replaced three main pieces of legislation that dealt with environmental protection: the Environment Planning Act, Environmental Contaminant Act, and Water Resource Management Act.	○
2	The Environment Act, 2002 (the Act)	2002	This is a small amendment of the principle act dealing with environmental protection, the Environment Act 2000.	○
3	Environment (Prescribed Activity) Regulations, 2002	2002	This Regulation aimed to provide for the prescribing of activities to be Level 1, Level 2 (Category A or Category B) and Level 3. In Schedule 1 of the regulations describing Level 2 activities and Schedule 2 of the regulations describing Level 3 activities.	○
4	Environment (Fees and Charges) Regulation 2002	2002	This regulation relates to fees and charges in three sections. Part 1 of the regulation describes the fee payable for the submission of an environment impact statement, Part 2 describes water usage charges and Part 3 describes miscellaneous charges.	○
5	Environment (Permits and Transitional) Regulation 2002	2002	This Regulation guides Environment Permits, in terms of its procedures and requirements for obtaining an environment permit. This includes submission of application, processing of application, issue of permit, renewal of permit, transfer of permit, amendment in permit, surrender and cancellation of permit, appeals and transitional arrangements.	○
6	Environment (Procedures) Regulation 2002	2002	This Regulation provides procedures of the Environment Council. It describes procedures for calling of meetings, proceeding of the meetings, disclosure of the meetings, delegations and reporting requirements of Environment Council and Environmental Consultative Group. This also sets procedures for review of Director's decisions.	○
7	Environment (Water Quality Criteria) Regulation 2002	2002	This Regulation provides water quality criteria and describes water quality criteria and mixing zone.	○
Guidelines				
1	Guidelines for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement, 1st January 2004.	2004	This Information Bulletin is aimed at assisting prospective proponents of development activities that may be classified as a Level 2 or Level 3 activity in accordance with the Environment (Prescribe Activities) Regulation 2002 to meet their legal obligations under Section 48 of the Environment Act 2000.	○
2	Notification of Preparatory Work in Level-2 and Level-3 Activities, 1 January 2004.	2004	This Information Bulletin is aimed at assisting prospective proponents of development activities that may be classified as a Level 2 or Level 3 activity in accordance with the Environment (Prescribe Activities) Regulation 2002 to meet their legal obligations under Section 48 of the Environment Act 2000.	○
3	Guidelines for Submission of an Application for an	2004	This Information Guideline has been developed to guide proponents of Level 2 (Category B) activities and Level 3	○

	Environment Permit to Discharge Waste, 1 January 2004.		activities where Minister“ s Approval in Principle has been issued, to submit relevant information when applying for an Environment Permit to discharge wastes.	
4	Technical Guidelines for Noise, Air and Water & Land Discharges	2004	This is intended to assist applicants in submitting the relevant technical information in the permit application. Other similar guidelines will be developed in the future to address a specific environmental concern or to recommend best practice environmental guidelines in relation to a prescribed activity.	○
5	Guidelines for Preparation of Environmental Inception Report, 1 January 2004	2004	This Information Guideline is intended to assist prospective proponents of development activities in Papua New Guinea to meet their legal obligations under Section 52 of the Environment Act 2000 (the “Act”). The Act requires a person or company that intends to carry out a proposed Level 3 activity to prepare and submit an Environmental Inception Report.	○
Related Protected Area				
1	Fauna (Protection and Control) Act: 1966		This Act provides for the establishment of Wildlife Management Areas. Local communities are established (and gazetted) and operational rules are prepared and approved (which must be compatible with the purpose of the Act).	○
2	National Parks Act 1982:		This Act provides a process for the establishment of National Parks.	○
3	Conservation Areas Act 1978		This Act provides for the establishment of protected conservation areas.	○
4	Forestry Act 1991		This Act provides the permission procedure on the forest use. namely “Timber Permit”.	○
Related to Land Acquisition				
1	Land Act 1996	1996	The law provides procedures apply to the acquisition of land and assets by the State, legally owned/leased by other parties (persons) than the State. The also define the land tenure system in the country. The land categorized as two, customary and Alienated lands. The land acquisition by state made 2 ways, 1) by agreement; or 2) by compulsory process.	○
2	Land Groups Incorporation Act, 1974	1974	The law provides the outline of the registration of incorporated land groups and its procedure. The purposes of the Act are to encourage– (a) greater participation by local people in the national economy by the use of the land; and (b) better use of such land; and (c) greater certainty of title; and (d) the better and more effectual settlement of certain disputes, by– (e) the legal recognition of the corporate status of certain customary and similar groups, and the conferring on them, as corporations, of power to acquire, hold, dispose of and manage land, and of ancillary powers; and (f) the encouragement of the self-resolution of disputes within such groups. (Current situation of the Land Groups Incorporation Act based on the governmental review (especially related to Mining?))	○
3	Valuation Act 1967	1967	The law provides the valuation of the property on the registration of land values and other purposes.	○
4	Survey Act 1969	1969	The law provides the registration of surveyors and the regulation of the practice of land surveying, and for related purposes. This Act applies only to and in relation to surveys of	○

			the boundaries of, or for the purpose of the establishment, re-establishment or determination of titles to, land, and other surveys authorized by the Surveyor General.	
5	National Land Registration Act 1977	1977	The law provides the national land registration, for the registration in the Register of National Land of all land acquired or to be acquired by the State.	○
6	Land Registration Act 1981	1981	The law provides the registration of the land for its use, describing the case of lease the lands.	○
7	Land Disputes Settlement Act 1975	1975	The law provides efficient and effective machinery for the settlement of disputes in relation to interests in customary land by— (a) encouraging self-reliance through the involvement of the people in the settlement of their own disputes; and (b) the use of the principles underlying traditional dispute settlement processes.	○
8	Land (Tenure Conversion) Act 1963	1963	An Act Relating to the Conversion of the Tenure of Customary Land into Individualized Tenure, and for other purposes.	○
9	Organic Law on Provincial Governments and Local-level Governments,	2009	The law provides for some changes to the financial arrangements for the fiscal years 2004 to 2008 and a new intergovernmental financing system for the 2009 fiscal year and beyond aiming to have a similar financial capacity to meet the cost of its assigned service delivery functions and responsibilities between each Provincial Government, urban Local-level Government and rural Local-level Government. This consistent with the Constitution's Second National Goal and Directive Principle of equity and participation.	○

Source: ADB (2009) Papua New Guinea: Power Sector Development Plan, Legal Office FAO Lex: <http://faolex.fao.org/>, Pacific Islands Legal Information Institute - Pacific Law: <http://www.paclii.org/>