



BIWRMDP

**Balochistan Integrated Water Resources
Management & Development Project**
GOVERNMENT OF BALOCHISTAN



Post Flood Damage Assessment Study in Balochistan Province - Nari and Porali River Basins

under

**Balochistan Integrated Water Resources Management
and Development (BIWRMDP)**

Draft Study Final Report

December 2022

MMP

MM Pakistan (Pvt) Ltd.

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Table of Contents

Section 1	Data Reconciliation.....	1-1
1.1	Background	1-1
1.2	Target Area	1-2
1.3	Nari River Basin	1-3
1.4	Porali River Basin.....	1-4
1.5	Preliminary Damage Assessment	1-5
1.6	Available Secondary Data	1-6
1.7	Preparatory Mapping.....	1-7
1.8	On-Site Data Collection.....	1-8
Section 2	Damage Assessment---Porali River Basin.....	2-1
2.1	Flood Protection Works	2-1
2.2	Nimmi Perennial Irrigation Scheme	2-3
2.3	Khuzdar Perennial Irrigation Scheme.....	2-3
2.4	Gundacha Irrigation Scheme.....	2-3
2.5	Nurg-Hingri Irrigation Scheme.....	2-4
Section 3	Damage Assessment---Nari River Basin.....	3-1
3.1	Flood Protection Works	3-1
3.2	Mushkaf Irrigation Scheme.....	3-1
3.3	Tariqabad-Jhal Magsi Flood Protection Works.....	3-4
Section 4	Rehabilitation and Reconstruction Works.....	4-1
4.1	Rehabilitation Requirements	4-1
4.2	Reconstruction Requirements	4-2
Section 5	Design Review Requirement.....	5-1
5.1	General Design Considerations	5-1
5.2	Embankment Alignments	5-2
5.3	Head Regulator Intakes.....	5-2
5.4	River Training Works.....	5-2
5.5	Command Area Appropriations	5-2
5.6	Conclusions.....	5-3

List of Figures

Figure 1	Integrated Map of Nari and Porali River Basins in Balochistan Province.
Figure 2	Irrigation Network in the Nari River Basin, Balochistan Province.
Figure 3	Irrigation Network in the Porali River Basin, Balochistan Province.
Figure 4	Location of Nimmi Perennial Irrigation Scheme in Porali River Basin, Balochistan Province
Figure 5	Irrigation Network in the Gundacha Nurg-Hingri Scheme, Package 1, Porali River Basin
Figure 6	Diversion Weirs in the Gundacha Nurg-Hingri Scheme, Package 2, Porali River Basin
Figure 7	Location of Shab-e-Maidan Flood Irrigation Scheme..... in Porali River Basin, Balochistan Province
Figure 8	Sample Navigation Map for On-site Damage Assessment in Khuzdar, Porali River Basin, Balochistan Province
Figure 9	Location of Inspection Sites by Consultants Staff in the northern part of Porali River Basin, Balochistan Province.

- Figure 10 Location of Inspection Sites by Consultants Staff in the southern part of Porali River Basin, Balochistan Province.
- Figure 11 Protection Bunds in northern part of Porali River Basin, Balochistan Province.
- Figure 12 Protection Bunds in southern part of Porali River Basin, Balochistan Province.
- Figure 13 Nimmi Perennial Irrigation Scheme in Porali River Basin, Balochistan Province.
- Figure 14 Location of Khuzdar Perennial Irrigation Scheme in Porali River Basin, Balochistan Province
- Figure 15 Location of Bakhra Ghulam Bolak Bund in Nari River Basin, Balochistan Province.
- Figure 16 Location of Mushkaf Flood Irrigation Scheme in Nari River Basin, Balochistan Province
- Figure 17 Location of Tariqabad Flood Irrigation Scheme in Nari River Basin, Balochistan Province.

List of Appendices

- Appendix A Flood Damage Assessment of BIWRMDP Works in Nari and Porali River Basins - Summary
- Appendix B Summary Status of Progress on BIWRMDP Works in Nari and Porali River Basins
- Appendix C Maps of Protection Bunds

Supporting Reports

- Deliverable 1 Data Gathering Summary
- Deliverable 2 Initial Report (Pre and Post Flood Implementation Status Report)
- Deliverable 3 Draft Damage Assessment Report

Section 1 Data Reconciliation

1.1 Background

This is the final report as a contractual submission for the Post Flood Damage Assessment Study under invited works by the Balochistan Irrigation and Power Department. An initial report on reconnaissance level appraisal, inclusive of preliminary findings and deliberations with the Client agency (Balochistan Integrated Water Resources Management and Development Project, BIWRMDP), was submitted in early November as the first step towards objective appraisal of the damages incurred due to recursive spate of flooding during July-August 2022. The initial report had highlighted evaluation of the secondary data and first hand observations by Consultant, M/s MM Pakistan, experts through on-site visits. This report, integrates the understanding of the damaged sites with the evaluations of site inspections, photographic evidence and adjunct mapping. The report contains evaluation of both Nari and Porali river basins and concludes with recommendations leading to the rebuilding/reconstruction effort towards restoration of the system.

In retrospect, Balochistan received 450% higher rainfall during July and August of 2022. In Porali basin, maximum rainfall was observed in the night between July 24-25 that resulted in a flood discharge volume exceeding 200,000 cusec causing damage to protection bunds through overtopping and scouring. During July, Balochistan received more than 163 mm rainfall (+450% more than the normal) followed by another spell of 155 mm rainfall (+590% more than the normal) during the month of August. According to Pakistan Meteorological Department, rainfall during these two months have superseded records dating back to 1961. Seemingly, such heavy downpours constitute the most potent cause of destruction due to recurrent flooding in the seasonal streams.

Irrigated agriculture, decidedly the backbone of food security has suffered unaccountable losses due to the harsh climate. Inclusive to these losses have been the investments under the Balochistan Integrated Water Resources Management and Development Project (BIWRMDP) that were financed through borrowings from the World Bank. Presently, any repair or replacement estimate of the damages would be a mere conjecture and a systematic effort is required to put the picture together.

The Government of Balochistan has solicited consulting services to establish a preliminary estimate of the extant and quantum of damages to the control structures that were developed under the Balochistan Integrated Water Resources Management and Development Project (BIWRMDP) such that the donor agency could be approached for restitution works. Aside from the formal invitation, the requirement focuses on post disaster needs assessment for irrigation schemes/flood structures and water supply schemes in Porali and Nari River Basins and in district Lasbela ([Figure 1](#)). The assessment is for most ongoing and completed schemes in the BIWRMD project area besides structures in Porali Basin and in Lasbela District. For the Client, the services are a means to formulate a recovery, rehabilitation and reconstruction plan and provide recommendations for medium and long term. The valuation of the reconstruction requirement is the emergent requirement under the solicited works.

This Study is, thus, part of a first response on the post disaster needs assessment through on-site data capture of data related to irrigation works of BIWRMDP. Data was analyzed and correlated against site inspections to verify/quantify the extent of damages due to flooding in the natural drainage channels. This is crucial towards remediation planning involving systematic consideration of damages with due consideration to resilience in rebuilding of structures.

Preliminary site visits by Consultants in September/October of 2022 to both the river basins indicate almost 70-80% flood embankments in Porali Basin have been washed out during floods. A complete washout augurs for retrospection on the stability of structures due either to design incapacitance or inappropriate placements and alignments.

1.2 Target Area

Project Components

Under the Balochistan Integrated Water Resources Management and Development Project (BIWRMDP), the Government of Balochistan (GoB) is seeking access to improved water resources planning, management and monitoring by the government, and increased adoption of water efficient practices and technologies by water users, in targeted communities in the Nari, and Porali River basins of Balochistan covering 80,840 km². The Project is being implemented over a period of six years at a total estimated cost of US\$253.72 million including financing from the International Development Agency (US\$205.56M), the International Fund for Agricultural Development (US\$38.06M) and the Government of Balochistan (US\$10.11M).

The Project has three major components with five sub-components following an integrated water resources management approach including:

- (i) new irrigation infrastructure and improved irrigation management,
- (ii) improved agriculture management and promotion of drought tolerant cropping varieties and other productivity measures including pest management to improve soil and water conservation;
- (iii) better decision making by farmers based on analysis of soil, improved water availability, and weather advisories;
- (iv) new and improved water supply systems,
- (v) enhanced flood protection and
- (vi) improved watershed and rangeland management to improve soil moisture retention, reduce erosion and improve groundwater recharge.
- (vii) These activities not only have a positive impact on environmental sustainability but also build resilience to climate change.

Water Utilization

Annual average surface water generated in Balochistan is around 10.8 billion cumec, of which around 21% is utilized. Around 8% and 13% of the surface water is utilized in the Porali and Nari River basins, respectively. This low utilization of surface water is due to the lack of limited storage and diversion infrastructure especially for the episodic flood flows.

Major portion of the water is lost along the inefficient conveyance and on farm application. Unreliability of surface water and the dilapidated water infrastructures, groundwater became a critical water resources in Balochistan. Intense rainfall events, deforestation, virtually no mechanism to naturally recharging groundwater table, this episodic and over-exploitation of groundwater is leading to rapid decline of groundwater tables. Investing in new water infrastructure and rehabilitation of existing facilities are urgently needed to address the critical state of agriculture, food security, and economic development in the province.

The lack of adequate water storage facilities, flood retention areas as well as flood protection dykes exacerbated the damages experienced during those years – and will cause damages again in the future. To minimize flood risk, construction of storage facilities and flood protection works is necessary.

Flooding

In Balochistan, flooding has always been a major concern, especially in the project area. High intensity rains in the upper steep catchments tend to generate high-energy flash flooding in the area. Since very little investment has been made in flood protection works to-date, there is an urgent need for flood protection works in five districts in Nari and two districts in the Porali Basin. Seven schemes are envisioned for the Nari Basin and five are envisioned for the Porali River Basin. The funding will be allocated as 60% for the Nari schemes and 40% for the Porali schemes.

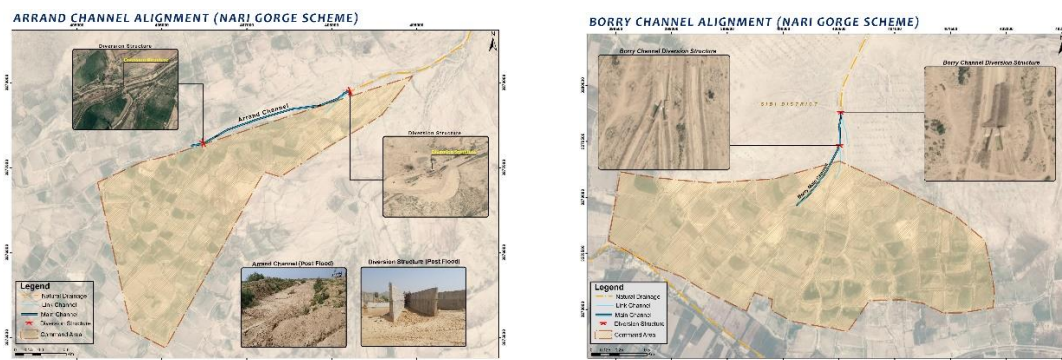
Across the two river basins, the flood protection works are expected to protect 14,600 ha of farmland, 4,100 homes of low-income families and 4,500 farming families through minimizing damage to agricultural land.

1.3 Nari River Basin

The Nari Gorge Integrated Sub-Project comprises perennial canal irrigation having six branch canals and their sub-branches covering Luni, Bakhra Ghulam Bolak, Khajjak, Kurrak, Dehpal and Marghazani (**Figure 2**). In addition, there are two small-scale spate irrigation systems, namely Arrand and Bori. The potential command area of the perennial and spate irrigation system is about 400 km, which is around 98,800 acres, out of which only 17,266 acres (6,990 ha) are cropped. In the six perennial channels, the water flows are available all the time while spate irrigation channels work during rainfalls. The geographical area of the sub-project is in the chakar lehri sub-basin of the Nari River basin and lies in District Sibi.

The remodeling of perennial irrigation and restoration of spate irrigation for the sub-project provides benefits to the population. For the perennial canal irrigation scheme, the designed command is around 44,065 acres (17,832 ha) and with the designed cropping intensity of 133%, it would crop 58,606 acres per annum (23,727 ha/annum). It is important to note that the current cropping intensity is only 39%.

The community is not able to divert flood water for the Sailaba (run-off) lands as they can't manage the floodwater without the development of the spate irrigation scheme. The flood water is available in the sub- project and it can be utilized by developing a spate farming system through the development of two small- scale spate irrigation schemes (Arrand and Bori) and development of the command area. Currently very little land is under flood water irrigation.



1.4 Porali River Basin

Porali River basin covers some 11,600 km² and extends to the Arabian Sea to the south after emerging at its head through a narrow gorge. The river basin is divided into 13 sub-basins, 9 drainage points which pour all the sub basins. Perennial river flows are diverted by local people through irrigation control structures that command small tracts of land called 'Bents' at various locations. Groundwater is being over exploited in the basin and therefore reliance on surface supplies is limited.

Presently, Porali basin includes the perennial irrigation schemes of District Khuzdar near the border with District Lasbela. These include perennial irrigation systems of Nimmi, Gundacha and Shab-e-Maidan (**Figure 3**). The conveyance channels of Sheb Medan and Gundacha Nurg Hingri are earthen with provision of embankments whereas RCC conduit is also constructed at Nimmi PSI.

The Nimmi scheme is located at the main Porali River, at a distance of roughly 3.5 km from the Regional Cooperation for Development (RCD) Highway in the north-west direction, where the agricultural land are located at both banks of Porali River (**Figure 4**). A sharp crested overflow weir with an un-gated concrete structure of 295m length with designed discharge of roughly 3,500 cumec is proposed for rehabilitation on main Porali River (Nurg-Hinjri Integrated Scheme).

The Gundacha Nurg-Hingri area starts at about 5 km downstream of Gundacha Village (**Figure 5**). This perennial flow is mainly for agriculture purpose. The spate command area is about 4,858 ha and 3,239 ha on Nurg and Hingri flood channels (**Figure 6**), respectively. The main Gundacha Channel is 3,550 m with guide banks to safely lead the flow into the downstream unlined channels. The Gundacha diversion weir is designed for raising the water level to ensure continuous irrigation water supply to the command area. The head works and associated structures consist of the following components:

- Overflow Concrete Weir
- Trifurcation Structure (Divide Walls)
- Earthen Bund duly pitched (for division of flow)
- Guide Bund at both banks (Shorli and Faizo bunds)

The pre-existing weir in the scheme had uncontrolled off-takes that resulted in entrance of excessive flood peaks into downstream earthen channels. This caused erosive damage to channel sections and guide banks besides flood damages to the command area. Under BIWRMDP, the new weir is located at a slightly d/s location.

The Shab-e-Maidan irrigation scheme is located at the eastern most boundary of the Porali River basin in District Bela about 120 km away from Winder Town (**Figure 7**). It is designed for water withdrawal of 4,798 ac-ft through diversion weir. Prior to this scheme, there was no proper irrigation system in Shab-e-Maidan and the local farmers diverted the perennial flows to their lands through indigenous means, entirely on a temporary basis. The cultivable land in the area of Shab-e-Maidan is about 971 ha. The scheme has two main irrigation channels with a combined length of about 16 km. Under BIWRMDP, there are two development packages that were between 20-40% complete by the end of July 2022.



Construction of Main Weir at Shab-e-Maidan

Package 1 has Main Weir and Main Channel; the Main Channel (3,575 m) sustained slight damage across 200 m of its earthen portion, however there are no damages in the channels of Package 2. The main weir (under construction) was also safe and no damage has been observed. Under Package 1 there are separate head regulators for flood and perennial channels. The main weir is broad crested with a length of 100 m and discharge estimated at 367 cum against a 50 year return period flow. The flood channel has a length of 3,575 m with a command area of 1,200 ac. The perennial channel has a length of 2,500 m with a command area of 300 ac. Work on the main weir, main channel and fall structures is currently in progress.

Under Package 2, there are two main channels for flood irrigation. Channel 1 has a length of 5,758 m while Channel 2 is 6,200 m long. Currently, work on Channels 1, 2 and fall structures is in progress.

1.5 Preliminary Damage Assessment

Preliminary damage estimates have been prepared by both the Project Implementation Consultants and the respective contractors over multiple schemes in both Nari and Porali River basins comprising separate accounting of protection bunds, irrigation structures and channels. Summary accounting of these estimates has been compiled and an example of the damages reconciliation provided below for the Porali River Basin schemes.

Estimation of Flood Damages Porali River Scheme

Sr. Nr.	Scheme	Cost of Damages	Contract Cost	Percentage of Damages
1	Nimmi Perennial Irrigation Scheme	107,538,399	424,652,611	25.32
2	Nurg Hingri Irrigation Scheme – Package 1	14,552,087	527,081,666	2.76
3	Nurg Hingri Irrigation Scheme – Package 2	36,903,766	568,902,172	6.49
4	Porali Flood Protection Scheme	44,986,948	185,785,120	24.21
5	Khuzdar Perennial Irrigation Scheme	27,919,560	404,241,116	6.91
	Total	231,900,760	2,110,662,685	10.99

The damage assessment summary is derived against information provided both by the PSIAC and the construction contractor staff deployed at respective sites however the same was duly checked at site through our experts and inspection team. The assessment is provisional due to accessibility issues and time constraints and not based on quantity takeoff as a part of this consultancy. However, before proceeding to rehabilitation it is advisable to revisit the existing designs and ascertain proper cost assessment based on detailed quantification. Tabulation of such damages for the Porali River Basin appears in [Appendix A](#) and could generally be summarized as follows:

- Protection bunds
- Irrigation structures, and
- Irrigation channels

There are at least 15 locations of protection bunds that have been completely washed out in the Porali River basin while another 10 have partial damages. Damages are due both to protection bund embankments and stone pitching. On the main Porali River, protection bunds like Nimmi 2, Sordeer, Kanar 2, Langro, Soneri, Kashari, Ghot Hayatwala, Ghot Jafferani, Mazharwala, Ghot Allah Rakha, Thararra 1 and Mauza Mureedani are a complete washout. Similarly, protection bunds for irrigation schemes like Nurg-Hingri Package 1 of BIWRMDP comprising of Faizo bund, Hingri Triangle Portion and Shorli bund have washed away.

All irrigation structures under the Nimmi irrigation scheme are heavily damaged while those in Gundacha Nurg-Hingri Package 1 are in varying states of damage. Irrigation channels in Gundacha, Bhit and Jamoot are also damaged on account of embankment erosion and bed siltation.

The foregoing needs to be understood in the context of completed and ongoing works under BIWRMDP prior to flooding. Based on material information provided by the Client, the Consultants have been able to reconcile the state of progress against many of the schemes against multiple levels of structural adjustments, from the river basins to the head regulators and the irrigation channels below. This is not a compendium of the entire scope of works under BIWRMDP but only those related to the perennial and non-perennial irrigation water diversion arrangements. The information in terms of '17' such development schemes is summarized in [Appendix B](#).

The extent of damages shown in [Appendix A](#) could be correlated to photographic evidence that has been compiled from different sources (Consultants, contractors, Client Office) and is presented in Appendix A of Draft Damage Assessment Report.

1.6 Available Secondary Data

During initial interaction with the Client, Consultant's staff had been able to retrieve soft copy archives of BIWRMDP related to both design and contractual elements of information. This data had redundancies and duplications and was not organized against an objective classification. Through rigorous data sorting, data files were organized as per following nomenclature:

Folders	Data Categories
Alignments	Map and CAD details on irrigation channels, protection bunds and natural drainage
Channel Statistics	Discharges, lengths, embankments, hydraulic structures
Command Area	Maps and drawings
Contractual Data	Contractual agreements, variations, requests, site installations,

Contractual Reports	Feasibility and design reports
Damage Reports	Pre- and post-flood damage reports, photographs
Drawing Lists	Notes, titles, drawing indices
Investigations	Electrical resistivity surveys
Listed Data on Contract Management	Contractual packages and site conditions
Presentations	BIWRMDP citations
Profiles	Plans and profiles of irrigation channels
Progress Reports	Monthly and quarterly progress reports by BIWRMDP supervision consultants
Protection Bunds	Images, layouts, profiles and cross sections
Quantity Sheets	Estimates of construction works on packages of irrigation schemes
Consultant's Site Visit Photos	Taken during reconnaissance visits in October to Nari and Porali River basins
Structures	CAD drawings of irrigation structures
Tabulations	Daily rainfall data
Cross Sections	Irrigation structures and channels

The Consultants have made exclusive reliance on the alignments and structural geometries of site layouts to prepare maps with minimal positional error. Contractual data was used to ascertain the level of on-site reporting from the contractors whereas information on protection bunds was used to assess drainage geometry. There was wholesome use of the compiled folder on Damage Reports from multiple sources bearing both written and photographic accounts of the site situation. A significant portion of this processed information appears under Appendix A of Draft Damage Assessment Report Site Photographs.

Mapping constitutes a very significant portion of the damage assessment exercise and for the Consultants the inputs have come from the softcopy CAD layouts of command areas, protection bunds, irrigation channels and land use details that were part of the reporting done by the PSIAC. The Consultants have rescaled and re-layered the information to derive customized layouts whose authenticity is at grade with that of the originals. Some of these layouts are inclusive to the main body of this Report while detailed plans for flood protection works are included systematically in **Appendix C** under Maps.

Appendix C is privy to following collation of planar details:

Since the Study invitation does not envisage design review, data sets on profiles, x-sections, structures, BoQs, contractual data and reports have been omitted from active review.

1.7 Preparatory Mapping

The Consultants have used mapping details not only for field mobility but also for orientation to the basic scheme constructs within the respective river basins. Maps have been prepared to show:

- Site orientations,
- Dimensional details
- Structural emplacements

- Network alignments
- Command area delimitations
- Sites of physical inspections

Entire set of mapping has been committed as follows:

Map Type	Paper Size
System plans	A3
Scheme plans	A4
Field plans	20 in x 24 in
Study plans	40 in x 40 in

Mapping themes have been established on account of

- integrated river basins
- coverage of irrigation networks
- protection bunds across entire river basins
- detailed alignments of protection bunds (by schemes)
- detailed alignments of protection bunds (over satellite imagery)
- individual irrigation schemes
- field inspection sites
- check dams

Mapping details appeared under Appendix A of Draft Damage Assessment Report.

1.8 On-Site Data Collection

The Study invitations required the Consultants to engage on-site verification of the damaged works as the first step towards integration of the multiple reports that were initiated by both the PSIAC and the construction contractors and also to ascertain the reasons behind the losses to the channel and structural regimes. As indicated above, orientation to the site geometry was based on maps that were prepared for use by field inspectors at paper size of 20 inches by 24 inches (**Figure 8**). In addition, a proforma was also provided to the inspectors to fill in relevant details of protection bunds, head regulators and check dams. Due to time constraints, irrigation channel alignments were not scouted, however there is ample evidence available from both primary and secondary data through photographs in Appendix A of Draft Damage Assessment Report that could be used to ascertain the situation. A total of '41' sites were visited in Porali River basin (**Figures 9 and 10**) and the collated observations based on proformas are provided under Appendix B of Draft Damage Assessment Report. Visits to the damaged sites in Nari River basin include Tariqabad Flood Protection Bund, Arrand and Borry irrigation channels under Package 3 of Nari Gorge Irrigation Scheme) and the Bakhra Ghulam Bolak Bund.

Site plans contained information as per sample shown above in **Figure 7**. These plans were typically between 1:2,500 to 1:3,000 map scale with basic land use shown against the flood protection works. Photographs were appended into the main body of the map to help the field staff get orientation to the structures. There were '23' plans prepared for site inspections in Porali basin and '6' in Nari basin.

Section 2 Damage Assessment---Porali River Basin

2.1 Flood Protection Works

The flood protection works on Porali River are shown in **Figures 3 and 4**. There are '16' flood protection bunds on the right bank of Porali River and '8' on the left bank. The respective lengths of these bunds are summarized as follows:

Protection Bunds on Porali River Basin

Right Bank	Lengths (m)	Left Bank	Length (m)
Nimmi 2	535	Muree	379
Nimmi 1	355	Kanar 1	527
Sordeer	775	Kanar 2	275
Kundi	404	Soneri	442
Langro	490	Jumman	449
Keshari	433	Khashkhali	337
Gundacha	500	Ghot Thararra 1 &2	300
Gagoo	556	Ghot Machar	400
Faizo	900	Shorli	271
Ghot Jafferani	513	Total	3,380
Mazarwala	400		
Ghot Hayat Wala	400		
Ghot Allah Rakha	278		
Mauza Sukhyani	400		
Balochi Ghot Khosa	600		
Mauza Mureedani	432		
Ghot Sabra	350		
Baghari	350		
Total	8,671		

The protection bunds shown in grey have been completely washed away. On the right bank, this totals to 5,156 m while on the left bank it is 1,118 m. Altogether, this is over 6 km of protection bunds that would require a complete reconstruction without resort to rehabilitation.

Since this information is owed to secondary data provided by the PSIAC, the Consultants have taken all alignments of FPs from the CAD layouts of the structures and lengths from the profiles drawn in CAD. Accordingly, FP bund layouts shown in **Appendix C** are legitimate to the extent of BIWRMDP records.

Based on an official account, following works on Porali River protection bunds were estimated to be 50% complete by June-August 2022.

- Allah Rakha Bund
- Hayat Wala Bund
- Jaffarani Bund
- Mazarwala Bund
- Mureedani Bund
- Balochi Ghot Khosa
- Bhagari Bund
- Tharrara Bund

Contractor reports indicate that 70% construction drawings are complete. Out of a total of '10' protection bunds, the Contractor has started embankment works on 8 bunds. There are material availability issues regarding construction of the remaining two bunds.

Although the Consultants were provided contractor estimates of the damages to the FP bunds, there incidentally exists a large body of photographic evidence that could be used towards an independent assessment of the post flood situation. Consultants have used this auxiliary information in ascertaining the extent of damages to the protection bunds and allied infrastructure.

Appendix A1 of Draft Damage Assessment Report shows damages to Nimmi protection bunds against embankments, spillway, pipe culverts and the head regulator. There is siltation in the regulator and the embankments are a complete washout. Appendix A2 of Draft Damage Assessment Report shows the Sordeer head regulator as a complete loss together with damage to the gabion wall. Kanar 1 is damaged for about 400 m out of its total length of 527 m while Kanar 2 is a total washout including the culvert. Langro bund has lost its stone pitching (Appendix A4 of Draft Damage Assessment Report) while Sonari bund has lost most of its embankment and stone pitching.

Kishari bund has been assessed as heavily damaged with complete erosion of stone pitching and total displacement of the pipe culvert. It would require a reconstruction. From Appendix A7 of Draft Damage Assessment Report, Jumman bund has lost more than 80% of its stone pitching.

Appendix A11 and A12 of Draft Damage Assessment Report show both Mazharwala and Ghot Hayatwala bunds to be a total loss and fit cases for reconstruction. Jafferani Bund (Appendix A24 of Draft Damage Assessment Report) has been stripped of stone pitching, however the bund is intact. Ghot Allah Rakha bund has 2/3rds of its embankment badly damaged and the remaining would require rehabilitation. Appendix A15 of Draft Damage Assessment Report shows both Tharrara bunds I and II to be a total loss, it is worth mentioning here that the Tharrara bund was constructed by the irrigation Department for protection of Bela Town in early nineties and only a small portion was reported to be rehabilitated under BIWRMDP. Same holds true for Mauza Mureedani Bund (Appendix A13 of Draft Damage Assessment Report) while Balochi Ghot Khosa Bund (Appendix A14 of Draft Damage Assessment Report) is stripped of its stone pitching with partial damage to the embankment.

Based on the above observations and the site evidence, it is obvious that there is a far greater proportion of reconstruction for FP bunds than rehabilitation works. The Consultants believe a cost estimation of these structures for reconstruction as per year 2023 schedule of rates would not be advised without a prior understanding of the causes behind total washouts. There are prerequisites to this evaluation that are discussed in Section IV of this Report.

2.2 Nimmi Perennial Irrigation Scheme

The Scheme is located between 30-38 km from Lasbella town and is made up of 10 sub schemes. It is located on the right bank of Porali River (**Figure 5**). As discussed in the previous section, the scheme is controlled and protected by a series of bunds. The Consultants were not able to conduct a thorough inspection of the scheme due to its scattered nature, however based on photographic evidence from Appendix A of Draft Damage Assessment Report, about two regulators have been damaged and as reported earlier the flood protection bunds are either washed or damaged.

2.3 Khuzdar Perennial Irrigation Scheme

In the scheme area of Khuzdar Perennial Irrigation Schemes, Porali River runs in the small gorge covered with mountains (**Figure 6**). The schemes are protected by two major bunds on the right side of the Porali River. Sailoon bund is upstream whereas Bizenjo bund is 6-7 km D/S. The combined irrigation command is over 1150 ha. Sailoon bund embankment has experienced partial damage across 525 m and a 950 m portion has been washed out. Bizenjo bund has suffered extensive damage with a washout of 187 m across its length. The bund will require a reconstruction.

2.4 Gundacha Irrigation Scheme

Gundacha irrigation scheme has been shown previously in **Figures 1 and 2**. Under Package 1, the scheme comprises the main Gundacha channel with a head regulator of discharge 05 cumecs. Other two main channels of Bhit and Jamoot are also of the same capacity. Pero channel is protected by a 3,075 m long embankment, followed by Sardarwala 1 at 1,925 m and Sardarwala 2 at 1,125 m. The Bhit Channel head regulator (under construction with reported 20 to 25% physical progress) has sustained damages to the Low Head Weir cutoff walls. Jamoot head regulator has lost its right side cutoff wall. Whereas it was observed that, the completed Gundacha head regulator has safely passed the flood flow and remained intact.



Gundacha Channel---Pre Flood



Gundacha Channel---Post Flood



Bhit Channel---Post Flood



Jamoot Channel---Pre Flood



Jamoot Channel---Post Flood

2.5 Nurg-Hingri Irrigation Scheme

The Nurg-Hingri area lies along the middle reach of the Porali River at about 5 km downstream of the Gundacha village (Figure 1). The existing Nurg and Hingri weirs command the area through flood flows and cover about 10,067 acres (4,076 ha) and 7,479 acres (3,028 ha) respectively. The Nurg Hingri weirs were constructed in the year 1987 through Saudi Fund and consist of three broad crested weirs over Porali River, Nurg channel and Hingri channel with respective lengths of 295 m, 66 m and 44 m.

Major problems observed in the prefeasibility phase of BSSIP were that during operations of the system, the high-volume discharge in the downstream earthen channels of Nurg and Hingri that eroded the guide bunds at several places due to scouring. The main issue at Nurg-Hingri, therefore, is the uncontrolled flow entering the command area. The diversion weirs of both the channels are without any controlling device. The open weir crests of considerable waterways let high discharges enter into the downstream earthen channels. The resulting damage is twofold whence the channel itself and its guide banks get severely eroded besides the command area that gets flooded. Consequently, the system suffers from frequent damages rather than yielding benefits.

The Nurg-Hingri Irrigation Scheme feasibility study had proposed rehabilitation of the existing weirs for the Nurg-Hingri stretch of Porali River. The excessive discharge was proposed to be controlled by providing a breast wall on the Nurg and Hingri Weirs to limit the entry of peak floods. Reconstruction and strengthening of the embankment bunds and spot repairs for minor damages was also proposed to be carried out.

A 50 years peak design flood of 3,076 cumecs was selected for the design of Nurg- Hingri channel weirs whereas main weir on the Porali River was checked for overflow conditions for 100 year design flood of 3,768 cumecs based on the feasibility/design Report of Balochistan Small Scale Irrigation Project (BSSIP). Based on the above design discharges, rehabilitation of the existing 295 m long weir on Porali River and construction of new weirs for Nurg (66m wide) and Hingri (44m wide) weirs with arrangement for placement of stop-logs was carried out.

The flood peak observed on the night of July 24 and 25, 2022, caused excessive floodwaters to pass through the rehabilitated weirs of Nurg, Hingri and Porali River weirs. The discharge volume was estimated to be more than 200,000 cusecs which caused damage to the Shorli Bund on the LHS of Nurg and Hingri weirs and Faizo Bund on the RHS of the Main Porali weir due to overtopping and scouring of the bunds. As narrated earlier, these two bunds were constructed by Irrigation Department during the period of eighties with the support of Saudi Fund, which were washed away during the citing flood.

The Nurg-Hingri weirs were designed for 108,700 Cs whereas the re-evaluated flood peak based on rainfall data from Pakistan Met Dept. indicated a flood discharge of 218,600 Cs corresponding to a 950 years return period storm, tabulated on the basis of data provided by ACE Consultants.

Post flood assessment for Gundacha main channel under Package 1, received minor damage to the stone pitching with entrance of silt deposition in the earthen canal. The head regulator is completely safe and effectively sustained the thrust of heavy flood flow. Bhit Channel (2,100 m) has a damaged regulator. Its embankment has been damaged for about 100 m, which was reportedly left unattended for construction activities. The head regulator (under construction with reported 20-to 25 % of physical progress) got damaged. Jamoot Channel also got some damages to the under construction head regulator and minor damages to the earthen channel and embankments.

The Nurg-Hingri stretch of Porali River marks the end of its middle reach. In this reach, the river channel gradually spreads out turning into a wide and shallow stream. This area falls under flood irrigated commands of Porali River, as no perennial flow reaches here. The spate users get benefitted through an existing diversion that facilitates partial flood flows to irrigate their lands.

Section 3 Damage Assessment---Nari River Basin

3.1 Flood Protection Works

Recent floods in District Sibi resulted in drastic damages to flood protection works at Bakhra Ghulam Bolak that had been partially completed by the contractor. During the heavy monsoon floods in the period between July 2 to August 20, and subsequently from August 25 to Sept. 2 scouring was observed that caused damages to the earthen bund at following sites:

From RD 0+000 to RD 540+000, the earthen embankment along with stone pitching was partially damaged in some places including scouring caused by rain cuts.

From RD 540+000 to RD 890+000, the protection works including earthen embankment, stone pitching were completely washed out.

According to the reports and on-site interviews, the earthen embankment of flood protection bund was almost complete and the stone pitching work was in progress. The flood protection bund remained intact during the heavy spells in the month of July 2022. The flood peak during the last week of August and parallel flow eventually damaged the structure and resulted in washing out about 350 m of the entire length from the downstream side.

Inspection of the 890 m length of the FP Bund by the Study Consultants indicated a 350 m portion as a washout (**Figure 7**).



Bakhra Ghulam Bolak Bund showing completely washed out portion (Approx 350M)

The protection works were damaged due to unprecedented and excessive discharge in the main Nari Gorge over and above the design allowance. The bund was designed for 100 k cusec whereas monitored flood flow was 240 k cusec.

The stable side slopes and type of soil depends upon the strength of the fill material and foundation characteristics.

3.2 Mushkaf Irrigation Scheme

Main components of the Mushkaf Spate Irrigation Scheme include

- Weir, sluice and head regulators of Luni-1, Luni-2, Mushkaf-1 and Mushkaf-2;
- Upstream flood protection/river training works;
- Irrigation conveyance system of main canal and distributaries;

Under BIWRMDP, following component works were undertaken and have since been completed:

- Weir raised by 1 m
- In the u/s reach, guide bunds on both sides have been extended and raised
- Head regulators have been constructed for Mushkaf 1, Mushkaf 2, Lundi 1 and Lundi 2 channels
- Lining of main channels has been completed
- Completion of 08 diversion structures
- Earthen channels have been extended.

The Consultant's visited Mushkaf main weir system (**Figure 8**) accompanied by the Client's and contractor's representatives for joint inspection of the structures.



Super passages in Package-2 Irrigation Scheme

A few of the 17 Super Passages, constructed under this package, were inspected and some insignificant damages were observed to masonry work and approaches.

Inspection of the Arrand Channel was made along both sides and no damages were found between Structure 1 and Structure 2. The concrete head structure of the channel was also safe with no major flood damage.



Arrand flood irrigation channel under Package 3



On-going work of stone pitching at Arrand Channel

The general post-flood condition of the structures is satisfactory; however, the clear watermarks on the piers of main weir had evidence of overtopping the structure during Flood-2022. The observation was strengthened by the presence of trash/straws on top of the main structure.



Visible water-marks on the Pier showing overtopping



Trash/straws on the top surface of the main structure

During inspection visits in November, the Consultants were informed that during the flood peak experienced on July 14, 2022 the local inhabitants/irrigators forcibly took control of the spate regulation in the presence of Irrigation Staff and the law-enforcing agencies. Not only did they abruptly open the gates of their respective head regulators in disregard to operating rules but also kept the gates of “undersluices” closed to allow for maximum inflows into their channels. Their action led to huge deposition on both the upstream and downstream sides of the weir. Moreover, silt laden flood water entry into irrigation channels caused massive siltation and erosion of the side banks.



Weir Siltation at Mushkaf Flood Irrigation Scheme



Channel Siltation at Mushkaf Irrigation Scheme

Left side guide bund was found damaged to a length of 100 meters however it was noticed that this bund was constructed by the Irrigation Department during past and it was only raised during BIWRMDP and the damaged portion was found to be filled with fresh earthwork at site. Initially, the Consultants reported the left side guide bund as a “breach” in the Initial Report that was filled and restored; however, a photo of the damaged site was subsequently showed accessed through secondary records that revealed the left side guide bund to be heavily eroded due to presence of an old spur in front of the

affected portion. The serious erosive action badly damaged the bund but did not entirely breach the section.



Erosion but no breaching of the left guide bund



Damaged section repaired

Damage to the earthwork filling behind concrete canal lining was also observed on the structures of distribution channels that would require replacement.



Damaged canal lining

A summary of the damaged works at Mushkaf irrigation scheme is as under;

- Generally, the main weir structure safely sustained the peak flows on July 14 and Aug. 26, 2022 without causing major damage to any of the offtake structures.
- Huge deposition of silt on the upstream and downstream sides needs to be removed/re-handled for which the Clients can get the required surveys done in order to assess the quantum of work.
- The shingle cover over the top surface of the structure seems to have been disturbed due to flood water flowing over the surface with minor settling of earthwork at some points. The same could be reinstated with the minimal effort.
- All the gates and gears are in satisfactory condition and are operating properly.
- A minor crack in a concrete joint was observed at Luni-1 head regulator which requires detailed inspection.
- Damaged portion of the left side guide bund has been repaired, however the quality of earthwork needs to be checked towards compaction.
- The distribution channels, presently choked with silt, need to be restored to design bed levels.
- Regulation of flows through the structures should be exclusive to the staff responsible for the operation of the system.

3.3 Tariqabad-Jhal Magsi Flood Protection Works

The Consultants also visited Tariqabad Flood Protection Embankment on Nov. 3rd at Jhal Magsi which is being rehabilitated under BIWRMDP (**Figure 9**). The site of Bund is 21 km from Jhal Magsi and the total length of the bund is 12 km. Earlier, the team could not approach this site during the first leg of inspection of Nari Basin on Oct. 28 and 29 2022, due to accessibility issues owed to standing floodwaters. As per site briefing, the rehabilitation of Tariqabad Flood Embankment is included in the

BIWRMDP for targeted length of 12 kilometers, and presently works are in progress in a reach of 5 km. There are a number of loops in the bund. A canal is flowing along the bund throughout its length while its other side has the Qabula River bund. Along the 5 km rehabilitation stretch, sand and spawl stacks have been washed during the floods.

Within the rehabilitation stretch, initially there were 09 pipe culverts out of which 07 got deleted from the scope of work. The contractor, during filling of the bund, left patches of 20-25 m for these culverts that got widened (50-100 m) during the flood period.

Site observations showed cracks on top and sloping portions of the embankments due to heavy rainfall. There were eroded banks in small patches that are likely the result of wave action of flood water along the embankment. Within the constructed reach, a portion of 60-80 meters was found washed-out. It was told that the local inhabitants made a relief cut in the embankment in a desperate pursuit of saving their houses and animals. The washed out portion could be seen in the photograph.



**Relief cut in the Embankment of
Tariqabad FP Bund**



**Stone pitching work suspended due
to quality issues**

During inspection, a completed 100 m section of stone pitching was also where no further activity was noticed due to work suspension prior to flooding. BIWRMDP Officers informed that the pitching work was suspended prior to the flood due to undersized stone. No significant loss of stone pitching work was observed in the observed reach.

There are a number of loops in the bund. A canal is flowing along L/S of the bund in its length. While on Right side of the bund there is the Qabula River bund. At RD 0+000 of the bund Lehri nullah and Nari River meet where a Head Regulator is proposed in the scope of the work. At RD 0+425 of the bund a channel is proposed where earthwork was in progress.

Section 4 Rehabilitation and Reconstruction Works

4.1 Rehabilitation Requirements

Site rehabilitation does not alter the geometry of the structure and adheres to the design configuration that remains practical after restoration works. The civil works are made up of earthworks duly pitched with solid stone, PCC and reinforcements for concrete works. All of these works would take reference from the design level profile and sectional details available for the structures and hence the quantification. Rehabilitation works are executed a prior to realize upfront tangible benefits towards operational worthiness of irrigation systems. Measurements are performed in reference to continuity of structural elements assuming parent controls and regulations are not altered, e.g. embankment heights, release levels, FSLs and crossover alignments. After detail consultation with all stakeholders at PMUs, PIUs and at field levels, in-depth review of the documents provided by PSIA consultant and field visits it is estimated that the cost of damages of structures in both Porali and Nari River Basins is around 231,900,760 Pak Rupees however, these costs must be reassessed and estimated before starting of work.

Sr. No.	Protection Bund	Total Riverside Length	Slope (M)	Countryside Slope	Extent of Partial Damage	Remarks
Flood Protection Works at Porali River						
1	Ghot Jaffarani	513	2:1	1.5:1	70% to 80%	160M washed out, 150M seriously damaged, remaining partially damaged
2	Balochi Ghot Khosa	600	1.5:1	1.5:1	70% to 80%	400M embankment washed out, remaining partially damaged
3	Bhagrai	350	1.5:1	1.5:1	70% to 80%	250M embankment washed out, remaining partially damaged
Nimmi Perennial Irrigation Scheme						
1	Soordeer (Guide Bund)	105	1.5:1	1.5:1	30% to 40%	50M embankment and stone pitching washed out
2	Murree	379	1.5:1	1.5:1	20%	Embankment and Stone pitching (70 M) damaged
3	Kundi	404	1.5:1	1.5:1	30% to 40%	80M washed out, 40M partially damaged
4	Kundi (Guide Bund)	165	1.5:1	1.5:1	50% to 60%	95M washed out, Head regulator damaged
5	Juman	449	1.5:1	1.5:1	65%	Embankment (250 M) damaged
Khuzdar Perennial Irrigation Scheme						
1	Salion Bent	1225	1.5:1	1.5:1	85% to 90%	1000M washed out, 225M portion partially damaged

2	Bezengo Bent	477	1.5:1	1.5:1	80% to 90%	407M washed out, 70M portion partially damaged
Gundacha Nurg Hingri Integrated Scheme Pkg-2 of 2						
1	Khaskheli Bund	165	2:1	1.5:1	80% to 90%	115M washed out, remaining portion partially damaged
2	Nurg Damaged Portion	200	2:1	1.5:1	20% to 30%	50M washed out, remaining portion partially damaged
3	Nurg Wash out Portion	200	2:1	1.5:1	50% to 60%	100M washed out, remaining portion partially damaged
4	Hingri Wash out Portion	200	2:1	1.5:1	20%	50M stone pitching damaged, 50M toe wall washed out
Gundacha Nurg Hingri Integrated Scheme Pkg-1 of 2						
1	Gundacha Bund	425	2:1 1.5:1	30% to	40% 70M	washed out, partial damage to stone pitching in remaining portion
Nari Gorge Integrated Scheme Pkg-1 of 2						
1	Bakhra Ghulam Bolak Bund	890	2:1	1.5:1	40-45%	Embankment and Stone pitching (350 M) damaged
Nari River Basin Pkg-1						
1	Tariqabad Flood Protection Bund	5000	2:1	1.5:1		Embankment (60-80 M) relief cut Rain cuts
TOTAL LENGTH		6747 M				

4.2 Reconstruction Requirements

A reconstruction is necessitated when the cost of repair does not fit into the overall altered hydraulic regime. This is obvious when damages to the main system supersede reconciliation with allied structural details, like the irrigation distribution system. The damage is considered to be so pervasive as to prevent restoration of structures to original specifications and, hence, a complete re-structuring approach is adopted based on new topo surveys and site control. In Balochistan, the operative irrigation regime is mostly a free-flow weir-controlled domain with pre-set hydraulic heads dictated by the main weir over the drainage channel. If the nullah flow is disturbed to the extent whereby offtakes are rendered inoperative then, barring adjustments to the irrigation channel flow regime, both the upstream and downstream reaches of the nullah would need to be reconstructed. This would include a new hydraulic regime for weir, u/s and d/s aprons, stilling basin level, diversion weirs and heights of flood protection embankments. The system would need to be reconstructed to match the draw-off sill levels and bed levels of the irrigation system. This a considerable expense and would require scope of works greater than the original construction effort. Since the following structures have completely washed out, the Client can rehash the design strategy for these structure with a robust approach based on new parameters.

Sr. No.	Protection Bund	Total Length (M)	Riverside Slope	Countryside Slope	Extent of Damage	Remarks
Flood Protection Works at Porali River						
1	Ghot Allah Rakha	278	2:1	1.5:1	Washed out	
2	Ghot Hayat	400	2:1	1.5:1	Washed out	
3	Mazarwala	400	2:1	1.5:1	Washed out	
4	Muza Mureedani	432	2:1	1.5:1	Washed out	Complete damage Embankment and gabion work
5	Ghot Tharrara	300	2:1	1.5:1	Washed out	
Nimmi Perennial Irrigation Scheme						
1	Nimmi-I	355	1.5:1	1.5:1	Washed out	Embankment washed out and Head regulator damaged
2	Nimmi-II	535	1.5:1	1.5:1	Washed out	
3	Soordeer	664	1.5:1	1.5:1	Washed out	Embankment washed out and Head regulator damaged
4	Kanar-1	527	1.5:1	1.5:1	Washed out	
5	Kanar-2	275	1.5:1	1.5:1	Washed out	
6	Langro	489	1.5:1	1.5:1	Washed out	
7	Soneri	442	1.5:1	1.5:1	Washed out	
8	Kishari	433	1.5:1	1.5:1	Washed out	
Gundacha Nurg Hingri Integrated Scheme Pkg-2 of 2						
1	Faizo Bund	830	2:1	1.5:1	Washed out	Embankment washed out
TOTAL LENGTH		6360 M				

Section 5 Design Review Requirement

5.1 General Design Considerations

Although unprecedented and disastrous rainfalls is the main reason for damages caused to irrigation infrastructure of BIWRMDP schemes, however, to avoid repetition of such events it would be worthwhile to review the design criteria for the flood embankments both in Nari and Porali basins. Existing approach based on conventional design configurations has become unsustainable on account of aggravated changes in rainfall patterns. A paradigm shift in reconstruction has become necessary.

Data from secondary sources indicates that hydraulic structures of BIWRMDP have been based on a 50 year return period. Keeping in view the above normal flows this year, it is imperative to rehash the strategy to revise the criteria to 100 years or more. This needs to be done on the strength of numerical modeling to establish new hydraulic parameters and benchmarks.

The Federal Flood Commission, a central engineering authority over floods in Pakistan, has prescribed certain criteria for the flood embankments. It also includes robust investigation into setting the alignment of such structures by not encroaching into the river basin or the active flow boundaries.

A review of the design criteria for embankments in the Porali basin indicates prevalent adoption under BIWRMDP as per following criteria;

Top (Crest) Width:	4.0 M
Side Slope (Country side):	1.5H: 1V
Side Slope (River Side)	2H to 1.5H: 1V (Riverside slope varying on a few embankments)

The above criteria does not seem to be in compliance with the Federal Flood Commission's Standard Criteria for Flood Embankments, which is given as below.

Top (Crest) Width:	7.5 M
Side Slope (Country side):	2H: 1V
Side Slope (River Side)	3H: 1V

Accordingly, the basis for adoption of a non-standard design for flood embankments could be a potent contribution to the observed design failure. Furthermore, there exists the need to scrutinize secondary data on design parameters provided by the client against embankment design.

- Soil properties
- Designed flood level and low water level of the river
- Phreatic line and pore water pressure
- Surcharge on the embankment
- Geometry of embankment

The stable side slopes and type of soil depends upon the strength of the fill material and foundation characteristics. The type of soil determines the rate of seepage, formation of boils on the landside natural surface, the settlement of the embankment and stability of the slopes.

5.2 Embankment Alignments

Flood bunds are low height earthen embankments extending generally parallel to river channels and designed to protect the area behind it from overflow of floods. Generally, embankments are aligned on the high ridge of the natural banks of the river, where the land is high and material available in the vicinity is suitable for the construction of embankments. The alignment is kept reasonably straight by avoiding acute curves and intrusion into river “Khadir” (i.e. the historical movement limits between the two high banks of the river on either sides).

5.3 Head Regulator Intakes

During site inspection of Porali Basin, in particular, it was noticed that some of the head regulator structures were damaged due to excessive flood waters.

5.4 River Training Works

River training covers various types of structures constructed on a river to guide and confine the flow to the river channel. Also, to control and regulate the river bed configuration for effective and safe movement of floods and river sediment. River training aims at controlling and stabilizing a river along a desired course with a suitable waterway, for one or more of the following purposes:

Flood protection; to provide sufficient cross-sectional area for the safe passage of the maximum flood. It concerns, essentially, proper location, alignment and height of embankment for a given flood discharge, without an attempt at changing the river bed conditions.

Bank protection; to deflect the flow away from the bank to prevent bank erosion. Generally, there is a tendency of meanders either to shift downstream or form cutoffs. The process of bank erosion is therefore constantly active and river training for the protection of banks continues to be a recurring problem.

Confined river channel; to rectify the alignment of the river where abnormal changes have taken place e.g. splitting of river section into various branches, development of sharp bends or meandering and formation of wide and shallow shoals.

Therefore, structures like Stone Studs, groynes, spurs or guide walls help the flow of floods in line with the embankments. In Porali River Basin, some of the flood protection embankments, which came under the direct hit of the flash floods, could have been protected well by providing Studs and Spurs to ensure a sufficient distance to avoid any outflanking during high floods.

5.5 Command Area Appropriations

Command area layouts within BIWRMDP have been appropriated on the basis of topographic surveys, however the secondary data provided by the Client agency does not show the details in terms of spot levels, contours and landforms. It is understood that a sloping plain like Porali basin cannot benefit from a high head reservoir and the minimal hydraulic heads realized from the regulators would be insufficient to extend the irrigation command across a larger trajectory of channels. Under the circumstances, it would be prudent to realize multiple reservoirs exclusive to onward pumpage of irrigation waters to higher gross command areas. Assured water supplies are fundamental to productivity increase and the Project has set minimal limits towards that objective, however given excess flood flows in the river systems it is but natural to extend the floodwater harvest benefits to higher slopes. Extension of command areas would encourage a larger spate of local investments into the system and perhaps a more judicious pattern of cropping that takes water security as the incumbent issue.

5.6 Conclusions

The Balochistan Irrigation Department in general and the Client agency in particular has a clear understanding that the province is deprived of basic facilities and BIWRMD Project will aid towards much needed improvements in both perennial and flood irrigated infrastructure to realize tangible benefits from the potential command areas along river banks. However, there is an ever present feudal influence that carries a strong impact on the policy/decision making for infrastructure adjustments. In such circumstances, there is great responsibility on the district administration ownership of the Project works and the intended benefits whereby the larger populace is made to understand the need for transformation. If engineering solutions are compromised at the altar of personal ambitions then operational worthiness is compromised and, in the present circumstances, require a complete makeover after damaging effects of floods.

Overall opinion of the Client, the PSIAC Consultants and the contractors deployed at sites is that unprecedented rainfall is the principal cause of disturbance and damages and issues of design inadequacy are secondary and not geographically consistent. MMP experts corroborate this opinion however, the emergent need is to revisit the design parameters and avoid critical design slips. Other points of consideration may include:

- There is a need to encourage watershed improvements over spate irrigation.
- A less than proactive emphasis on flood control and more on flood water harvest is required.
- Reliance on extensibility of command areas is a primer for disbursed benefits. This needs to take into account opportunities for pumpage rather than limitations imposed by gravity flows.
- BIWRMDP should consider an independent evaluation of the projected benefits vs recurrent capital and O&M expenses.

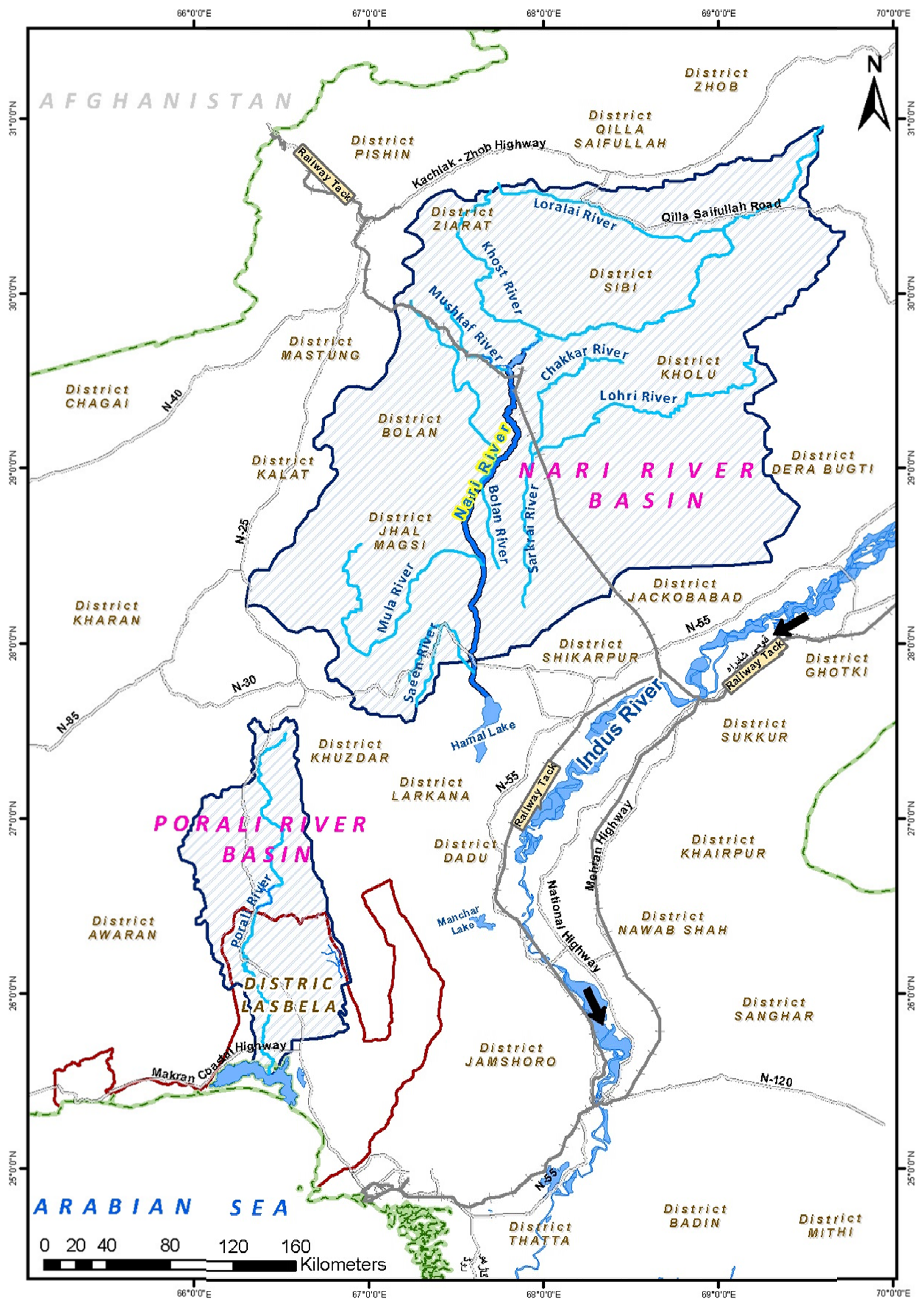


Figure 1 Integrated Map of Nari and Porali River Basins in Balochistan Province.



Figure 2 Irrigation Network in the Nari River Basin, Balochistan Province.

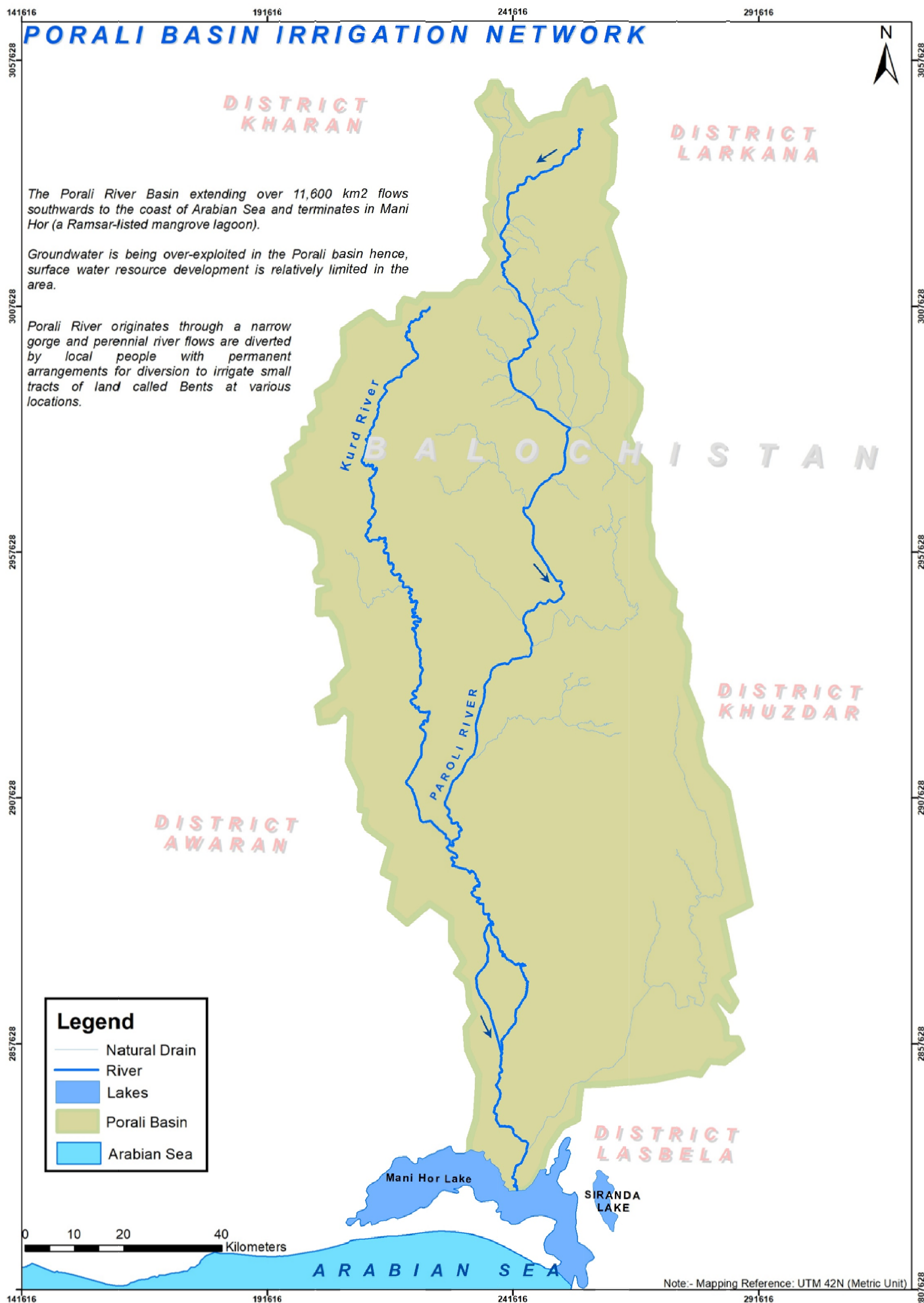


Figure 3 Irrigation Network in the Porali River Basin, Balochistan Province.

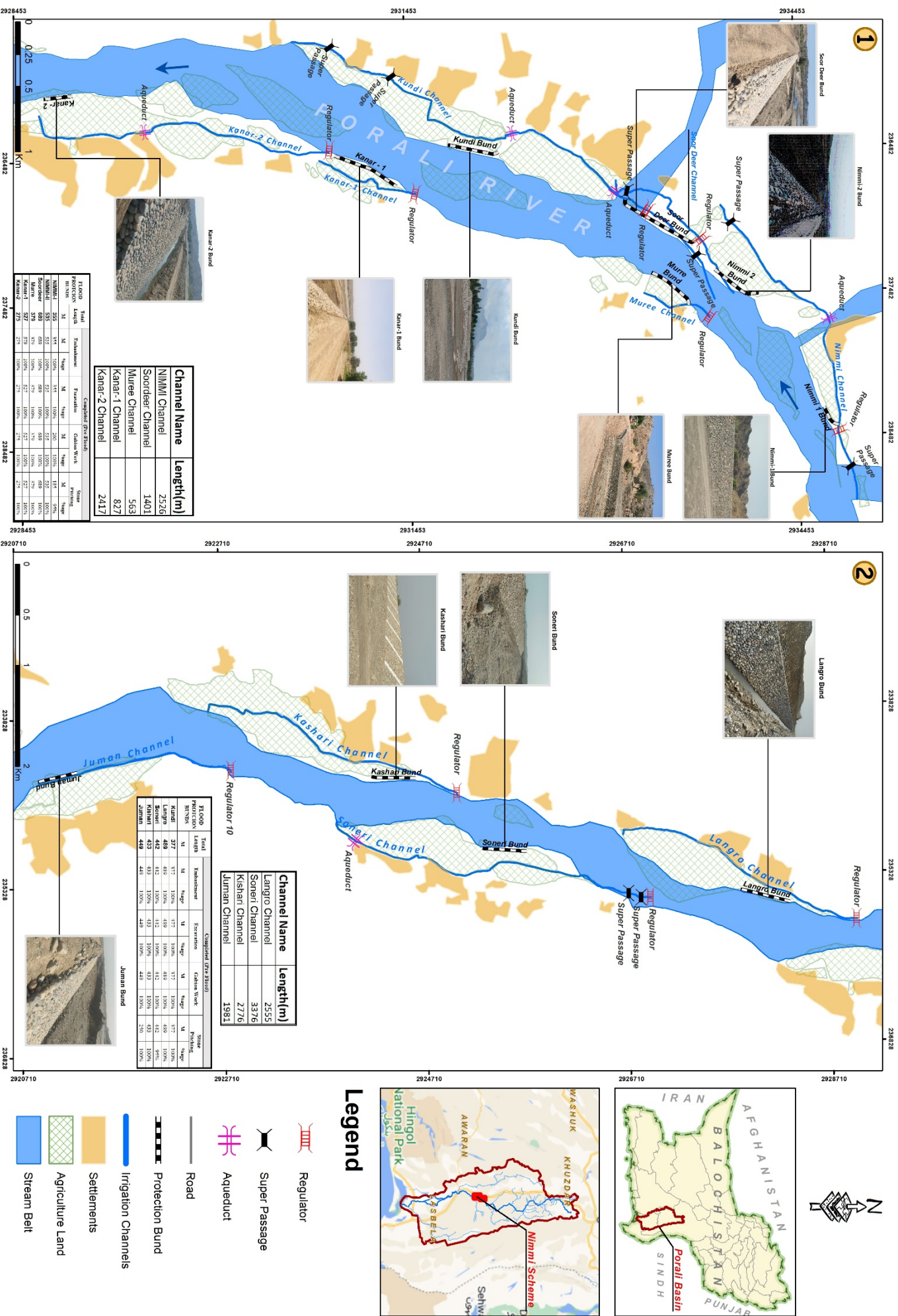
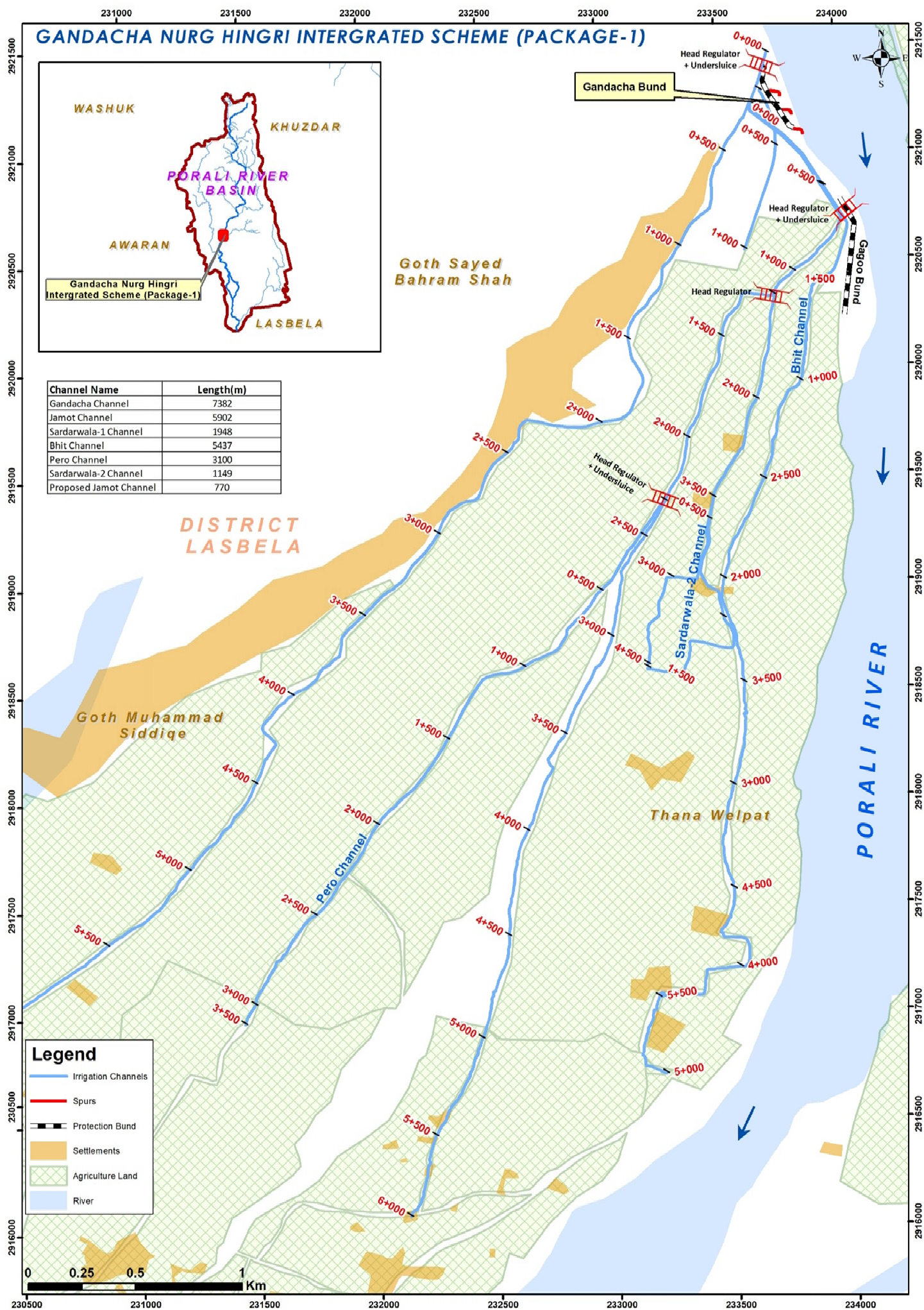


Figure 4 Location of Nimmi Perennial Irrigation Scheme in Porali River Basin, Balochistan Province



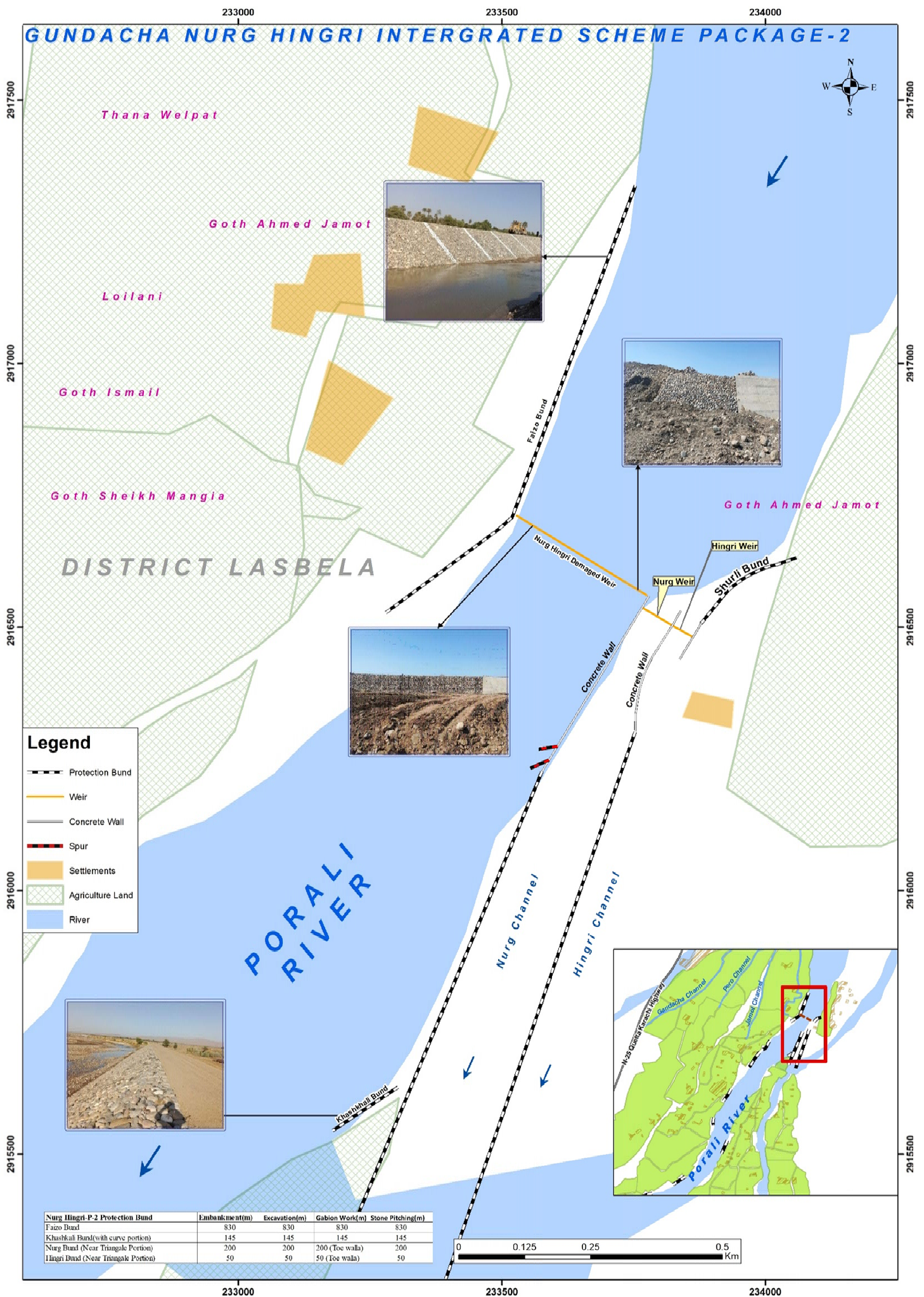


Figure 6 Diversion Weirs in the Gandacha Nurg-Hingri Scheme, Package 2, Porali River Basin

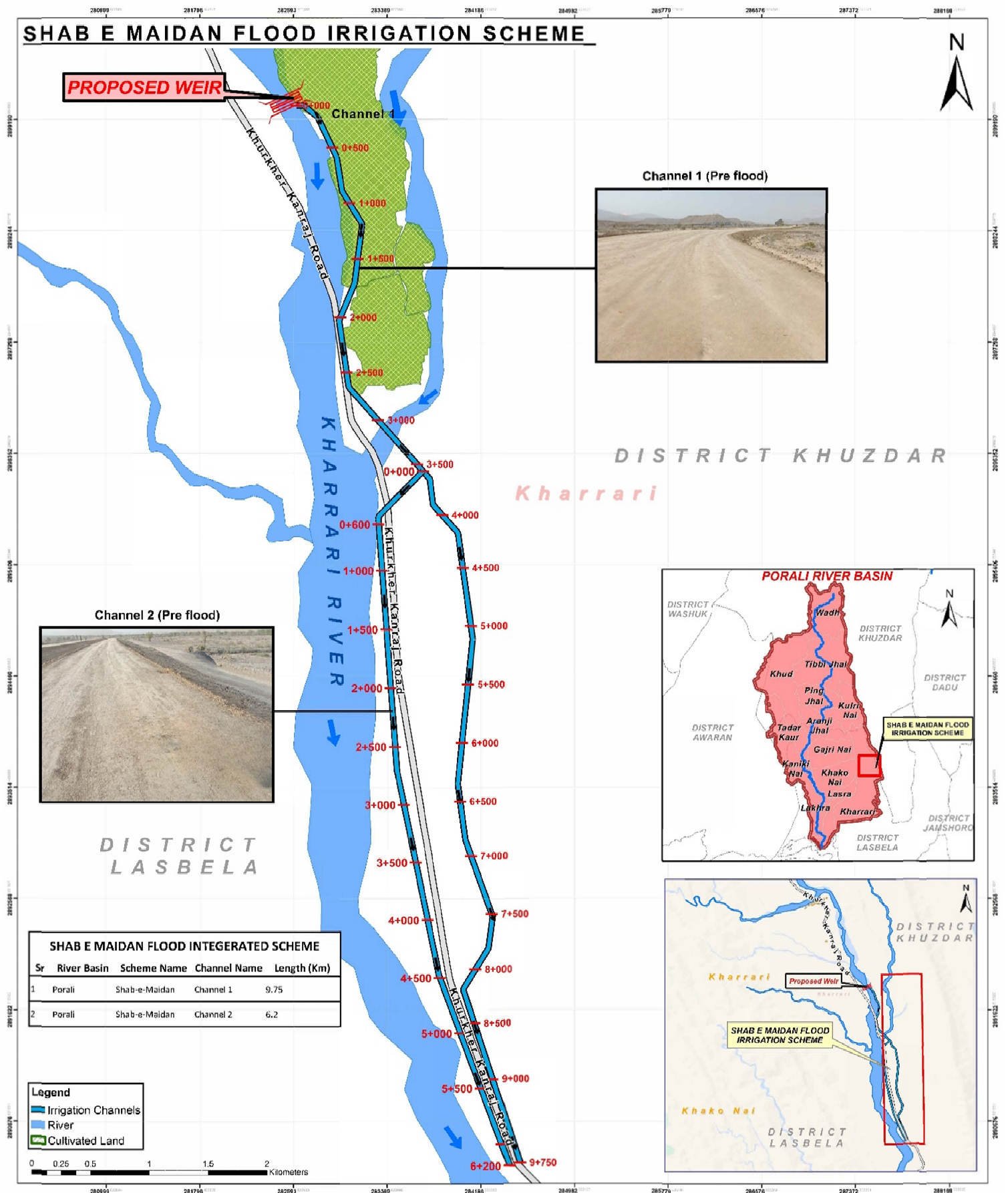


Figure 7 Location of Shab e Maidan Flood Irrigation Scheme in Porali River Basin, Balochistan Province

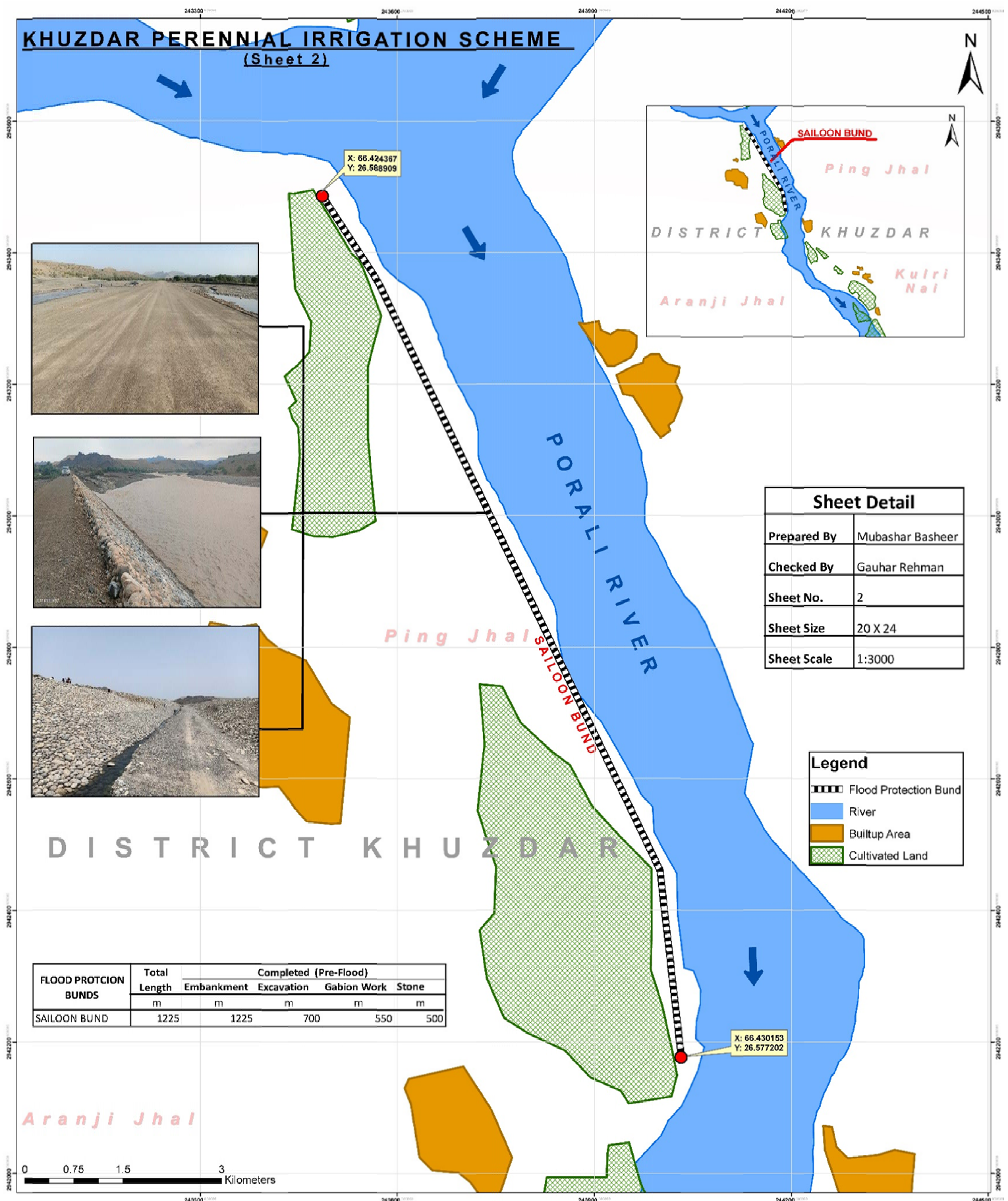


Figure 8 Sample Navigation Map for On-site Damage Assessment in Khuzdar, Porali River Basin, Balochistan Province

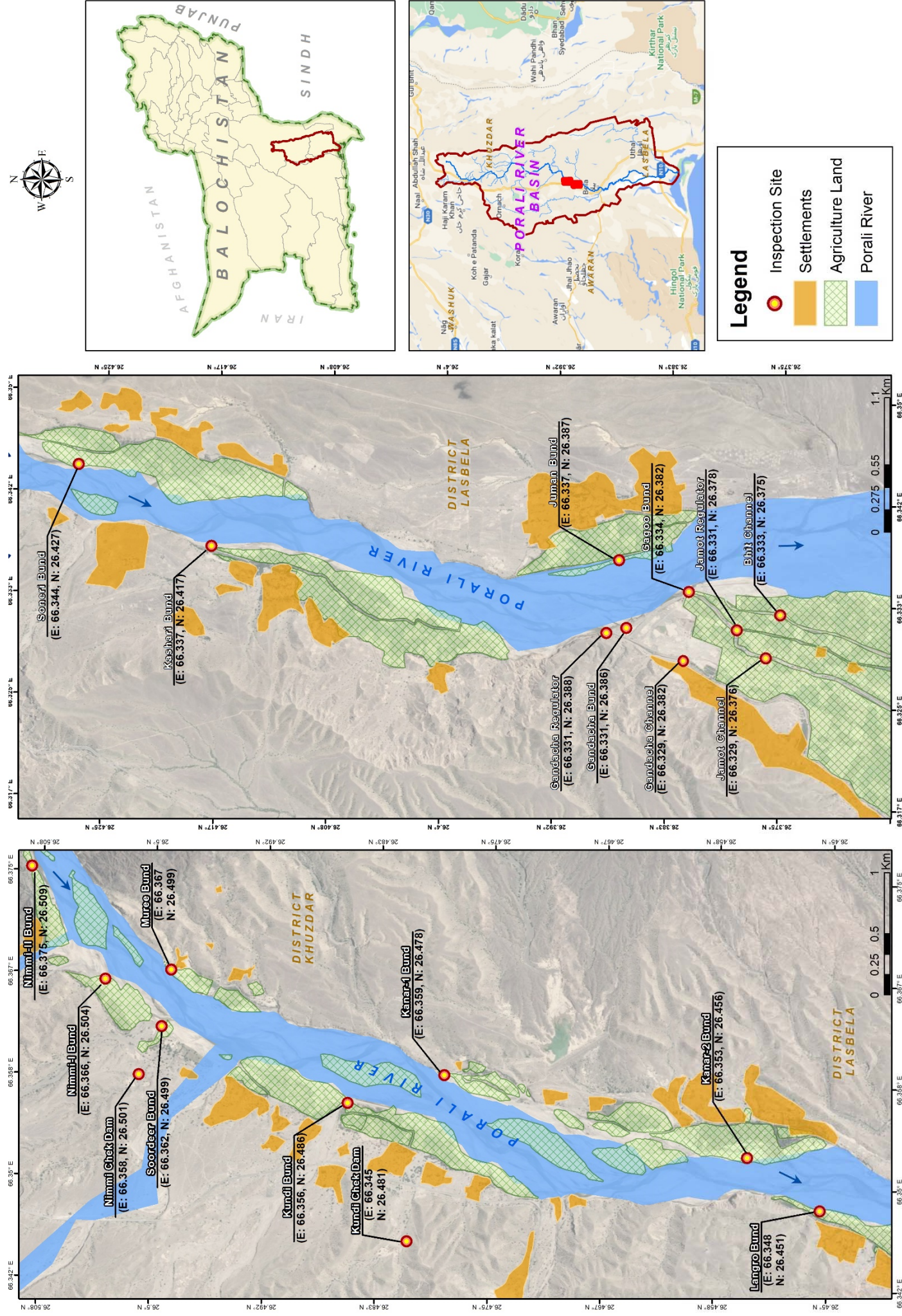


Figure 9 Location of Inspection Sites by Consultants Staff in the northern part of Porali River Basin, Balochistan Province.

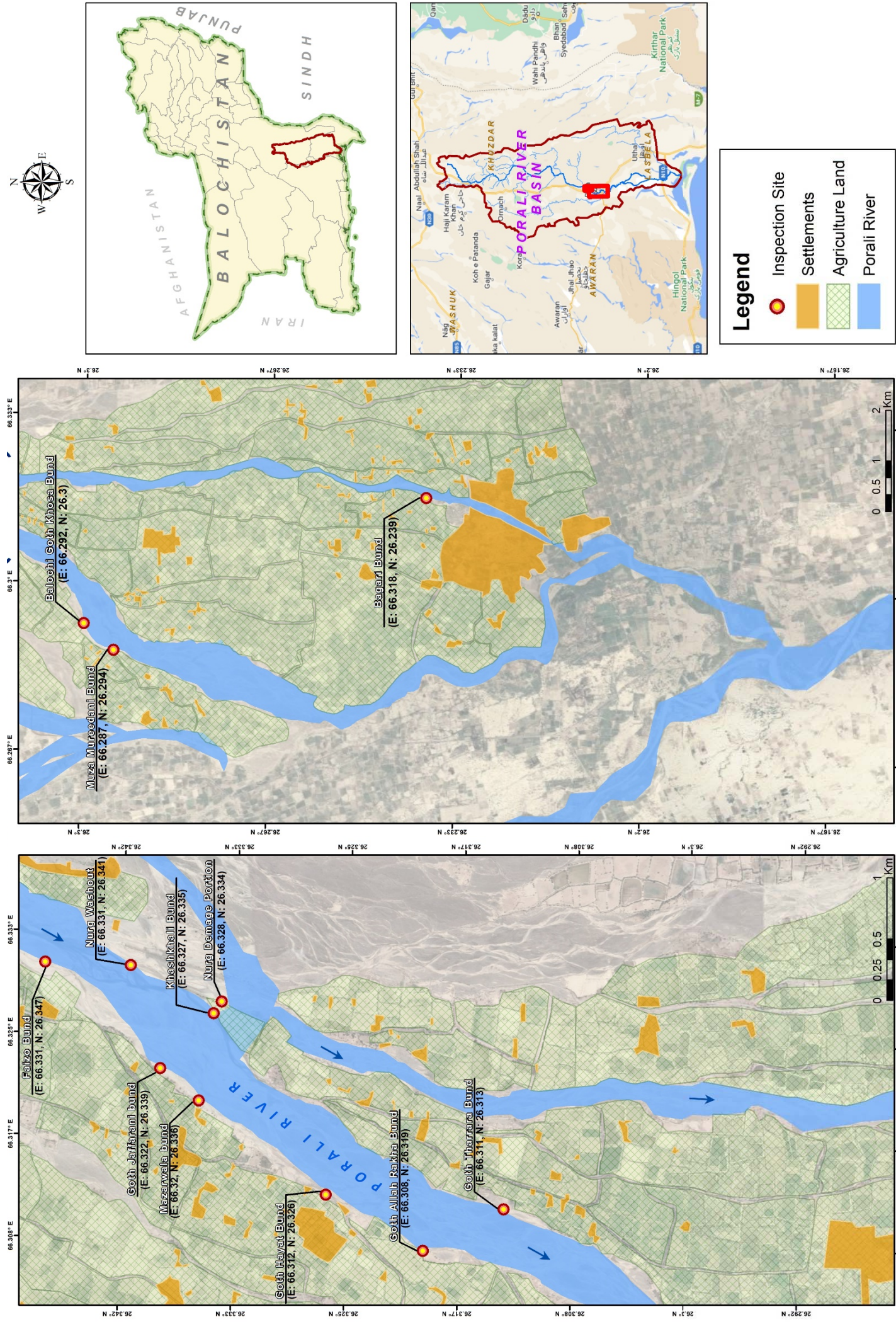


Figure 10 Location of Inspection Sites by Consultants Staff in the southern part of Porali River Basin, Balochistan Province.

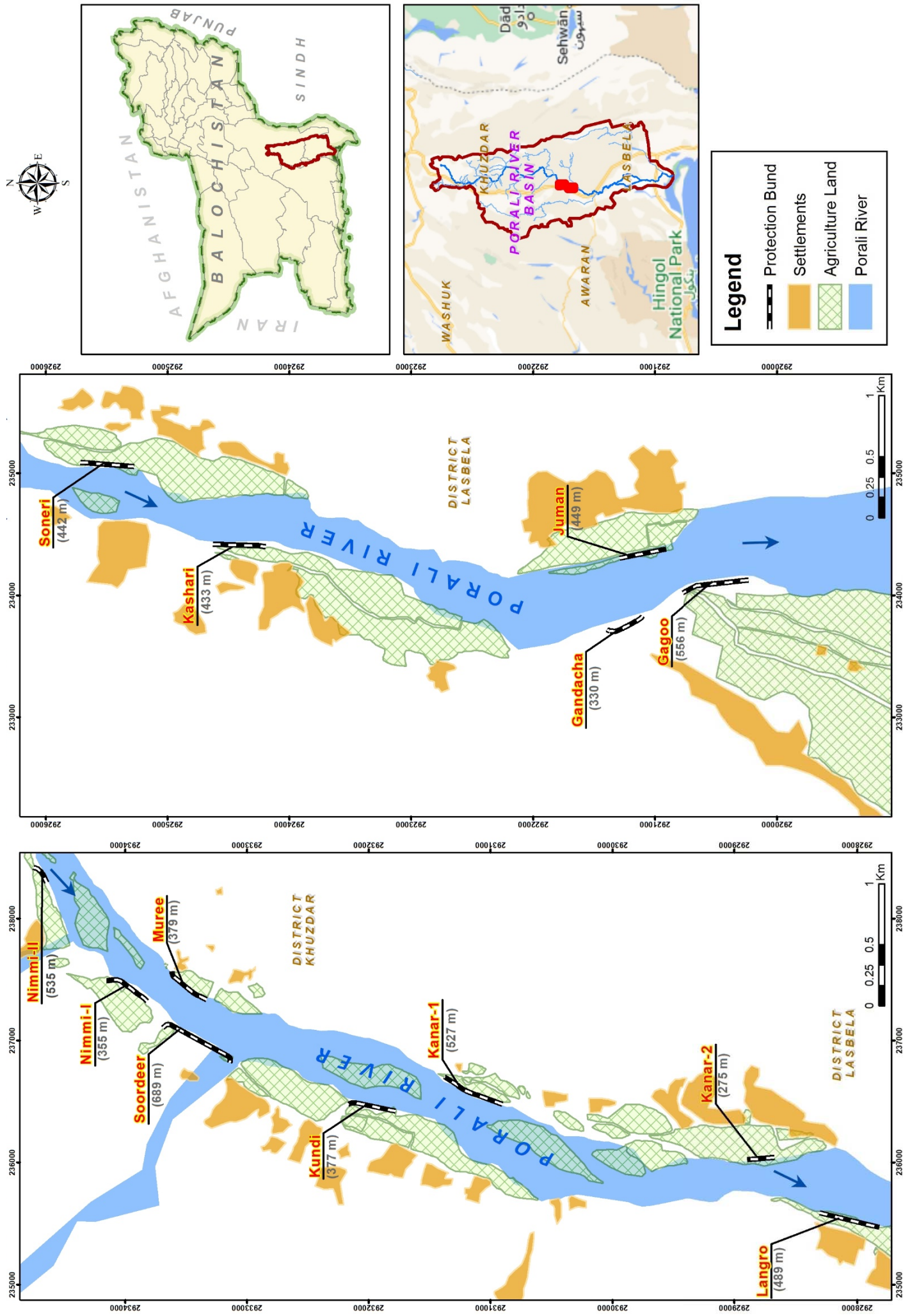


Figure 11 Protection Bunds in northern part of Porali River Basin, Balochistan Province.

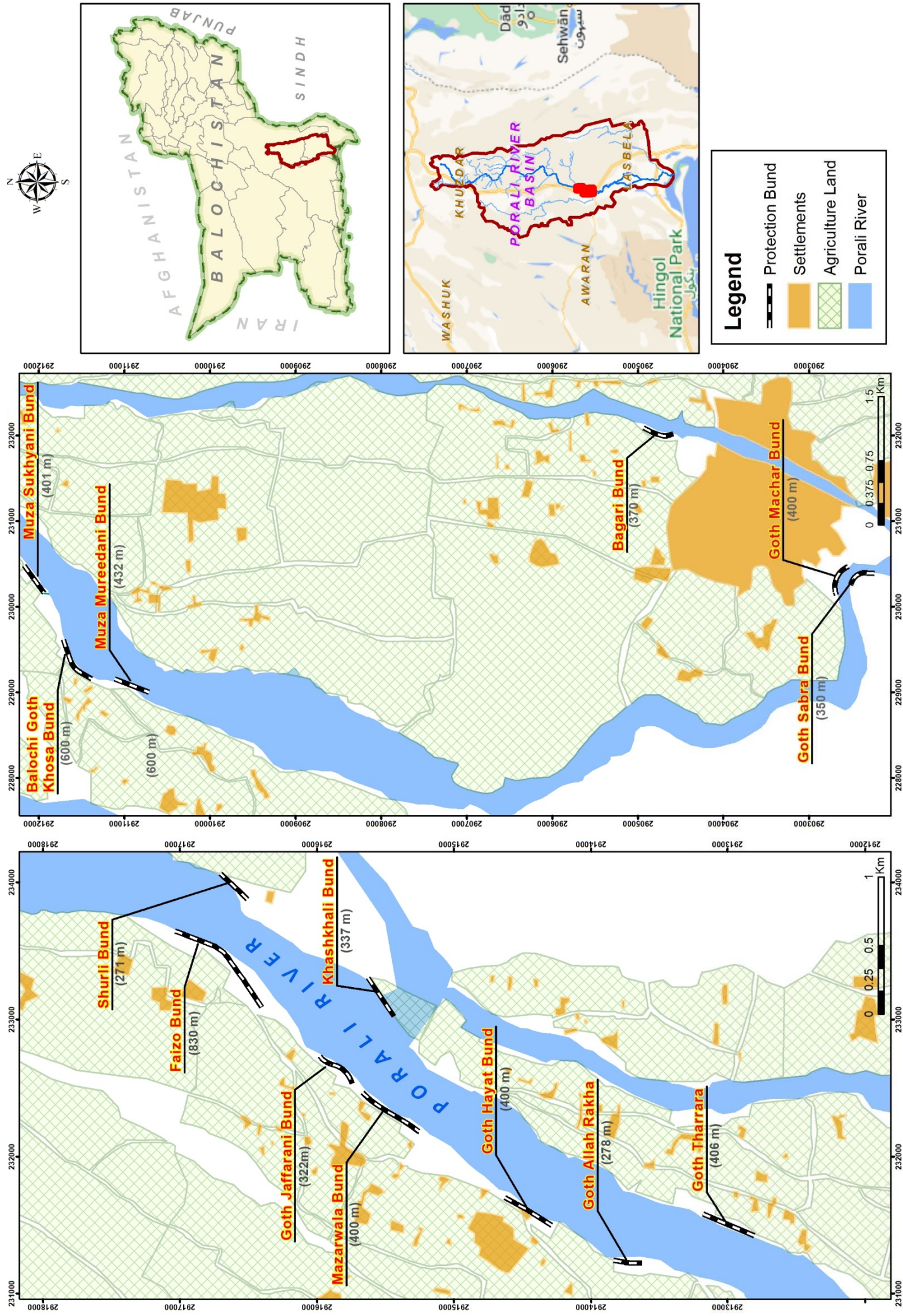


Figure 12 Protection Bunds in southern part of Porali River Basin, Balochistan Province.

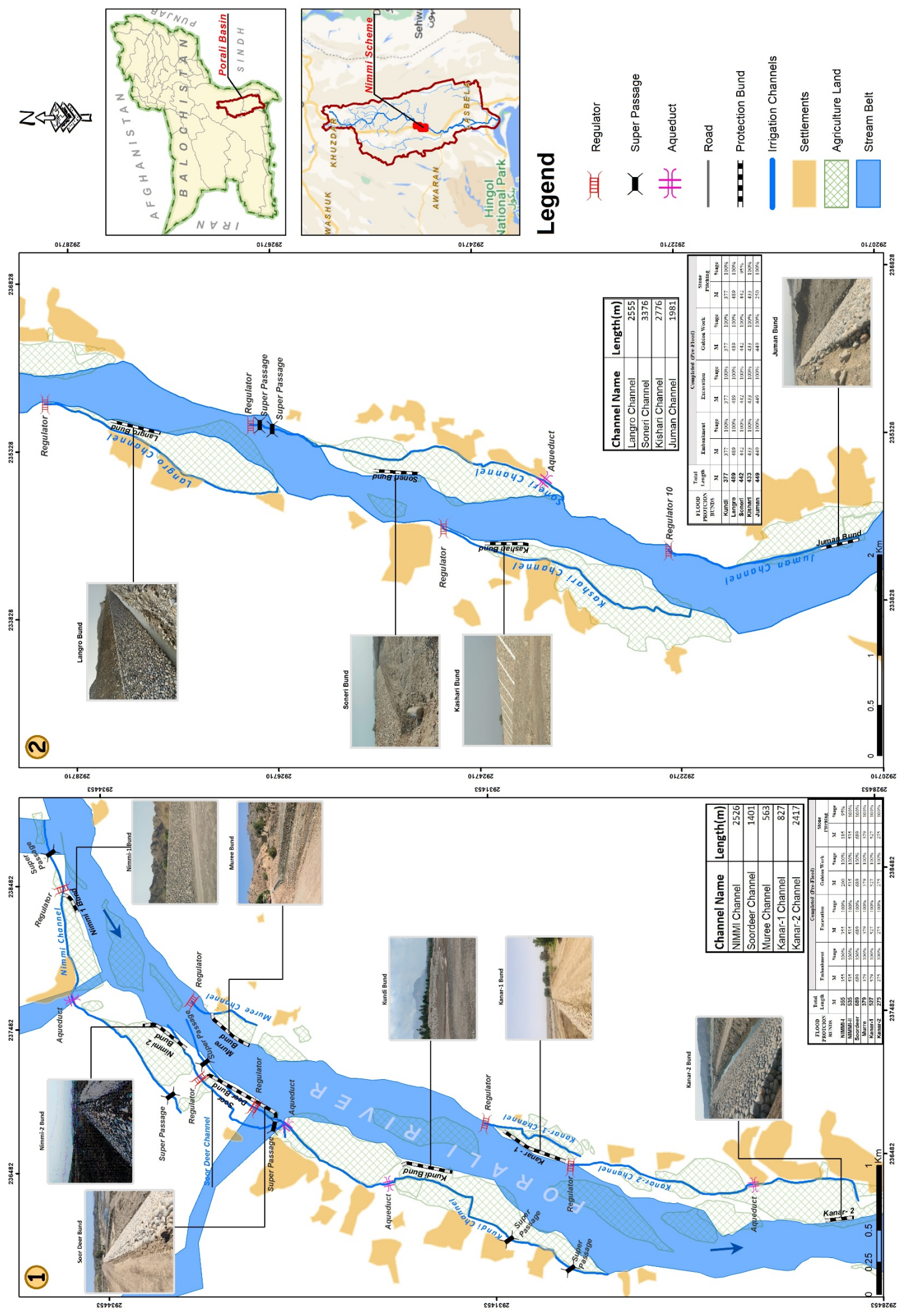


Figure 13 Nimmi Perennial Irrigation Scheme in Porali River Basin, Balochistan Province.

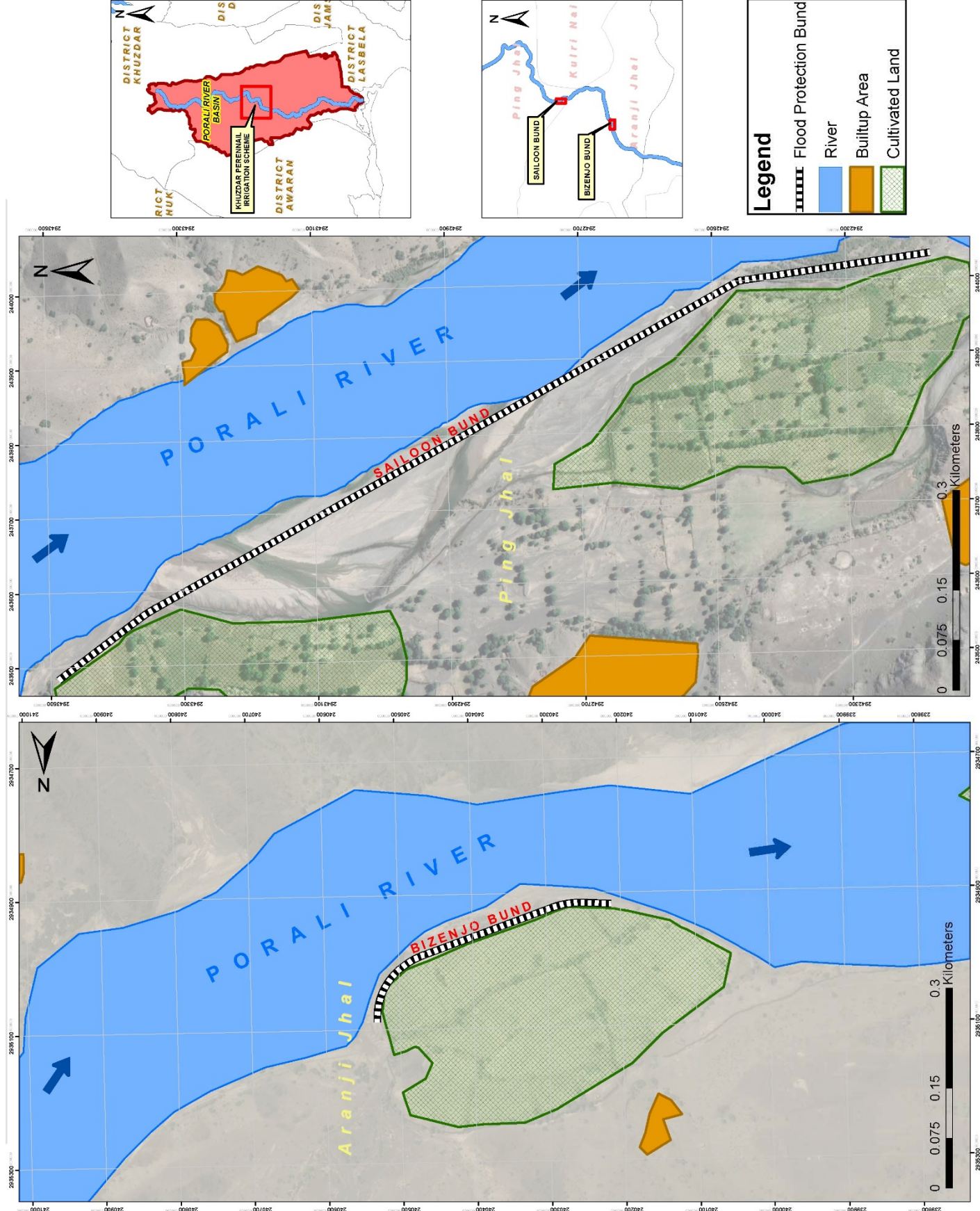


Figure 14 Location of Khuzdar Perennial Irrigation Scheme in Porali River Basin, Balochistan Province

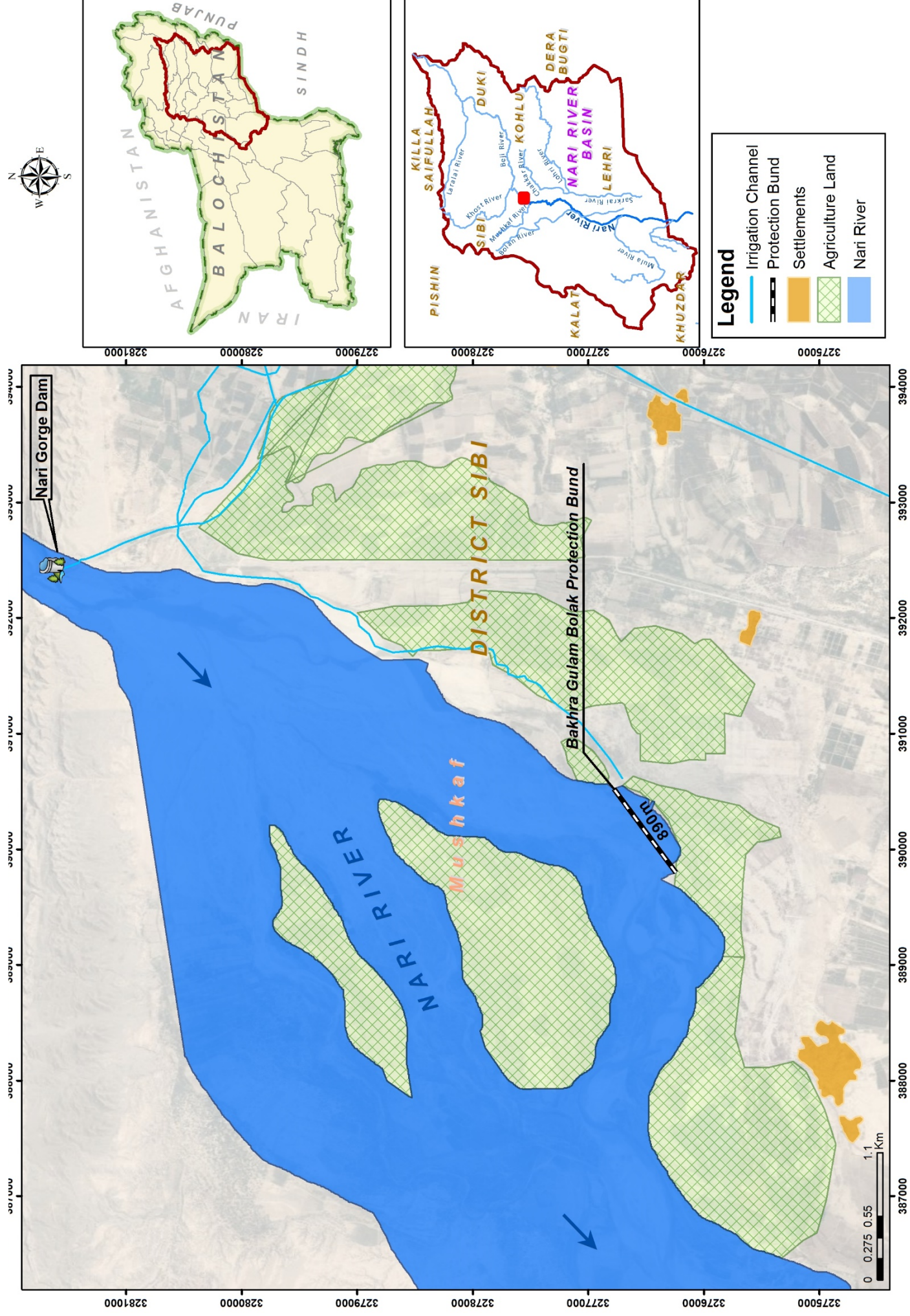


Figure 15 Location of Bakhra Ghulam Bolak Bund in Nari River Basin, Balochistan Province.

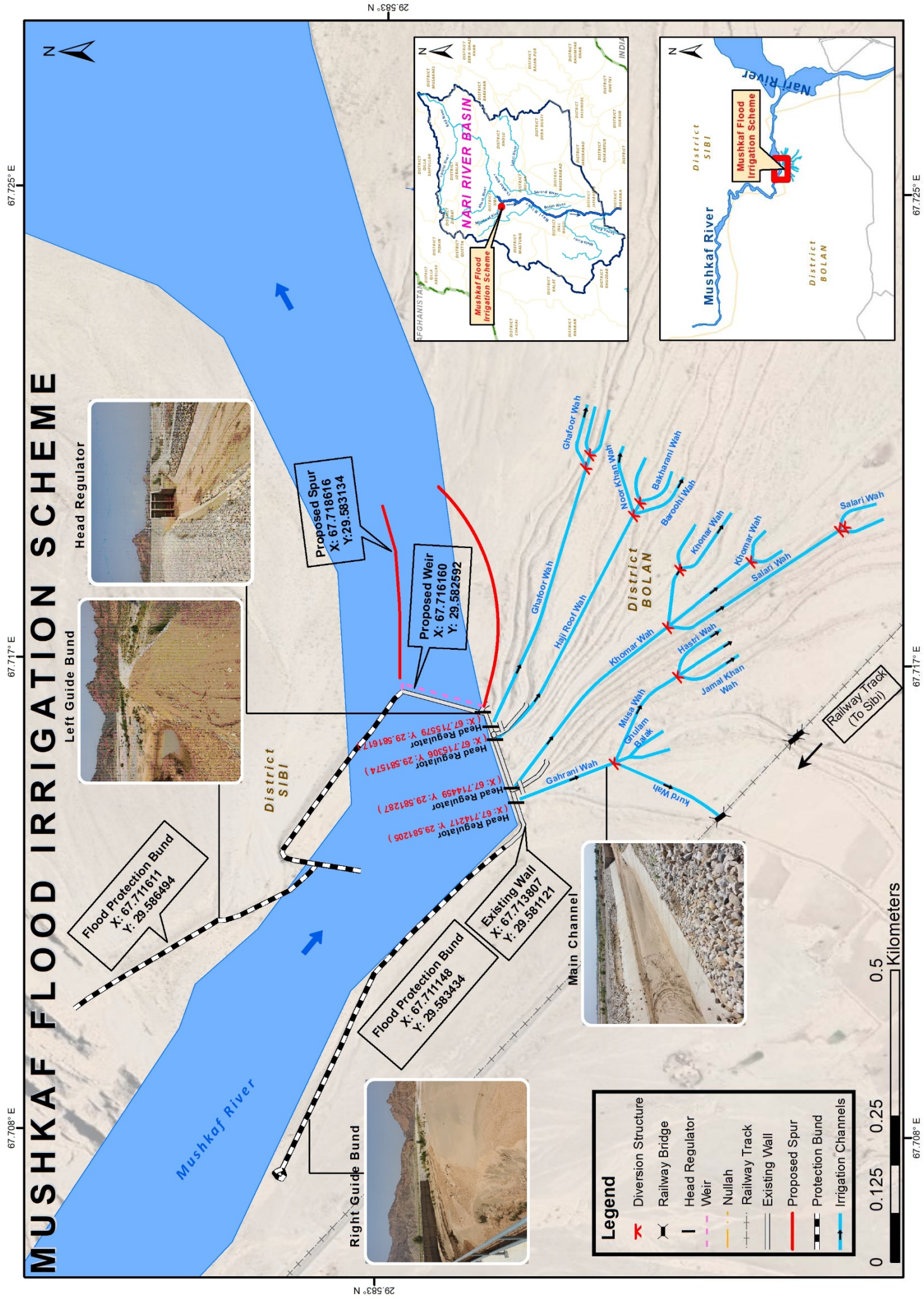


Figure 16 Location of Mushkaf Flood Irrigation Scheme in Nari River Basin, Balochistan Province

APPENDICES

List of Appendices

Appendix A	Flood Damage Assessment of BIWRMDP Works in Nari and Porali River Basins - Summary
Appendix B	Summary Status of Progress on BIWRMDP Works in Nari and Porali River Basins
Appendix C	Maps of Protection Bunds



Appendix A

Flood Damage Assessment of BIWRMDP Works in Nari and Porali River Basins - Summary



Appendix A

Flood Damage Assessment of BIWRMDP Works in Nari and Porali River Basins - Summary

Estimation of Flood Damages Before Flood Event of 19 Aug 2022.					
Protection Bunds					
Porali River Basin					
Sr.No	Name of Scheme	Total Length (m)	Damage Length (m)	Damage Description	Remarks
1	Nimmi-1 Bund	355	195	Embankment Partially Damage	Embankment (180m) damage, Excavation 150m,
2	Nimmi-2 Bund	535	535	425m Fully washout	Wash out, Excavation 535m,
3	Muree Bund	379	70	Intact	Embankment and stone pitching fully damage
4	Sordeer Bund	775	675	Stone Pitching Settlement along Wing Wall	Wash out, Gabion wall (23m) washout, Excavation 675m,
5	Kundi Bund	404	25	Intact	
6	Kanar-1 Bund	527	327	Partially Damaged in length of 5m	Embankment and stone pitching fully (400m) damage, Excavation 327m,
7	Kanar-2 Bund	275	225	Intact	Embankment and stone pitching fully (150m) damage, Excavation 225m, Excavation 389m,
8	Langro Bund	490	400	Partial Damage	Embankment (400m) Gabion (350m) Stone Pitching (400m) damage
9	Soneri Bund	442	442	Damage Length	Wash out, Excavation 442m,
10	Kashari Bund	433	433	Fully Washout	Embankment and stone pitching fully (70m) damage, Excavation 433m,
11	Jumman Bund	449	284	Partial Damage	Embankment (300m) Gabion (80m) damage, Excavation 284m,
1	Goth Hayat Wala	400	400	Washout	Washout (Embankment 400m and Gabion 250m), Stone Pitching nill, Excavation 250m,
2	Mazhar Wala	400	400	Washout	Washout (Embankment 400m and Gabion 100m), stone Pitching nill, Excavation 200m
3	Goth Jafrani	513	513	Washout	Embackment and stone pitching 400m damaged, stone pitching 250m, Excavation 450m,
4	Goth Allah Rakha	278	278	Washout	Embackment and stone pitching 250m Washout, Excavation 278m,
5	Tharara Bund-1	170	170	Washout	Embackment and stone gabion Washout, stone Pitching nill, Excavation 170m,
6	Tharara Bund-2	130			Embackment and stone gabion damaged, Excavation 130m,
7	Muza Mureedani	432	432	Washout	Embackment and stone gabion Washout, stone Pitching nill, Excavation 432m,
8	Balochi Goth Khosa	600	400	Damage	Embankment damaged, 200m washout, Gabion nill, Stone Pitching nill,
9	Baghari Bund	350	250	Partially Damage	Embankment damaged 200m, Gabion nill, Pitching nill,
Gandacha Nurg Hingri Irrigation Scheme- Package 02					
1	Gandacha Bund	500	100	Damaged	
2	Faizu Bund	830	830	Damaged and Washed Out	Embankment and Stone pitching 550m Wash out and 280m damaged
3	Khaskheli Bund	115	115	Damaged	Embankment and Gabion 50m damaged
4	Nurg Damaged Portion	200	50	Damaged	Embankment and stone pitching 50m damaged
5	Hingri Triangle Portion	50	50	Damaged	Embankment and stone pitching 50m damaged
6	Shurli Bund	250	250	Washed Out	
Gandacha Nurg Hingri Irrigation Scheme Package 01					
1	Package 02			Structures are safe Scour U/S & D/S super passages occurred	
Gandacha Nurg Hingri Irrigation Scheme Package 03					
1	Package 03			Approx 75m breach in earthen bund between STR 1 & 2 due to heavy rains and floods. Structures are safe	
Khuzdar Flood Protection Scheme					
1	Sailoon Bund	1225	1075	Washed Out	Washed Out
2	Bizenjo Bund	447	420	Damaged	Damaged

Estimation of Flood Damages Before Flood Event of 19 Aug 2022.					
Irrigation Structures					
Sr.No	Name of Scheme	Total Length (m)	Damage Length (m)	Damage Description	Remarks
1. Nimmi Irrigation Scheme					
1	Kundi Head Regulator	100%		Damaged	D/Stream walls Damaged, Head Regulator,
2	Sordeer Head Regulator	100%		Damaged	Damaged, Box Culvert, Head Regulator,
3	NIMMI-1	100%		Damaged	Head Regulator,
4	Kishari & NIMMI-2 Pipe Culverts	100%		Washout	Washout, Pipe Culvert
5	Kanar-2	100%			Box Culvert,
2. Gandacha Nurg Hingri Irrigation Scheme- Package 01					
1	Bhit Low Head Weir	85		Cut off Wall Damaged	Cut off Wall Damaged
2	Bhit Head Regulator			Wing Wall and Slab Damaged	Left side wing wall and upstream bed damaged
3	Jamoot Head Regulator			Cutoff Damaged	Upstream left side cutoff wall damaged

Estimation of Flood Damages Before Flood Event of 19 Aug 2022.					
Channels					
Sr.No	Name of Channel	Total Length (m)	Damage Length (m)	Damage Description	Remarks
1. Gandacha Nurg Hingri Irrigation Scheme- Package 01					
1	Gandacha Channel	7,325	650	Damaged	Stone Pitching 650m and Bed Bar 06 no damaged
2	Bhitt Channel	5,425	350	Damaged	Embankment 350m damaged
3	Jamoot Channel	5,900	2500	Damaged	Embankment 2500m damaged
2. Borry Channel					
1	Borry Channel				No Damage
3. Arrand Channel					
1	Arrand Channel			Approx 75m beach in earthen bund D/S arrand channel between STR 1 & 2 occurred due to heavy rains and floods the structures are safe	

Appendix B

**Summary Status of Progress on BIWRMDP
Works in Nari and Porali River Basins**



Appendix B

Summary Status of Progress on BIWRMDP Works in Nari and Porali River Basins

No	Development Scheme	Component Works	Actual Progress	State of Completion
1	Mushkaf Flood Irrigation Scheme	Weir Raised by 1 m U/S LHS and RHS Guide Bunds Extended and raised Head Regulators Constructed HR Mushkaf 1 HR Mushkaf 2 HR Lundi 1 HR Lundi 2 Channel Lining of Main Channels Division Structures – 8 Nos. Earthen Channels extended.	100%	Completed / defect rectification work is in progress
2	Nari Gorge Irrigation Scheme-Package -1	Bakhra Ghulam Bolak Channel and Branches Concrete Lining Luni channels and branches – Concrete Lining Dephal channels and branches – Concrete Lining Marghazani channel and Branches – Concrete Lining Kurruk channel - Concrete Lining Hydraulic structures	70%	Survey work, concrete work & E/W in progress.
3	Nari Gorge Irrigation Scheme-Package -2	Irrigation Channels of Khajjak and Branches.	96%	Survey work, concrete work & E/W in progress.
4	Nari Gorge Irrigation Scheme-Package -3	Arrand and Bori Channels Diversion Structures - 4 No	81%	Survey work, concrete work & E/W in progress.
5	Nimmi Perennial Irrigation Scheme	Consists of 10 No of Sub schemes with Flood Protection Bunds 1. Nimmi Scheme 2. Kundi Scheme 3. Soordeer Scheme 4. Langro Scheme 5. Kishari Scheme 6. Muree Scheme 7. Kanar 1 Scheme 8. Kanar 2 Scheme 9. Soneri Scheme 10. Jumman Scheme	85%	Works on protection bunds, intake structure and aqueduct in progress.

No	Development Scheme	Component Works	Actual Progress	State of Completion
6	Gandacha-Nurg-Hingri Irrigation System Package-1	Consist of 3 Main Channels and Head Regulators 1. Gandacha HR and Channel 2. Bhit HR and Channel 3. Jamoot HR and Channels 4. Hydraulic Structures on Channels	38%	Works on protection bunds, head regulator, channels and fall structures in progress
7	Gandacha-Nurg-Hingri Irrigation System Package-2	Rehabilitation and Reconstruction of Nurg Weir Hingri Weir and Main Weir Rehabilitation of Nurg Guide Bund Rehabilitation of Hingri Guide Bund Construction of Nurg Guide Wall Construction of Hingri Guide Wall Rehabilitation of the damages of Faizo Bund on Irrigation Department request	95%	Works on weir, Faizo & Khushdil protection bunds, Intake structures in progress.
8	Sheb e Maidan Irrigation Scheme Package -1	Construction of Shab-e-Maidan Main Weir, Undersluice and Head Regulators - Lining of Perennial Canal - Construction of Flood Canal Hydraulic Structures like aqueducts, fall structures and division structures	22%	Work on main weir, main channel and fall structures in progress.
9	Sheb e Maidan Irrigation Scheme Package -2	Construction of Flood Canals (Channel 1 and Channel 2) Construction of Distributaries Construction of Hydraulic Structures including Division Structures, Fall Structures etc.	44%	Work on channel 1& 2 and fall structures in progress
10	Khuzdar Perennial Irrigation Scheme (Lot-1)	Works at Hinami, Sat Bhai and Khazani Bent	15%	Contractor is mobilizing
11	Khuzdar Perennial Irrigation Scheme (Lot-2)	Works at Naik Muhammad and Bezinjo Bent	27%	Works for Bezanjo bent in progress.
12	Khuzdar Perennial Irrigation Scheme (Lot-3)	Works at Budri, Pury and Hassan Bent	15%	Contractor is mobilizing
13	Khuzdar Perennial Irrigation Scheme (Lot-4)	Works at Sailoon and Pepri Bent	20%	Works for Saloon bent in progress.
14	Flood Protection Works at Nari River	Raising of Tariqabad Flood Protection Bund near Jhal Magsi (12 kms)	15.5%	30% construction dwgs are complete. Jungle clearance and E/W in progress

No	Development Scheme	Component Works	Actual Progress	State of Completion
15	Flood Protection Works at Porali River	<p>Consists of construction of following Protection Works</p> <ol style="list-style-type: none"> 1. Allah Rakha Bund 2. Hayat Walla Bund 3. Jaffarani Bund 4. Mazarwala Bund 5. Mureedani Bund 6. Balochi Goth Khosa 7. Bhagari Bund 8. Tharrara Bund 	50%	70% construction drawings are complete. Out of total 10 protection bunds, the Contractor has started embankment works on 8 bunds. There are material availability issues regarding construction of 2 No. FPB.
16	Works for Construction of Check Dams in Porali River Basin (Package 2)	<p>Construction of 30 check dams in Wadh, Nimmi Area, Shab-e-Maidan</p> <p>Balo, Phir Pakwi, Mucchia, Chukali, Soro-I, Sooro-2, Yulia, Way Jo Jar, Badi, Nimmi, Sanjro, Khundi, Kishari, Soordeer-1, Jaar, Gabalo, Surmai, Ali, Muhammad Sanjrani, Kili Ibrahim, Chari, Boskandi, Khar, Umar Goth</p>	22%	Work on 8 check dams (in RED) out of 28 in progress.
17	Construction of Check Dams for Nari Basin	Construction of 30 check dams in Mekhtar, Sibi, Mushkaf, Ziarat	17%	Drawings have been issued. Work on Mushkaf area not yet started due to security issues.

Appendix C

Maps of Protection Bunds



Extended Area Plans of Flood Protection Bunds on Main Porali River

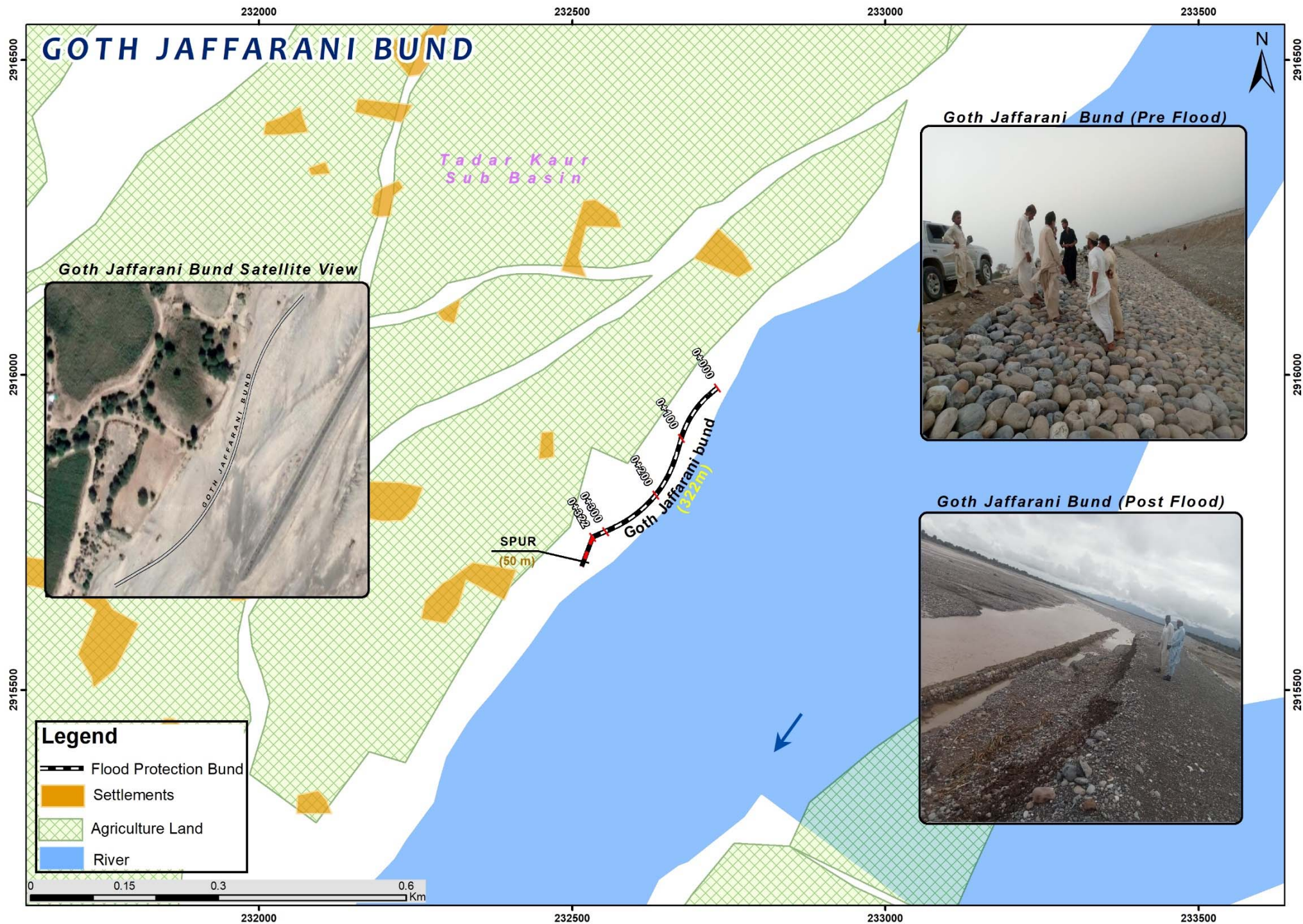


Figure C1 Goth Jaffarani Flood Protection Bund in Porali River Basin, Balochistan Province.

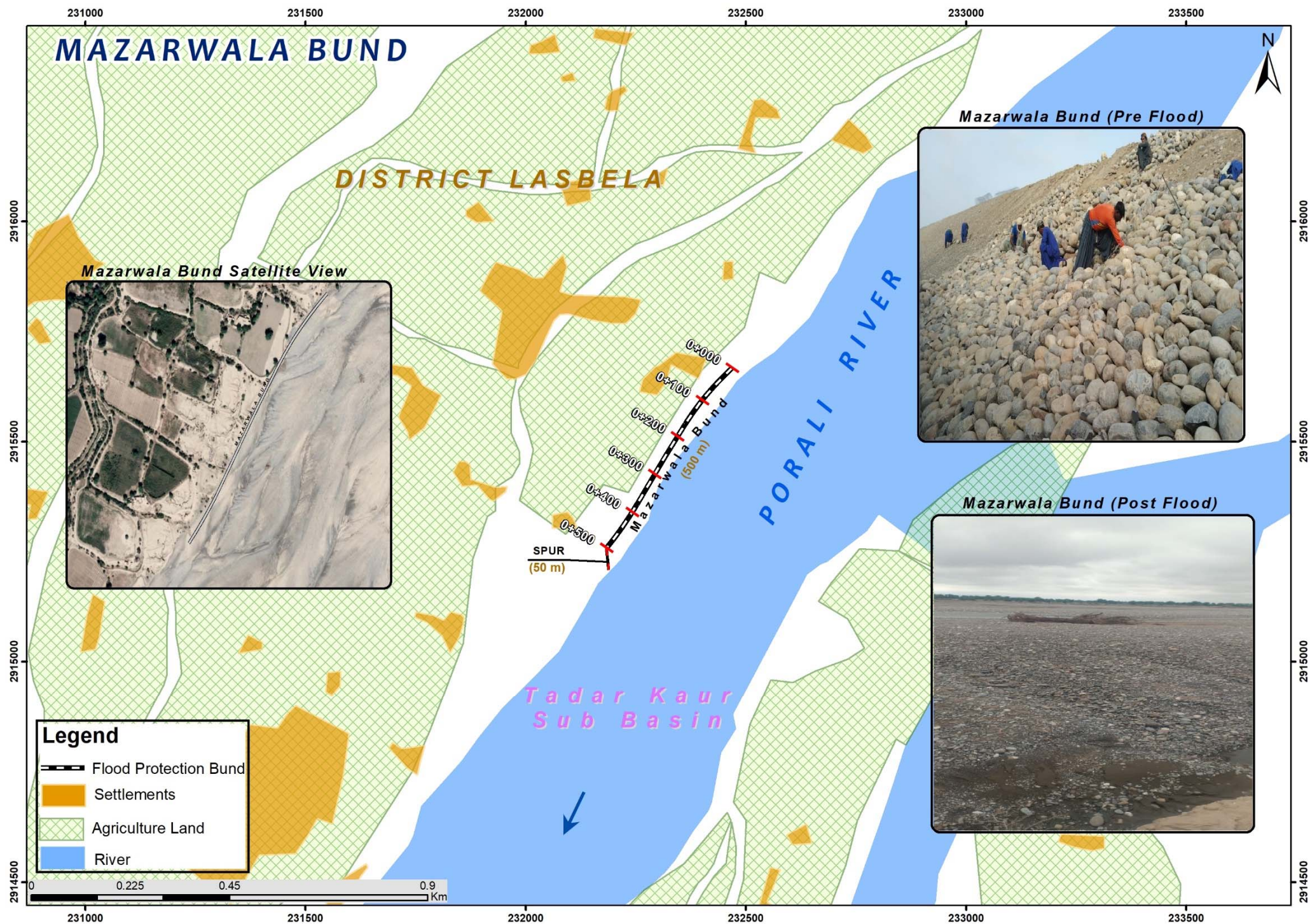


Figure C2 Mazarwala Flood Protection Bund in Porali River Basin, Balochistan Province.

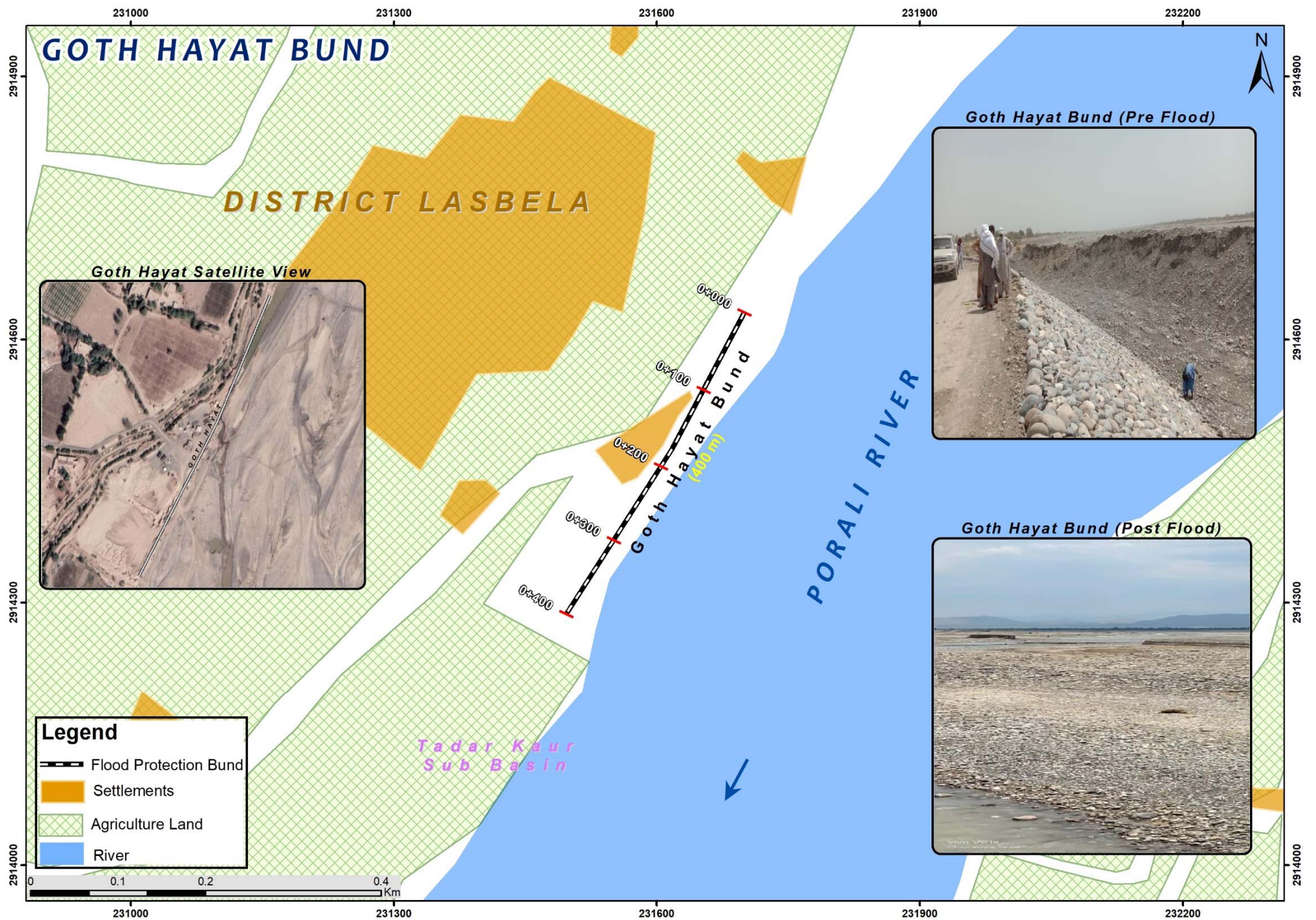


Figure C3 Goth Hayat Flood Protection Bund in Porali River Basin, Balochistan Province.

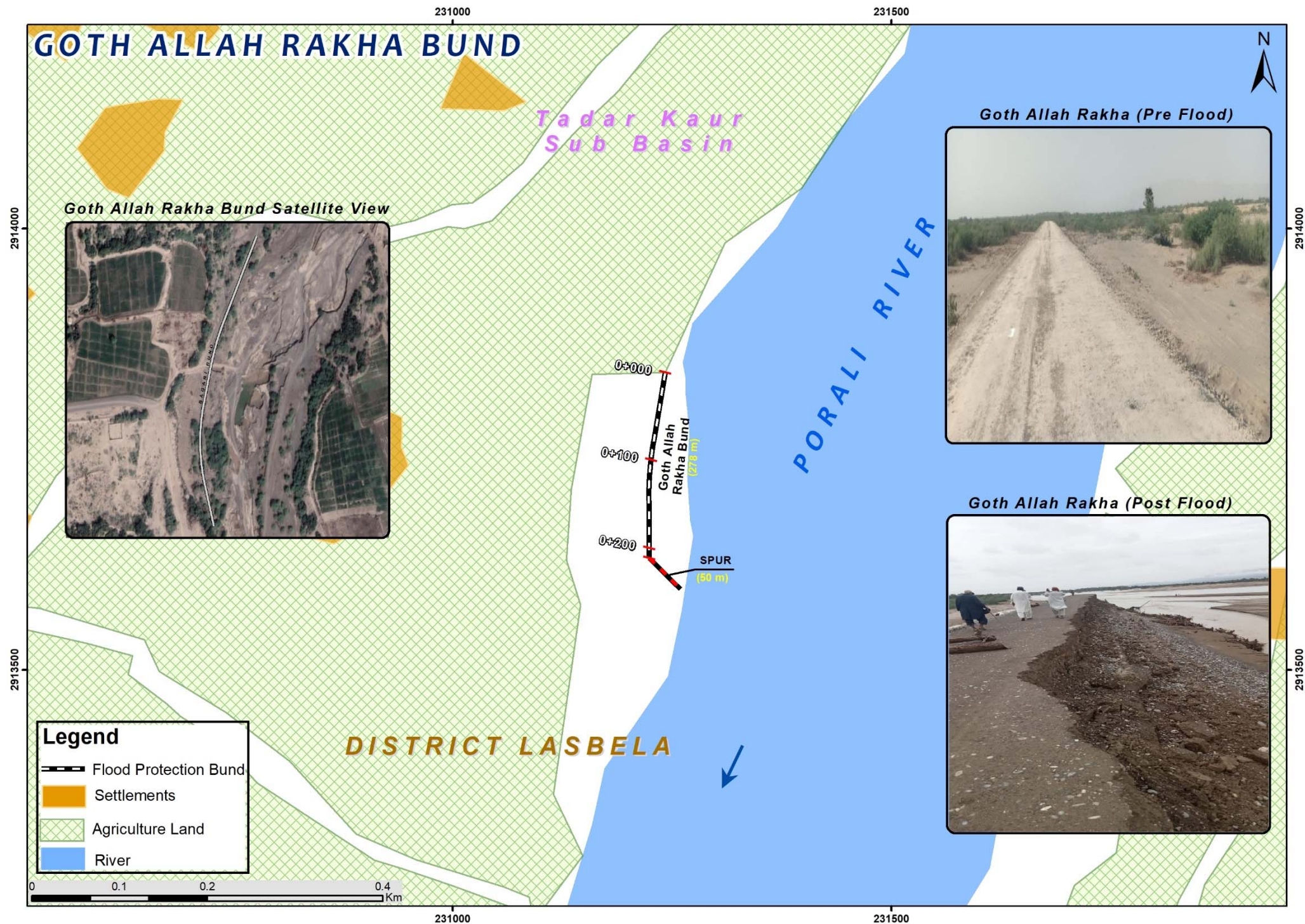


Figure C4 Goth Allah Rakha Protection Bund in Porali River Basin, Balochistan Province.

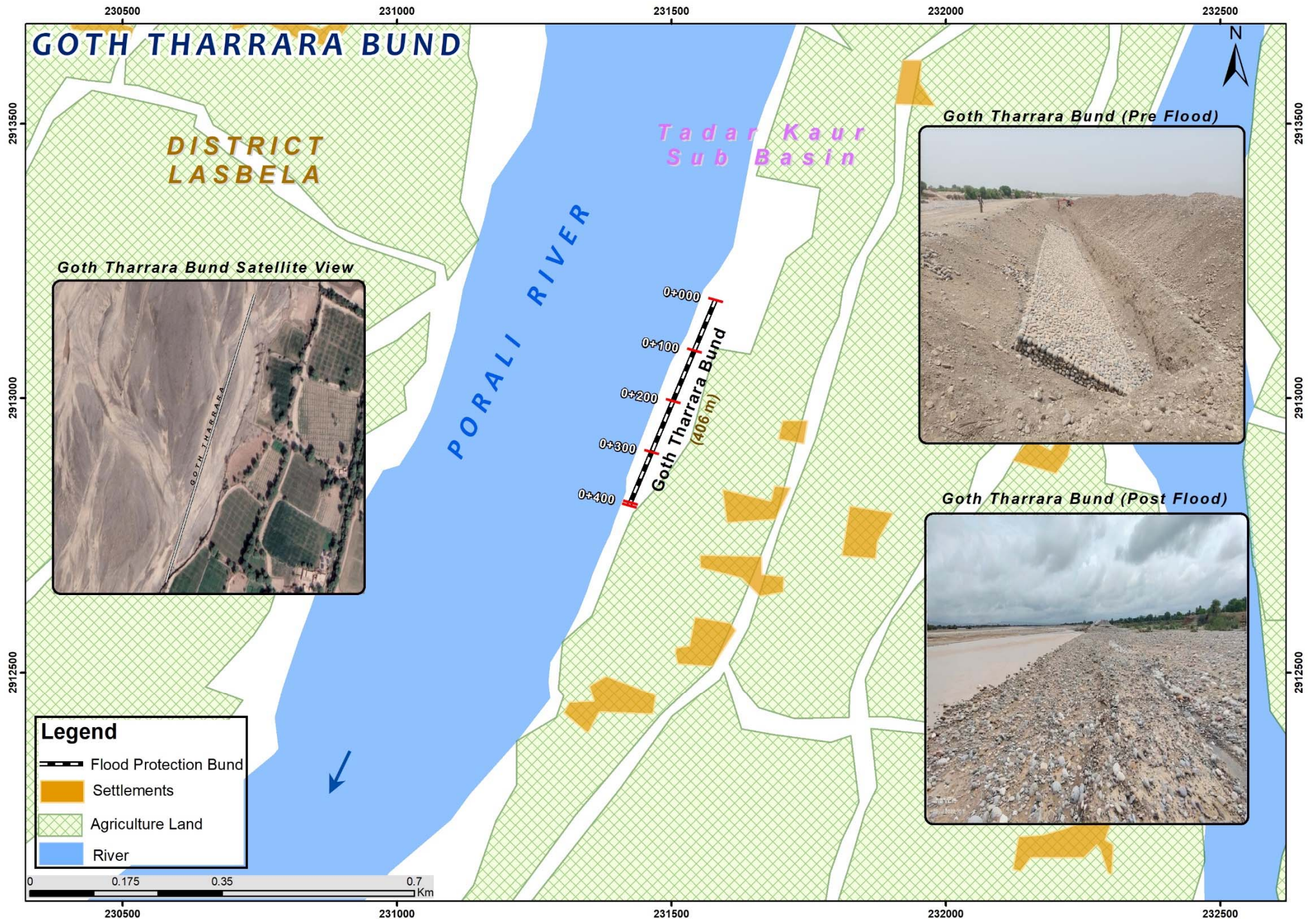


Figure C5 Goth Tharrara Flood Protection Bund in Porali River Basin, Balochistan Province.

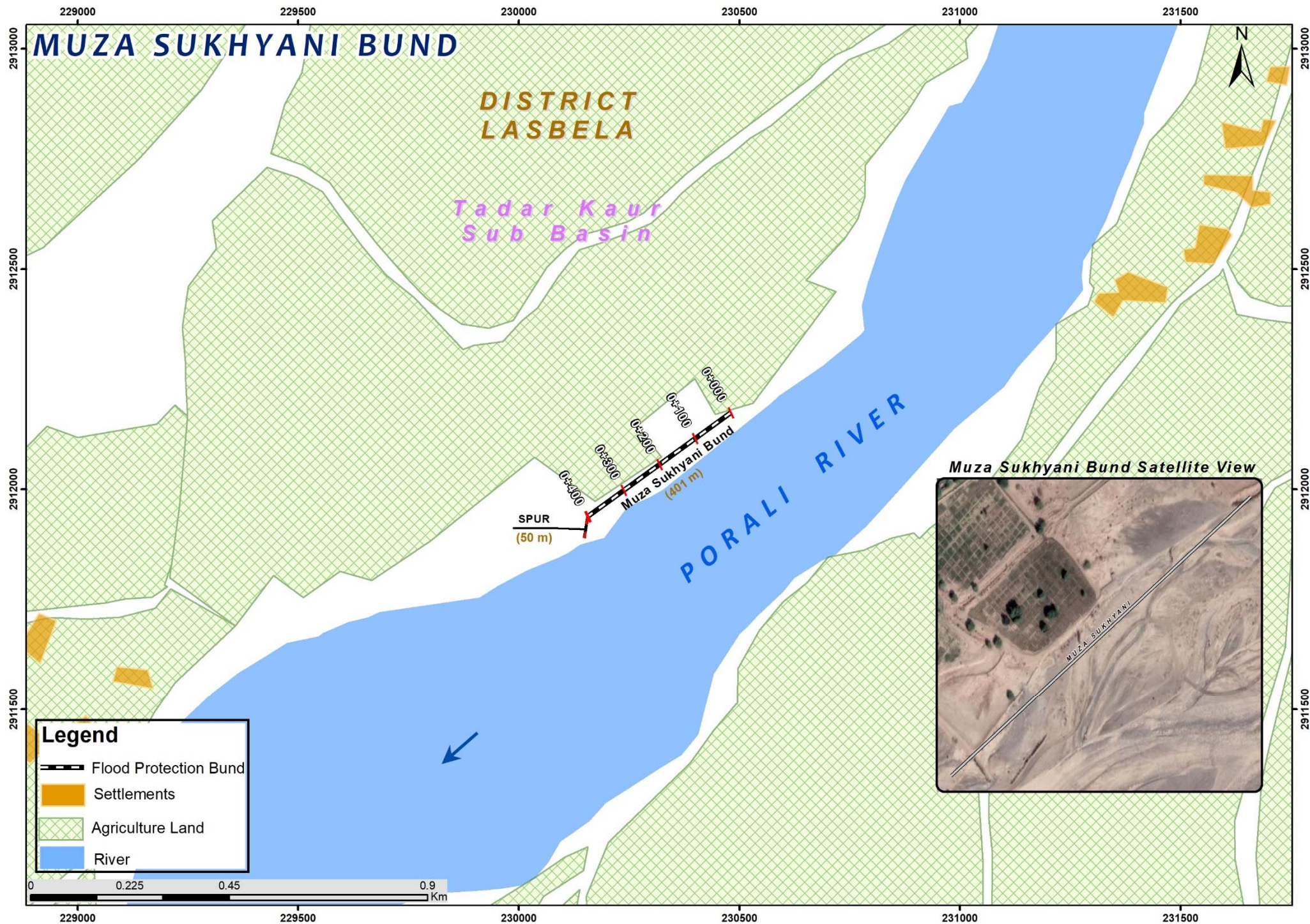


Figure C6 Mauza Sukhyani Flood Protection Bund in Porali River Basin, Balochistan Province.

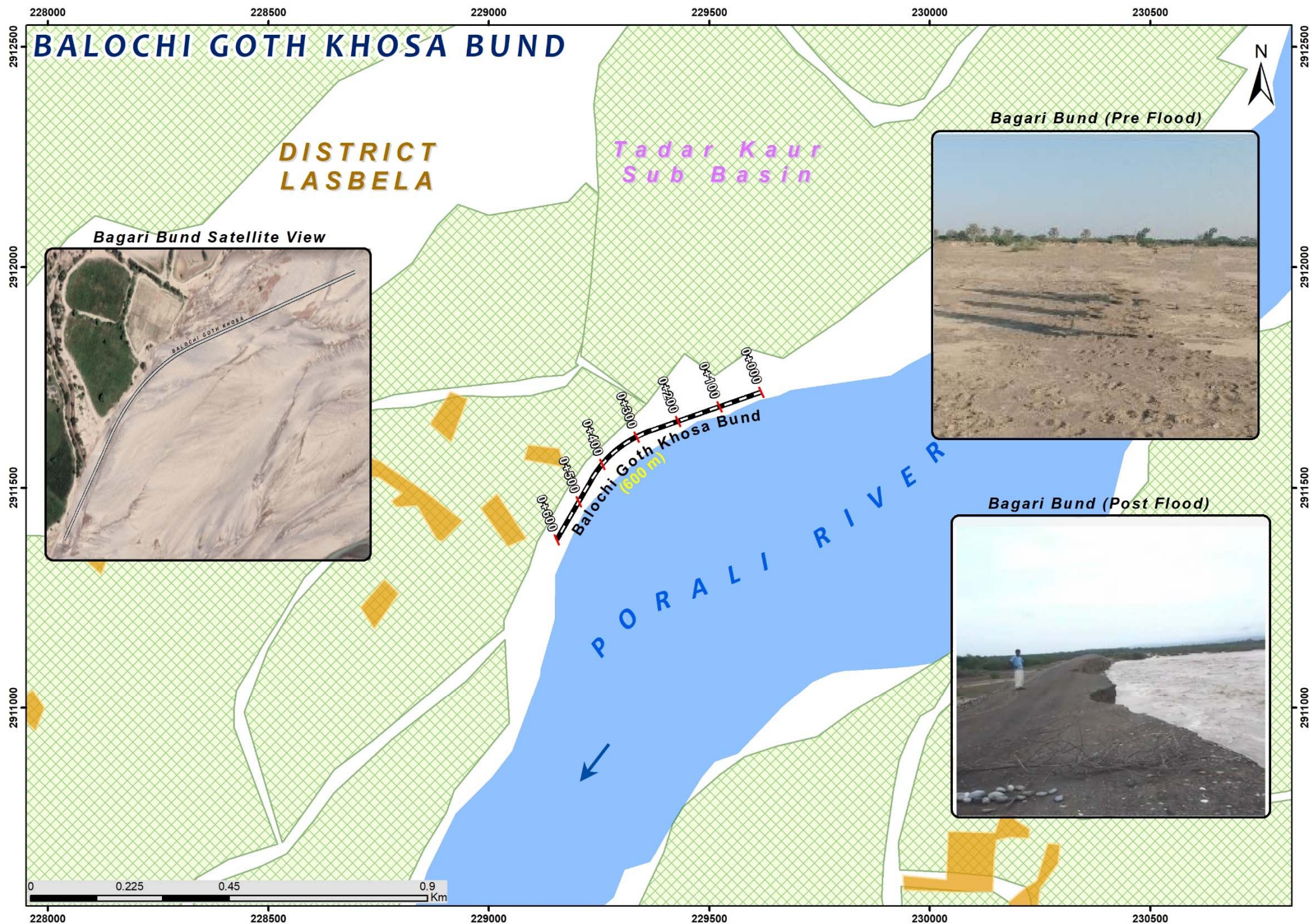


Figure C7 Balochi Goth Khosa Flood Protection Bund in Porali River Basin, Balochistan Province.

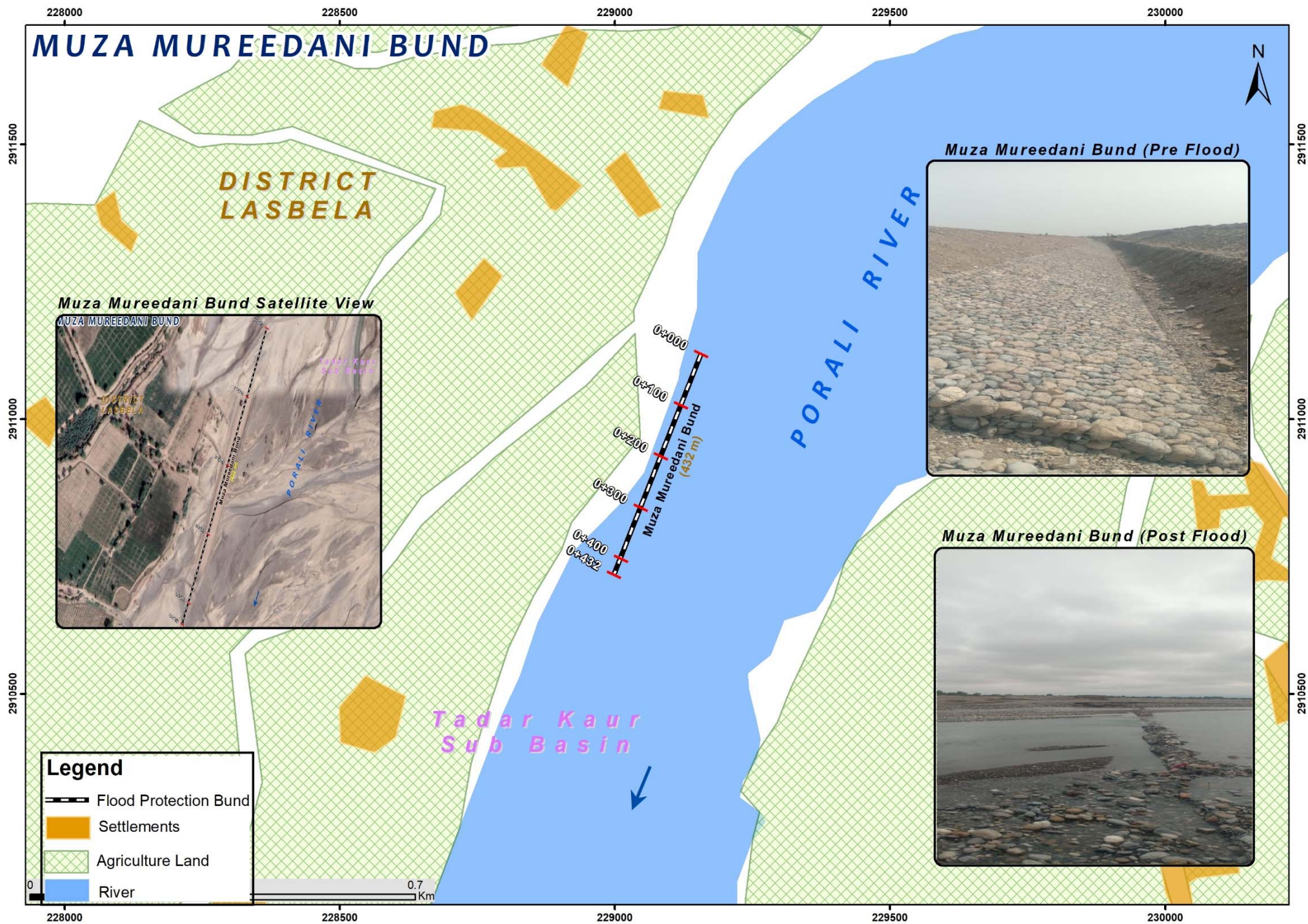


Figure C8 Mauza Mureedani Flood Protection Bund in Porali River Basin, Balochistan Province.

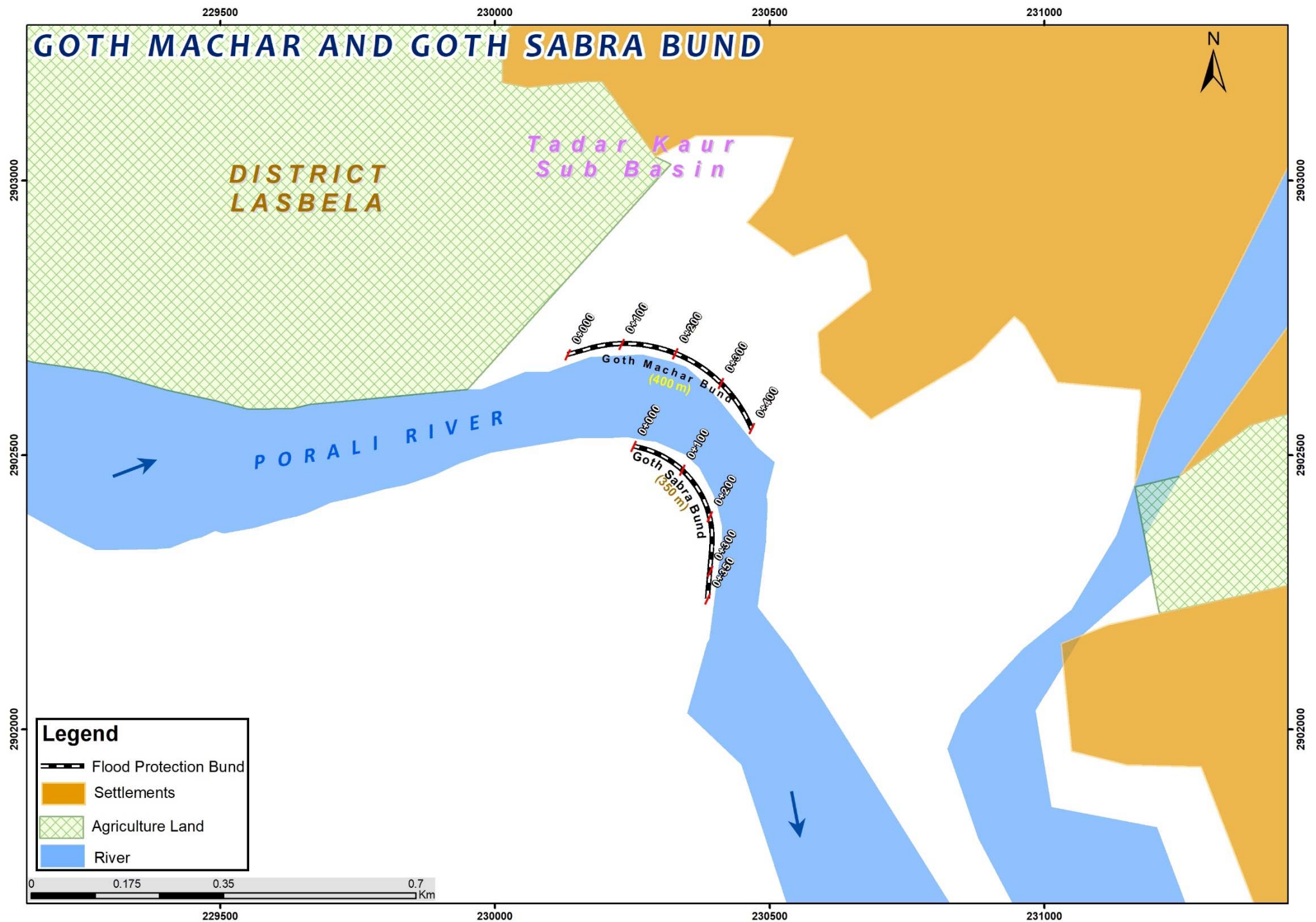


Figure C9 Goth Machar and Goth Sabra Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C10

Bagari Flood Protection Bund in Porali River Basin, Balochistan Province.

Extended Area Plans of Flood Protection Bunds for Gandacha Irrigation Scheme

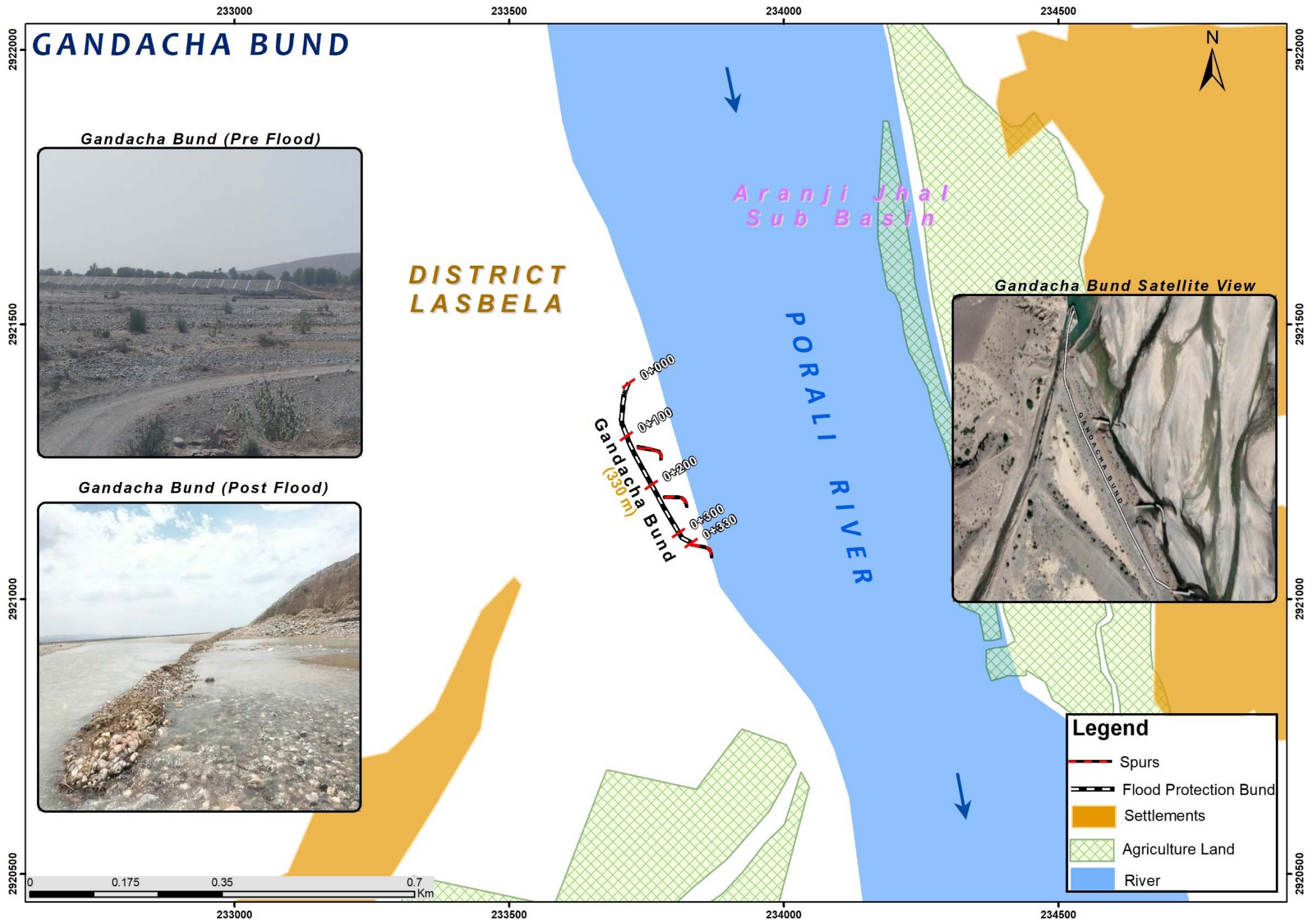


Figure C11 Gandacha Flood Protection Bund in Porali River Basin, Balochistan Province.

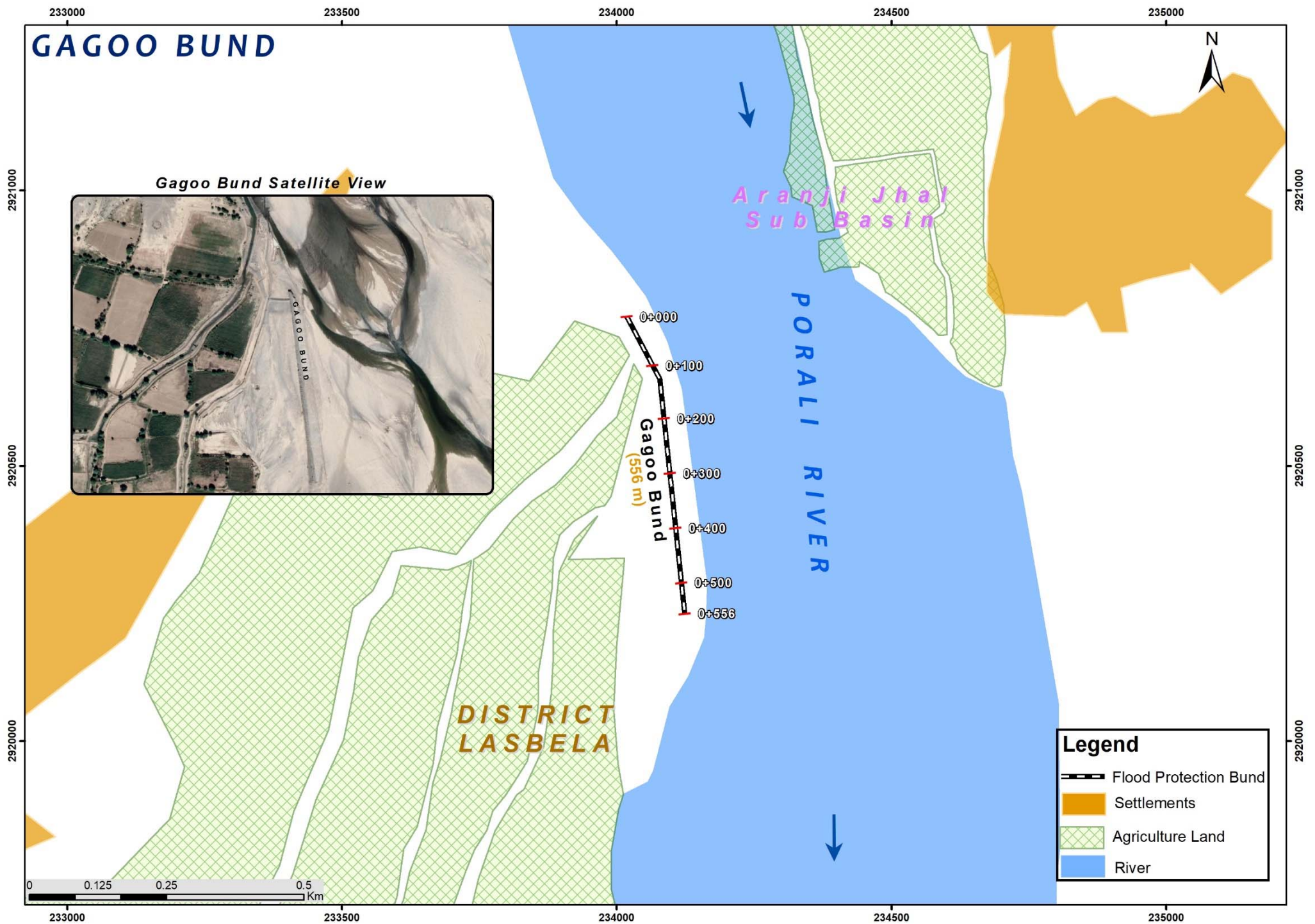


Figure C12 Gagoo Flood Protection Bund in Porali River Basin, Balochistan Province.

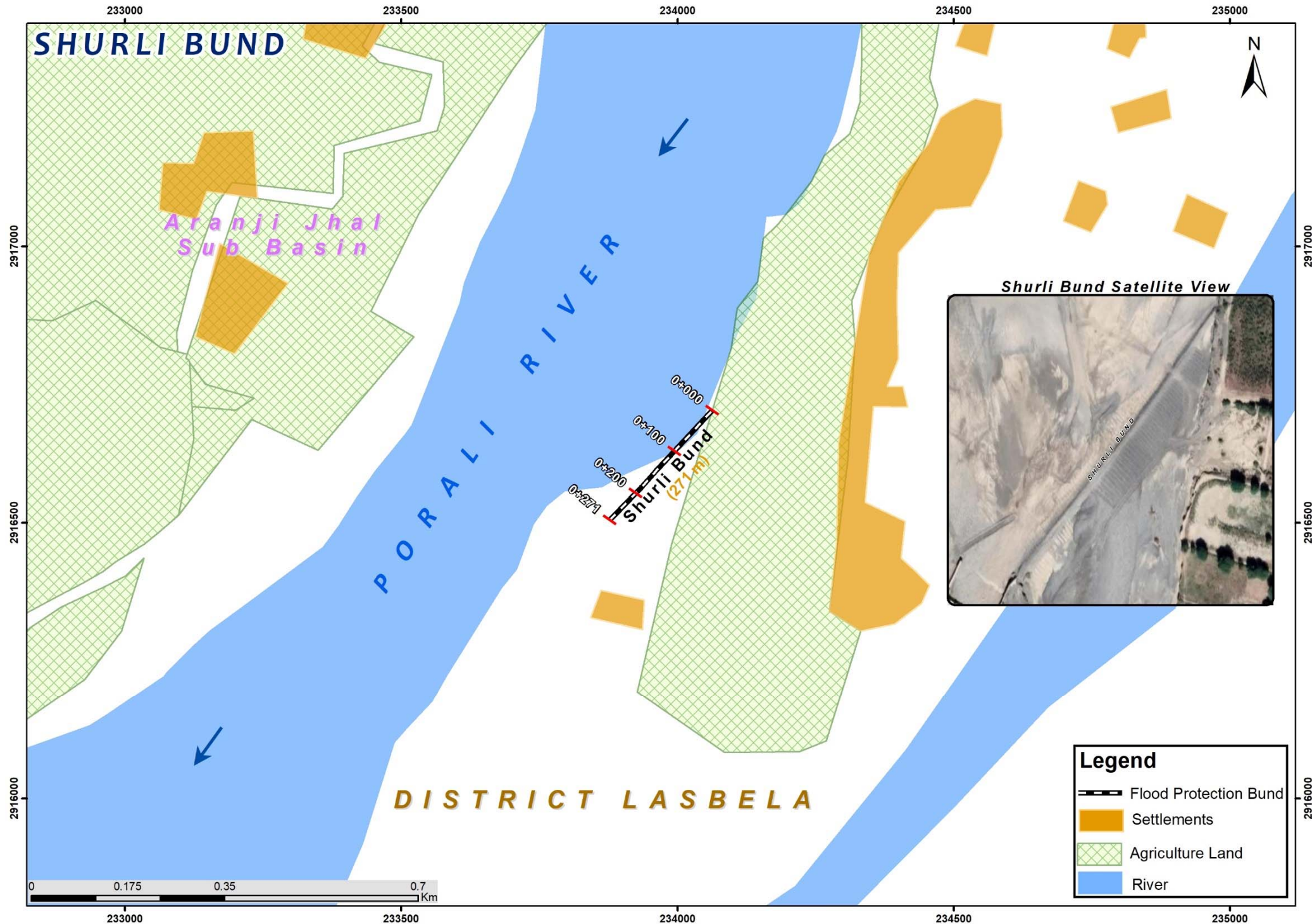


Figure C13

Shurli Flood Protection Bund in Porali River Basin, Balochistan Province.

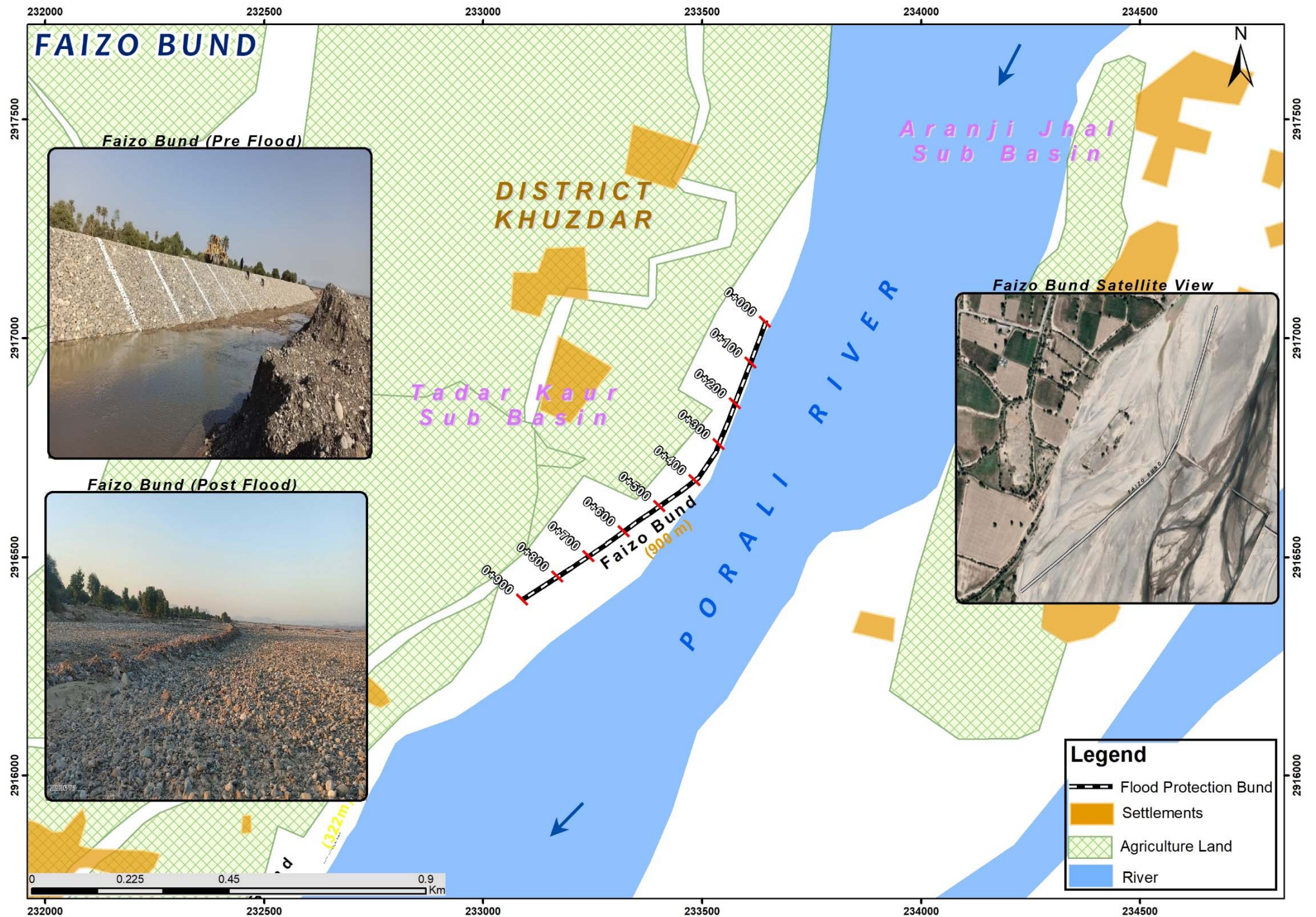


Figure C14 Faizo Flood Protection Bund in Porali River Basin, Balochistan Province.

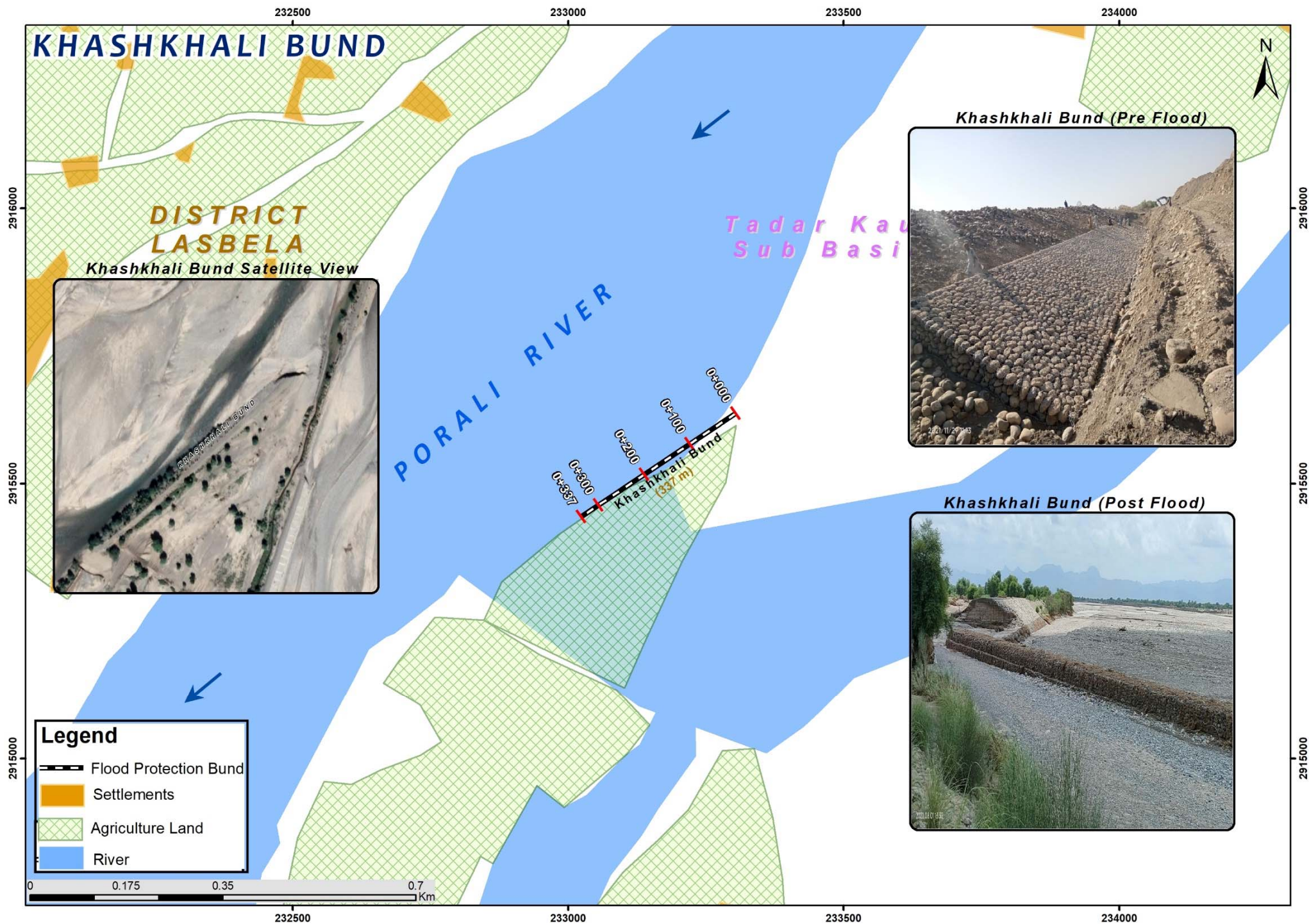


Figure C15 Khashkhali Flood Protection Bund in Porali River Basin, Balochistan Province.

Extended Area Plans of Flood Protection Bunds for Nimmi Irrigation Scheme

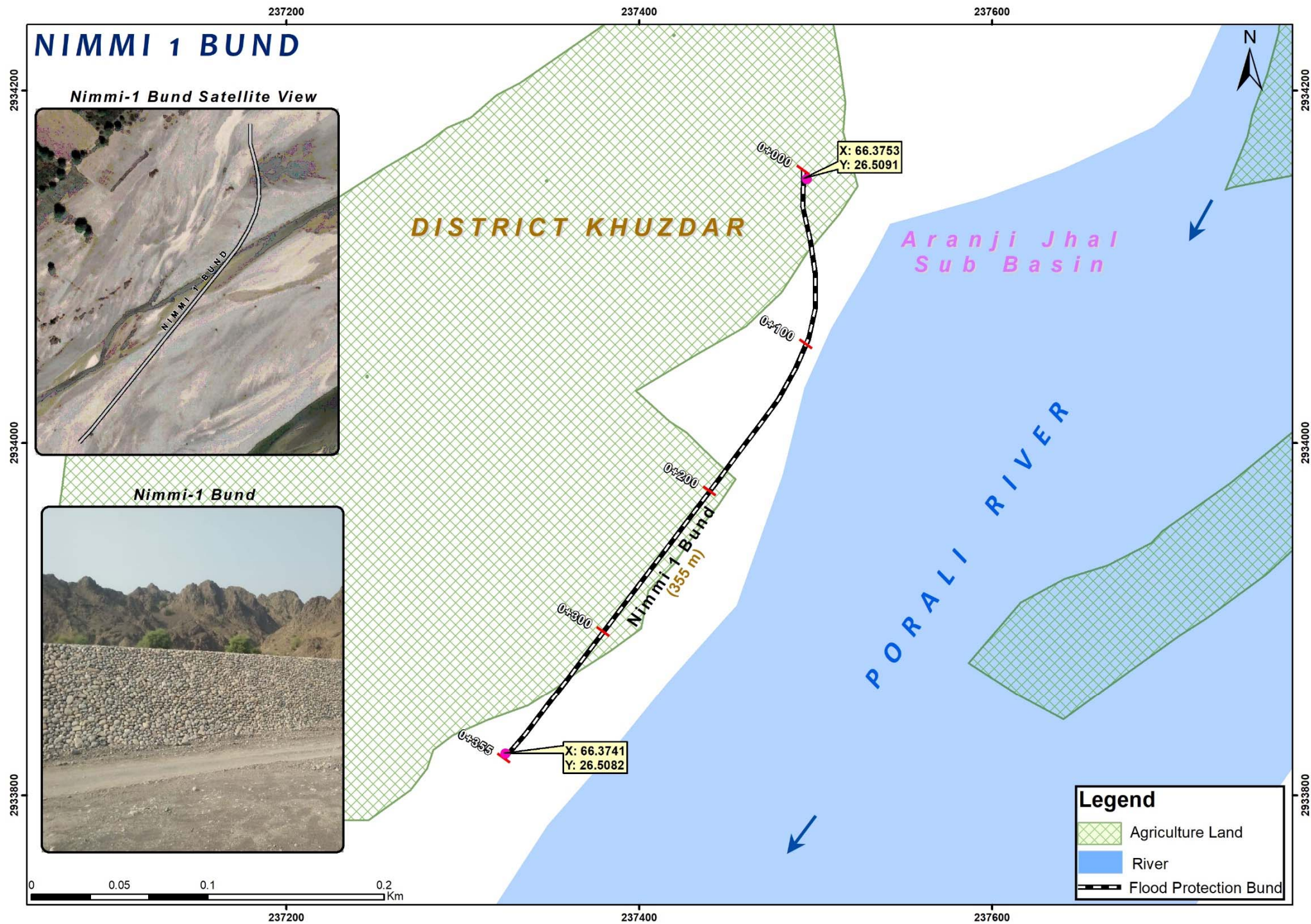


Figure C16

Nimmi 1 Flood Protection Bund in Porali River Basin, Balochistan Province.

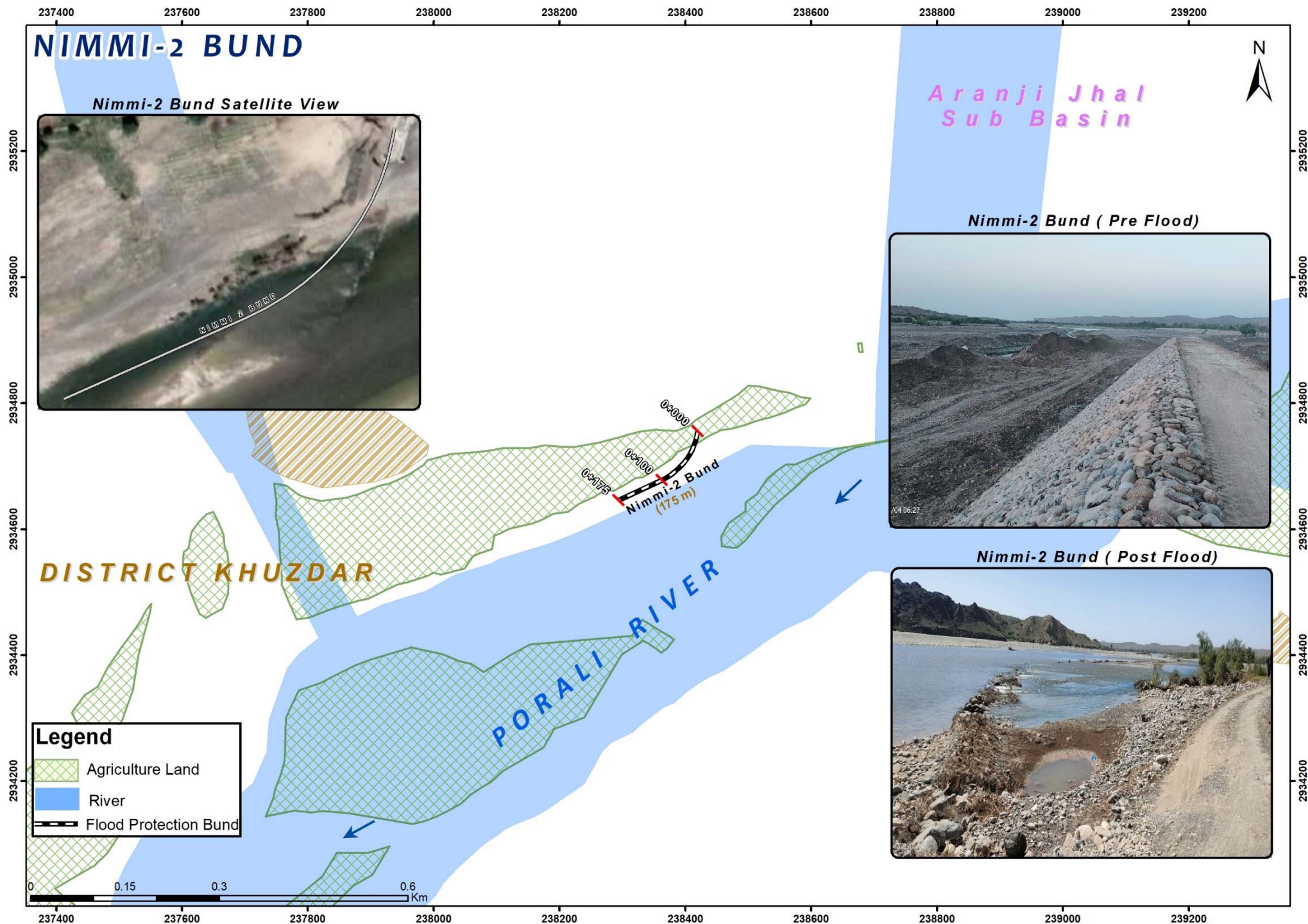


Figure C17 Nimmi 2 Flood Protection Bund in Porali River Basin, Balochistan Province.

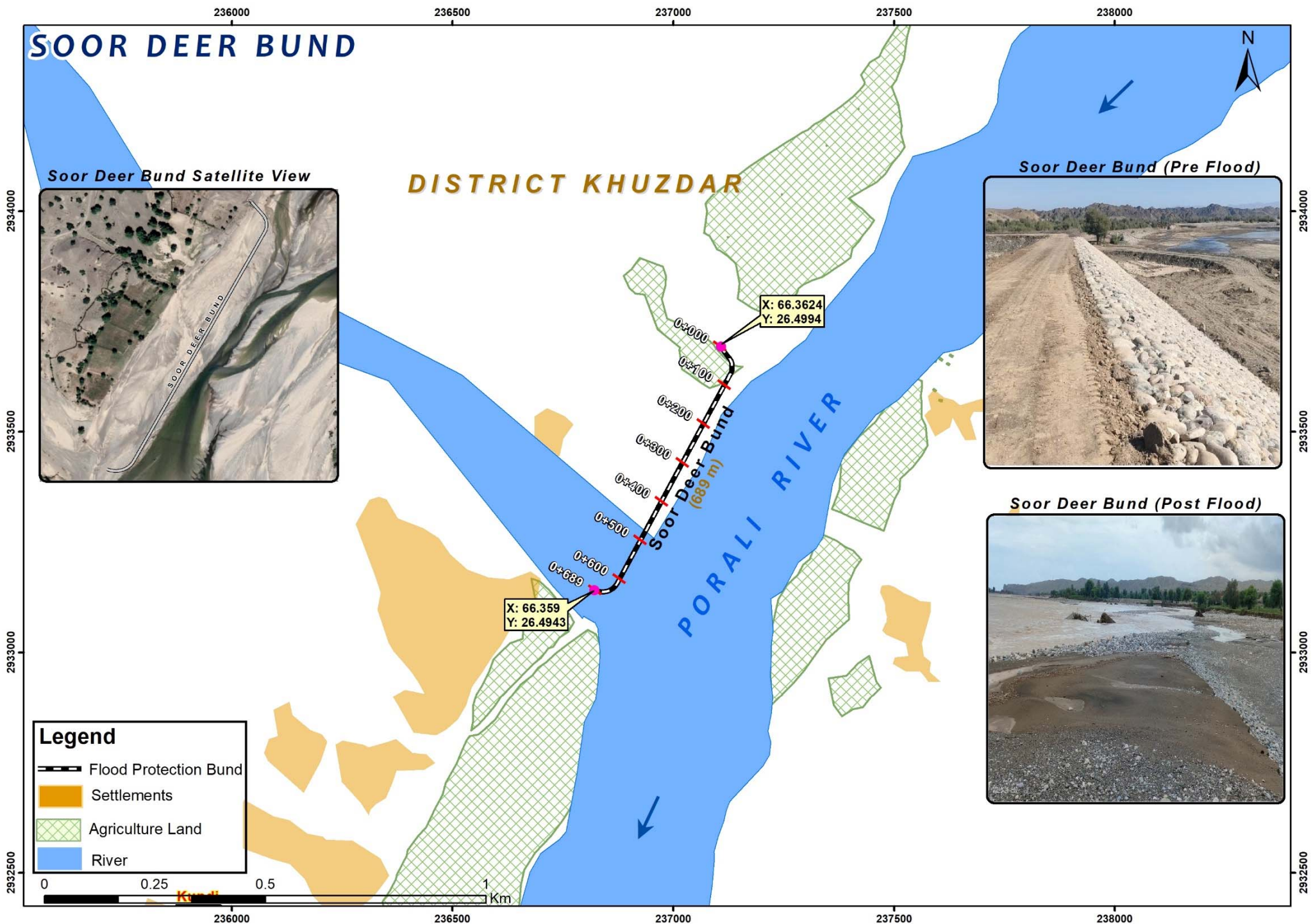


Figure C18 Sordeer Flood Protection Bund in Porali River Basin, Balochistan Province.

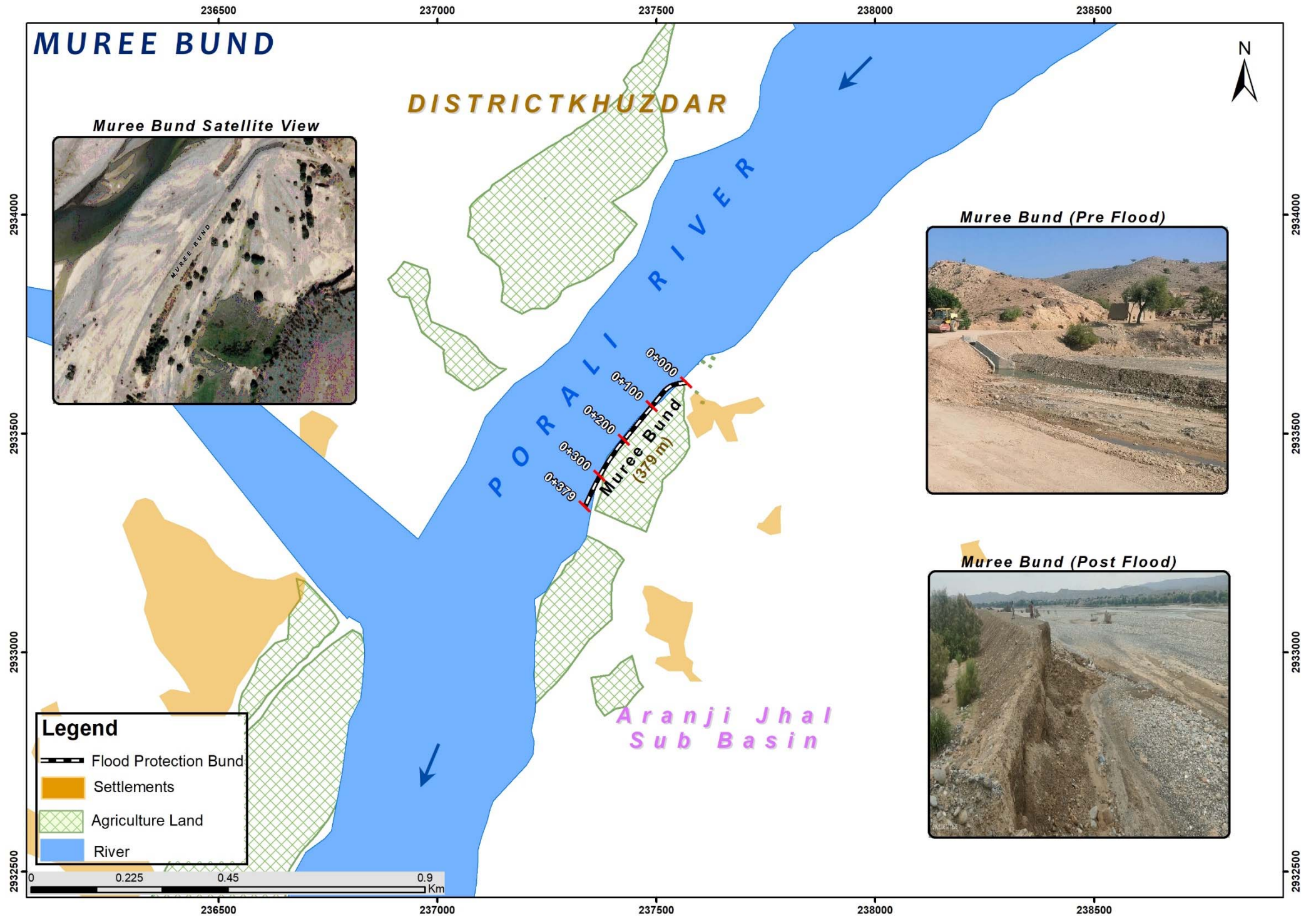


Figure C19 Muree Flood Protection Bund in Porali River Basin, Balochistan Province.

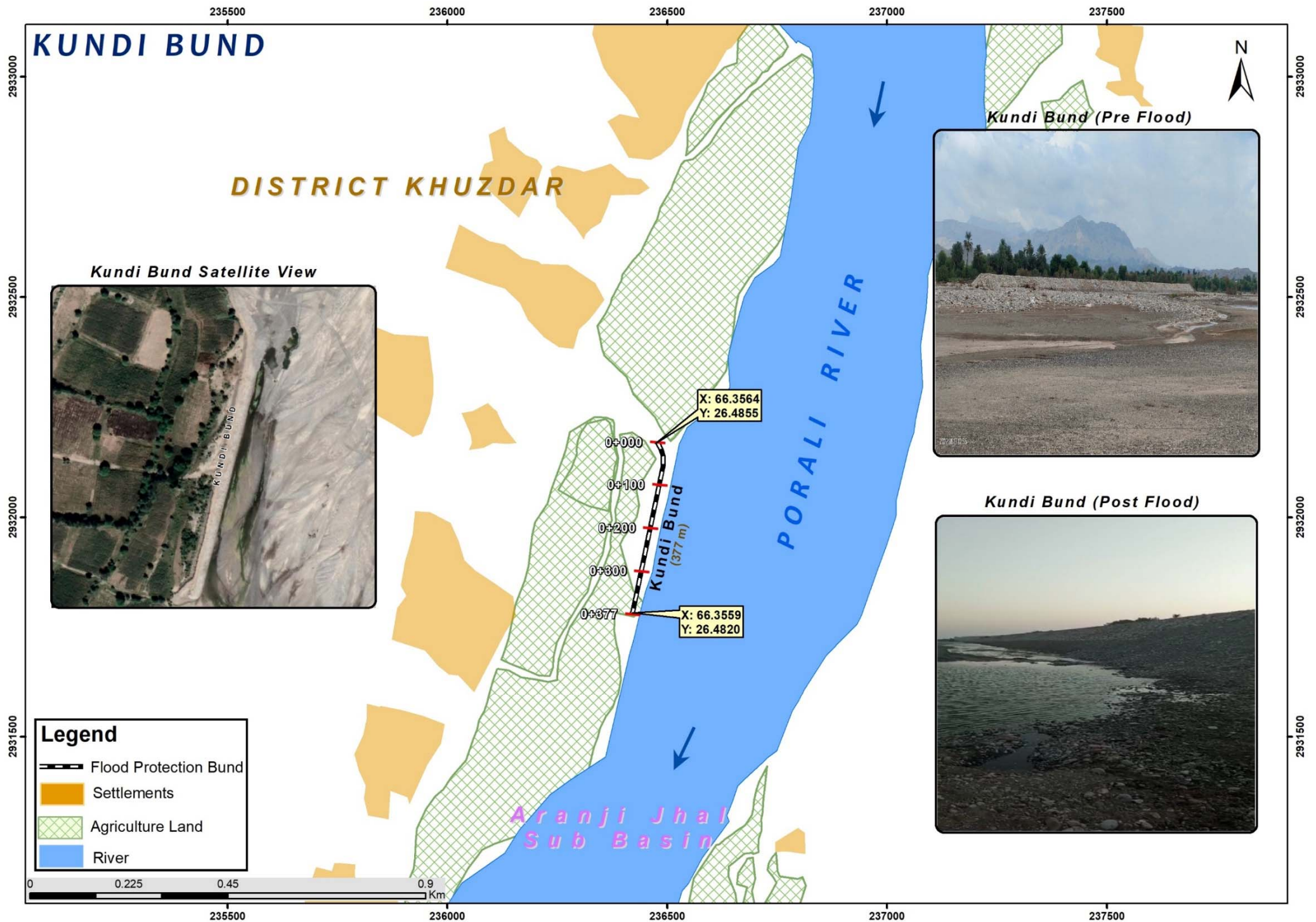


Figure C20

Kundi Flood Protection Bund in Porali River Basin, Balochistan Province.

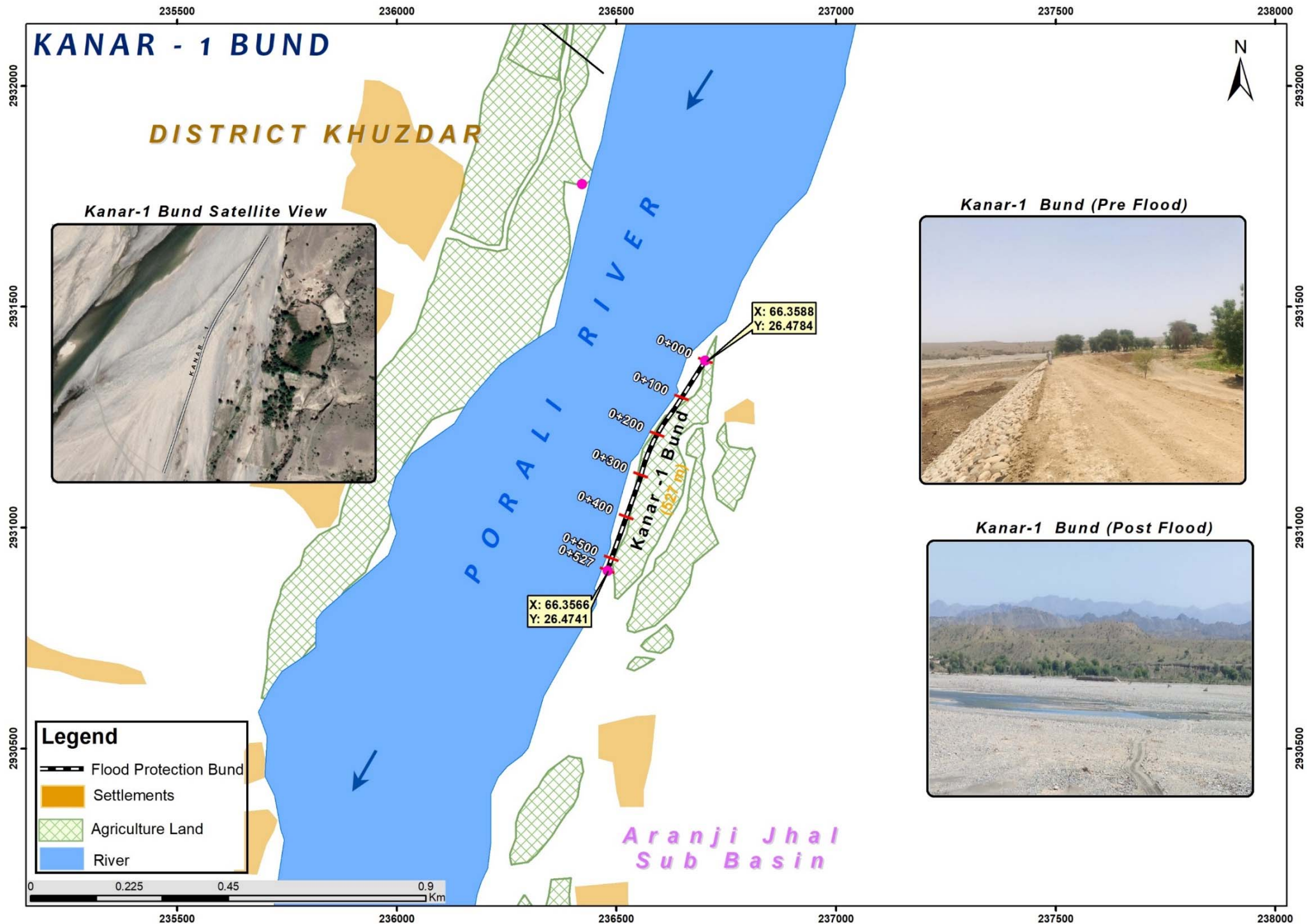


Figure C21 Kanar 1 Flood Protection Bund in Porali River Basin, Balochistan Province.

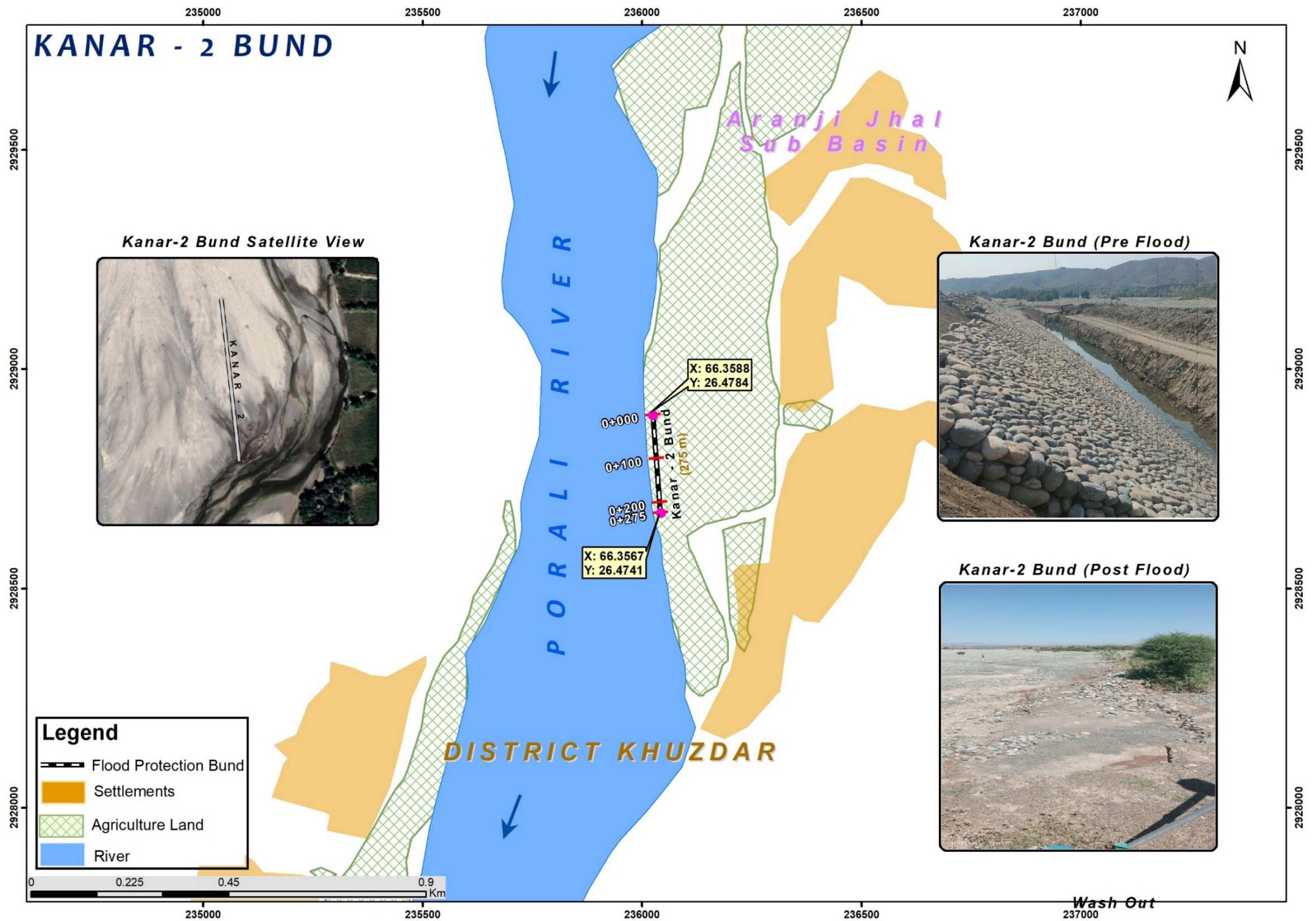


Figure C22

Kanar 2 Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C23

Langro Flood Protection Bund in Porali River Basin, Balochistan Province.

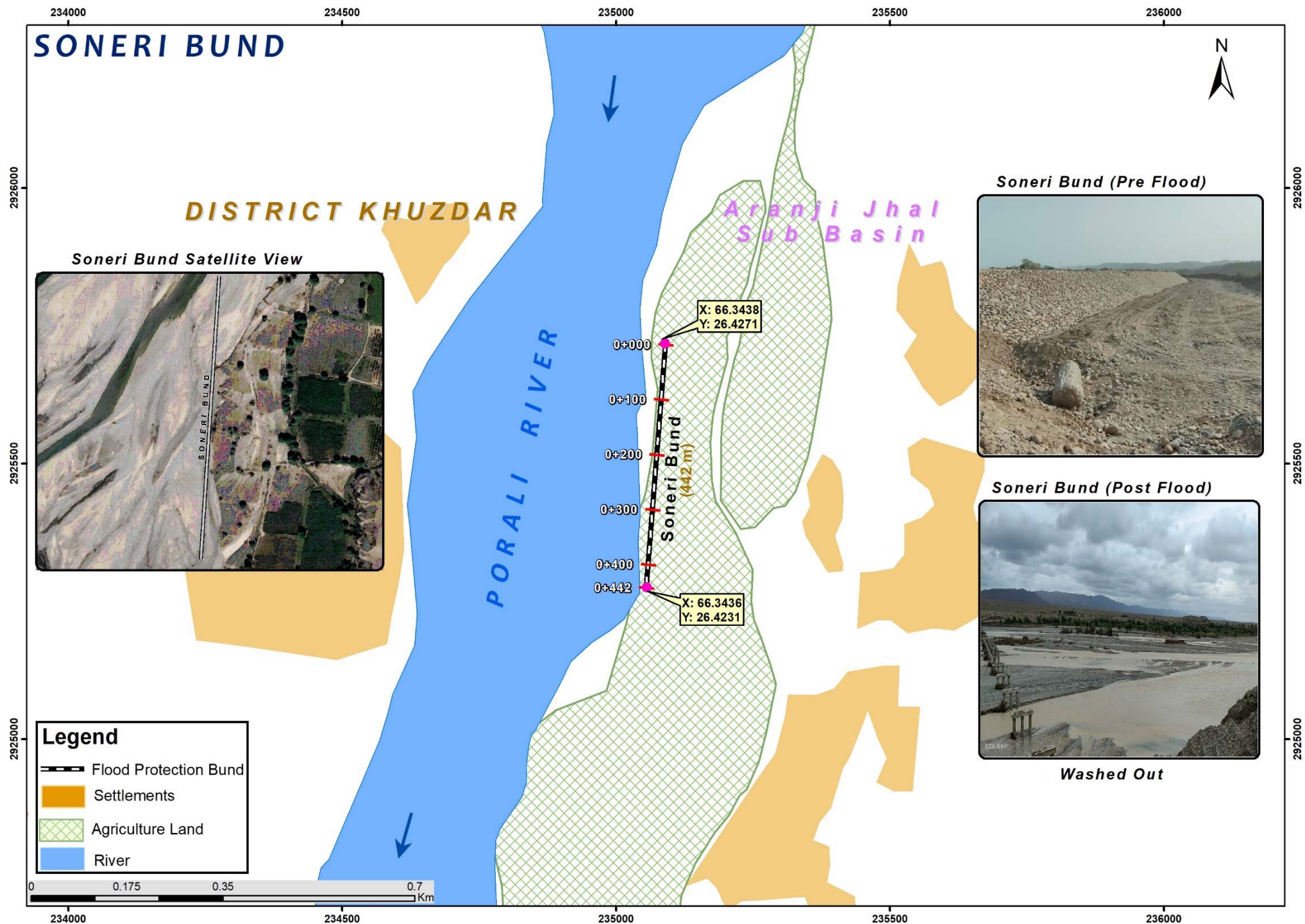


Figure C24

Soneri Flood Protection Bund in Porali River Basin, Balochistan Province.

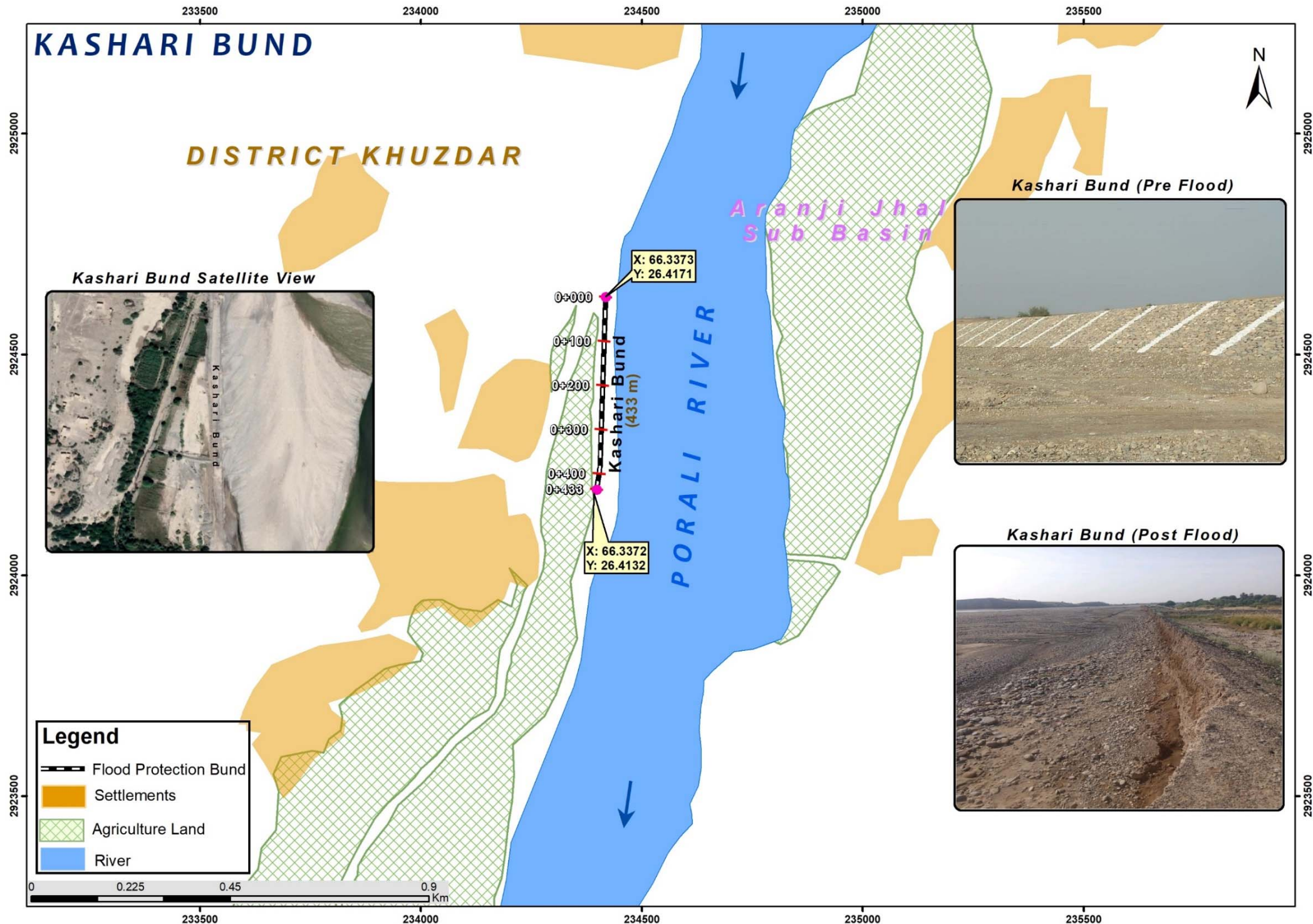


Figure C25 Kashari Flood Protection Bund in Porali River Basin, Balochistan Province.

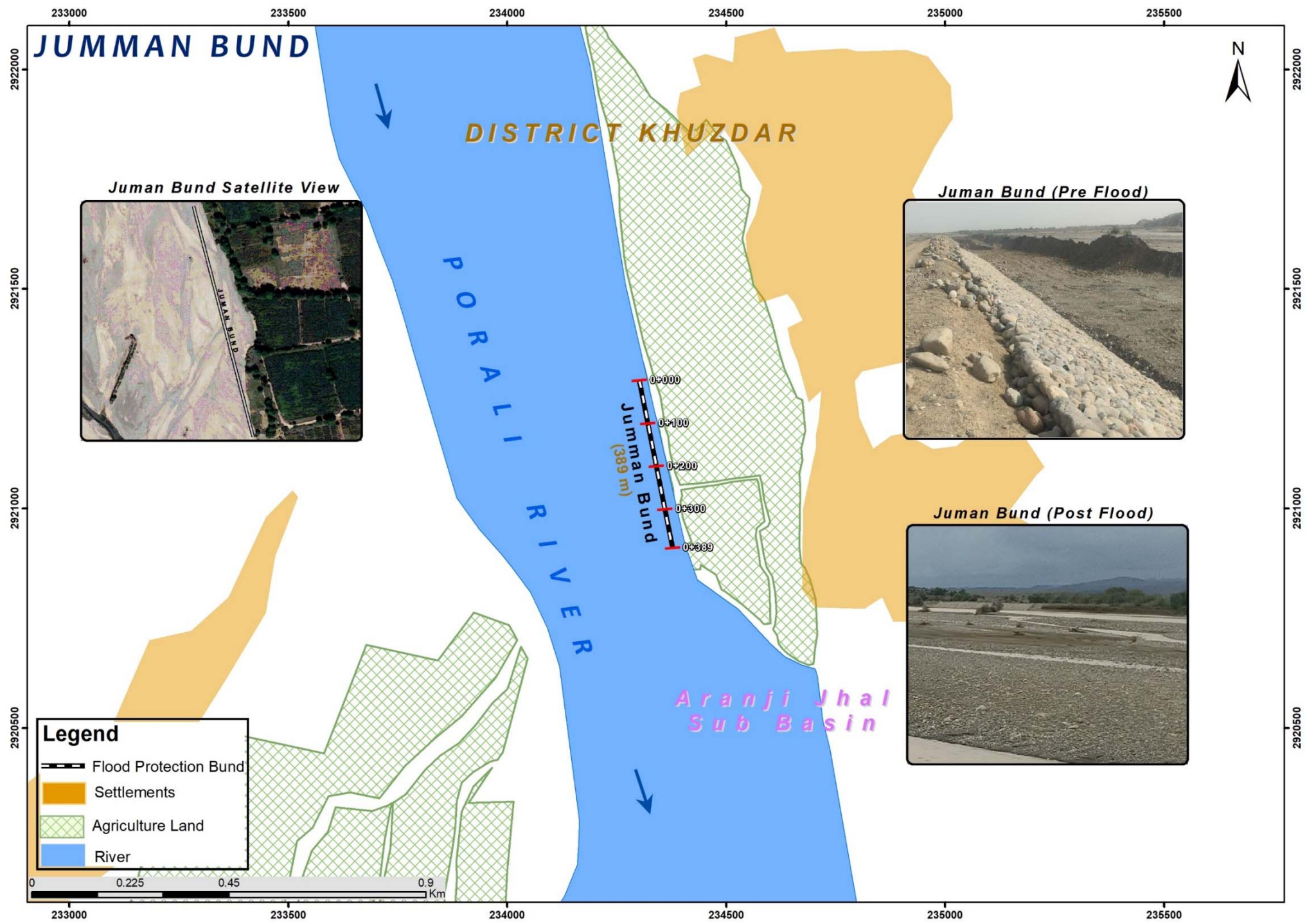


Figure C26 Jumman Flood Protection Bund in Porali River Basin, Balochistan Province.

Extended Area Plans of Flood Protection Bunds for Khuzdar Irrigation Scheme

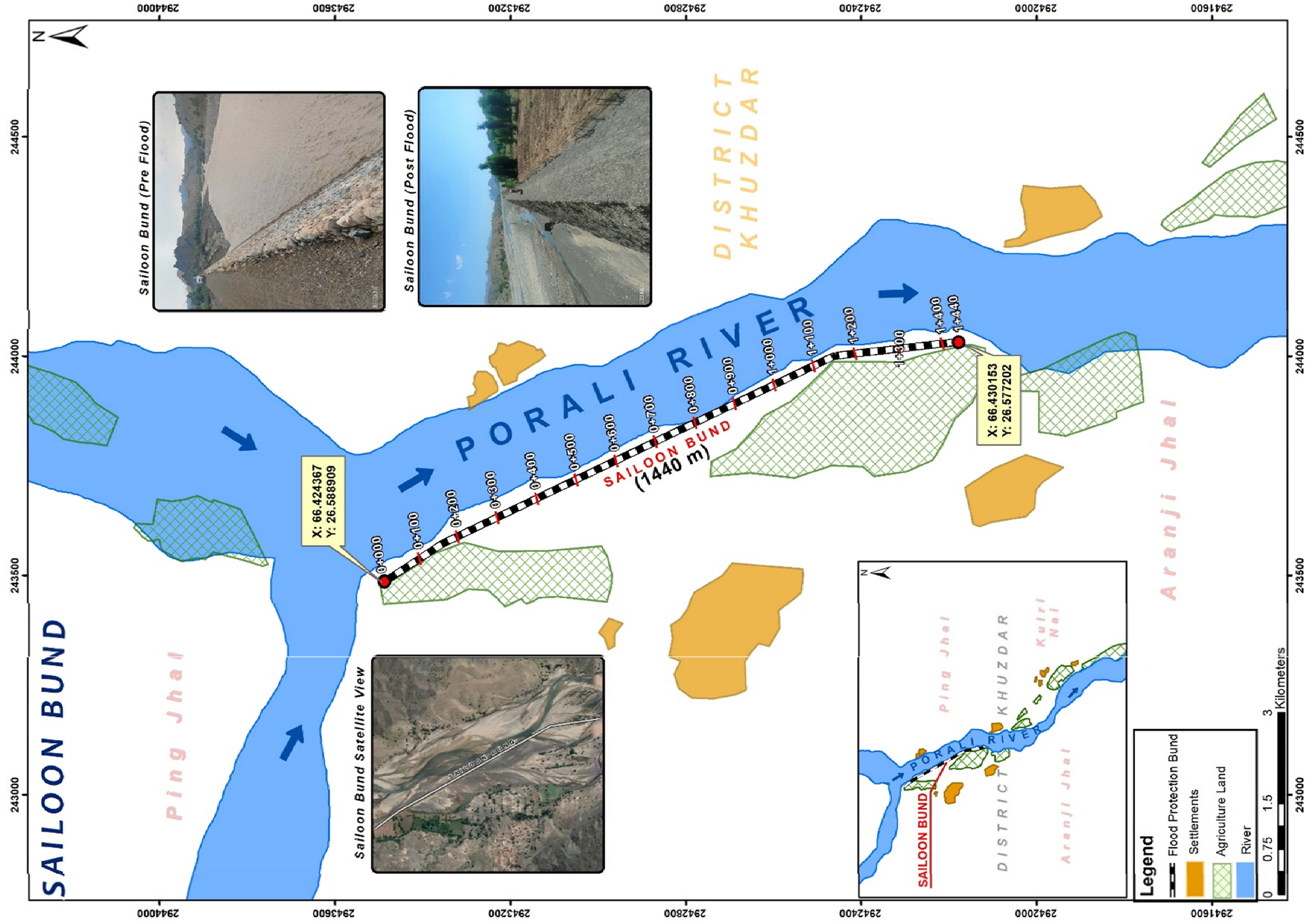


Figure C27

**Sailoon Flood Protection Bund in Porali River Basin,
Balochistan Province.**

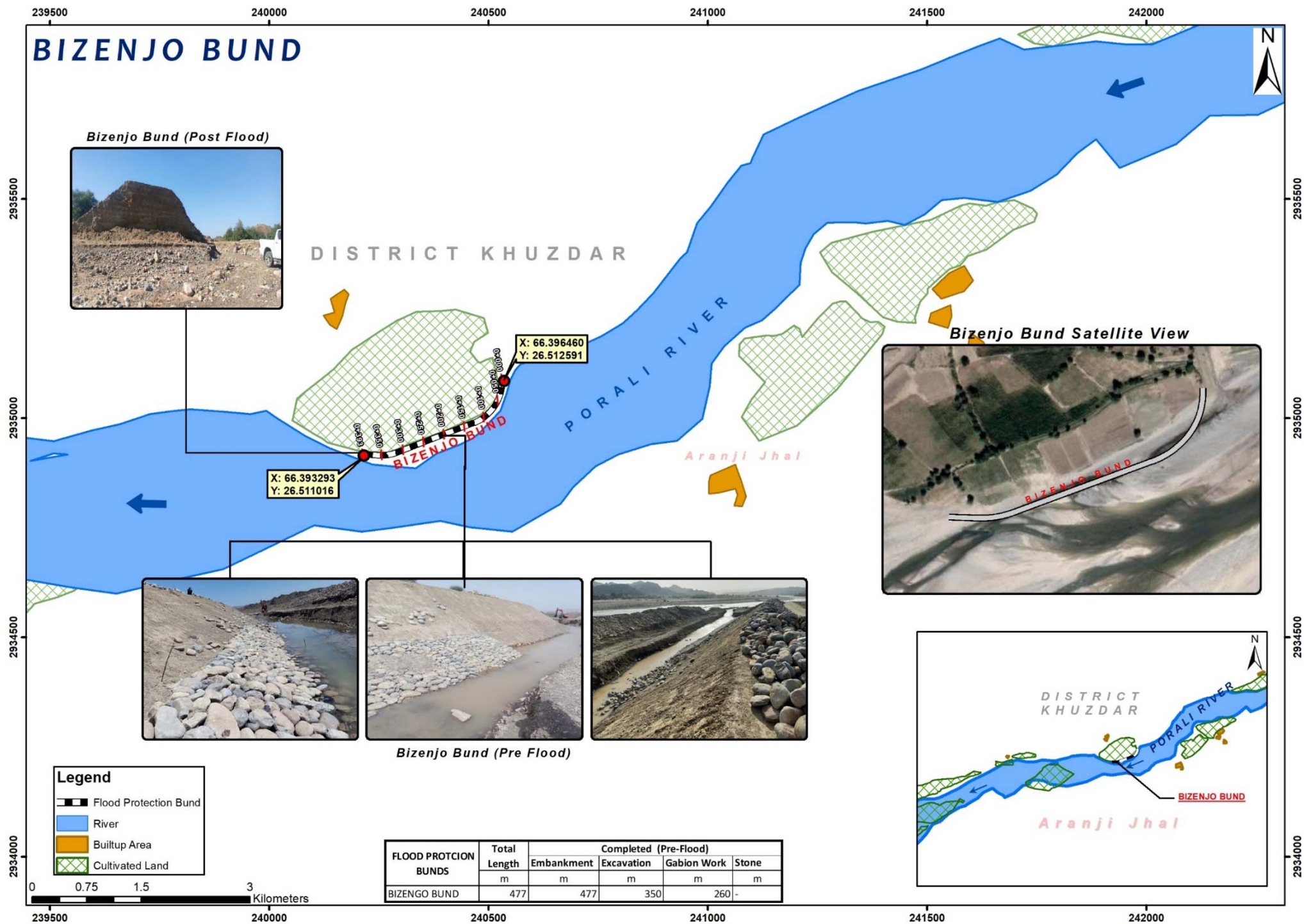


Figure C28

Bizenjo Flood Protection Bund in Porali River Basin, Balochistan Province.

Extended Area Plans of Flood Protection Bunds on Main Nari River

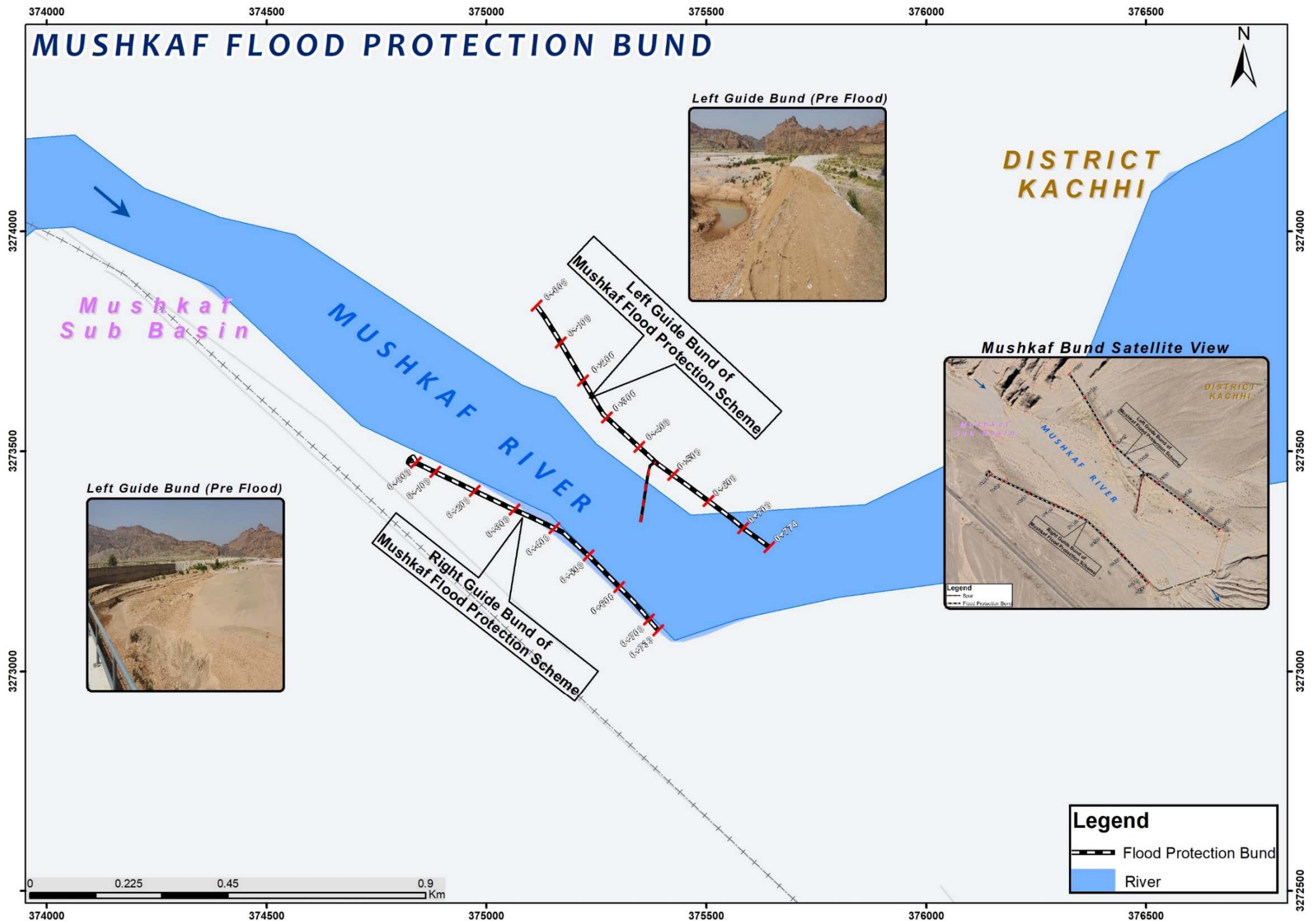


Figure C30

Mushkaf Flood Proteciton Bund in Nari River Basin, Balochistan Province.

Individual Maps of Flood Protection Bunds on Main Porali River (with image overlay)



Figure C31 Balochi Goth Khosa Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C32 Goth Allah Rakha Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C33

Goth Hayat Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C34

Goth Jafferani Flood Protection Bund in Porali River Basin, Balochistan Province.

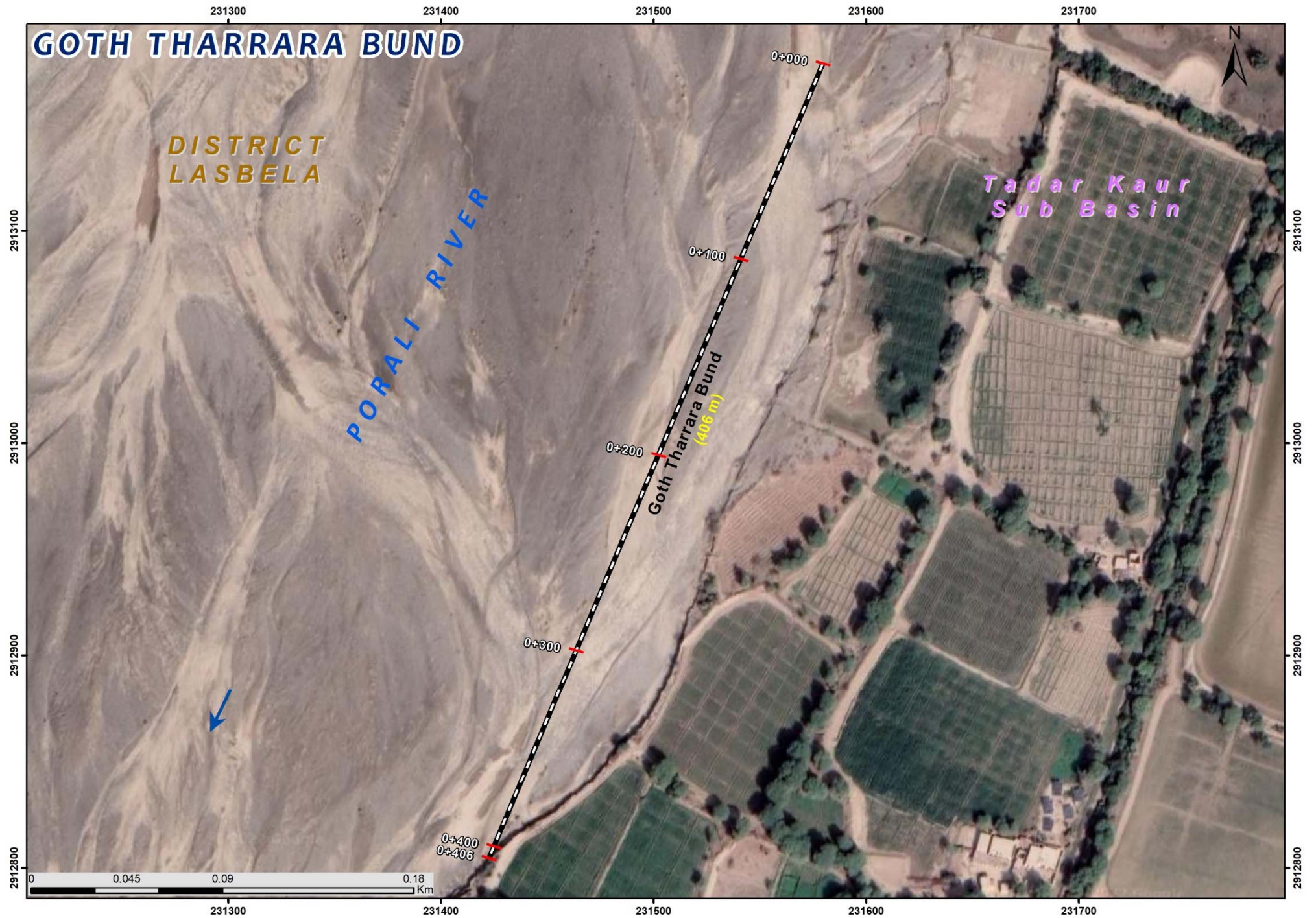


Figure C35 **Goth Thararra Flood Protection Bund in Porali River Basin, Balochistan Province.**



Figure C36 Mazarwala Flood Protection Bund in Porali River Basin, Balochistan Province.

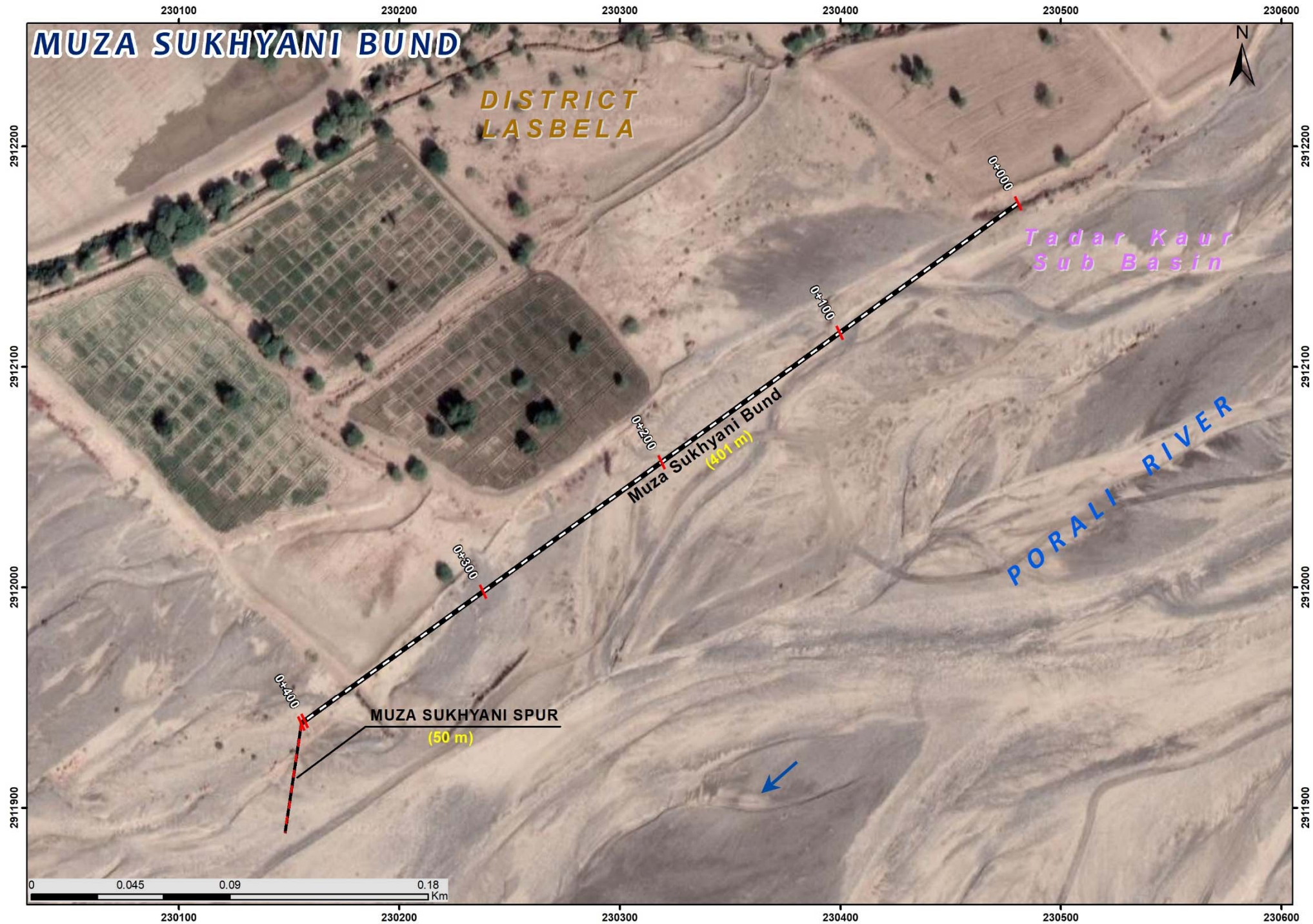


Figure C37 Mauza Sukhyani Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C38

Mauza Mureedani Protection Bund in Porali River Basin, Balochistan Province.

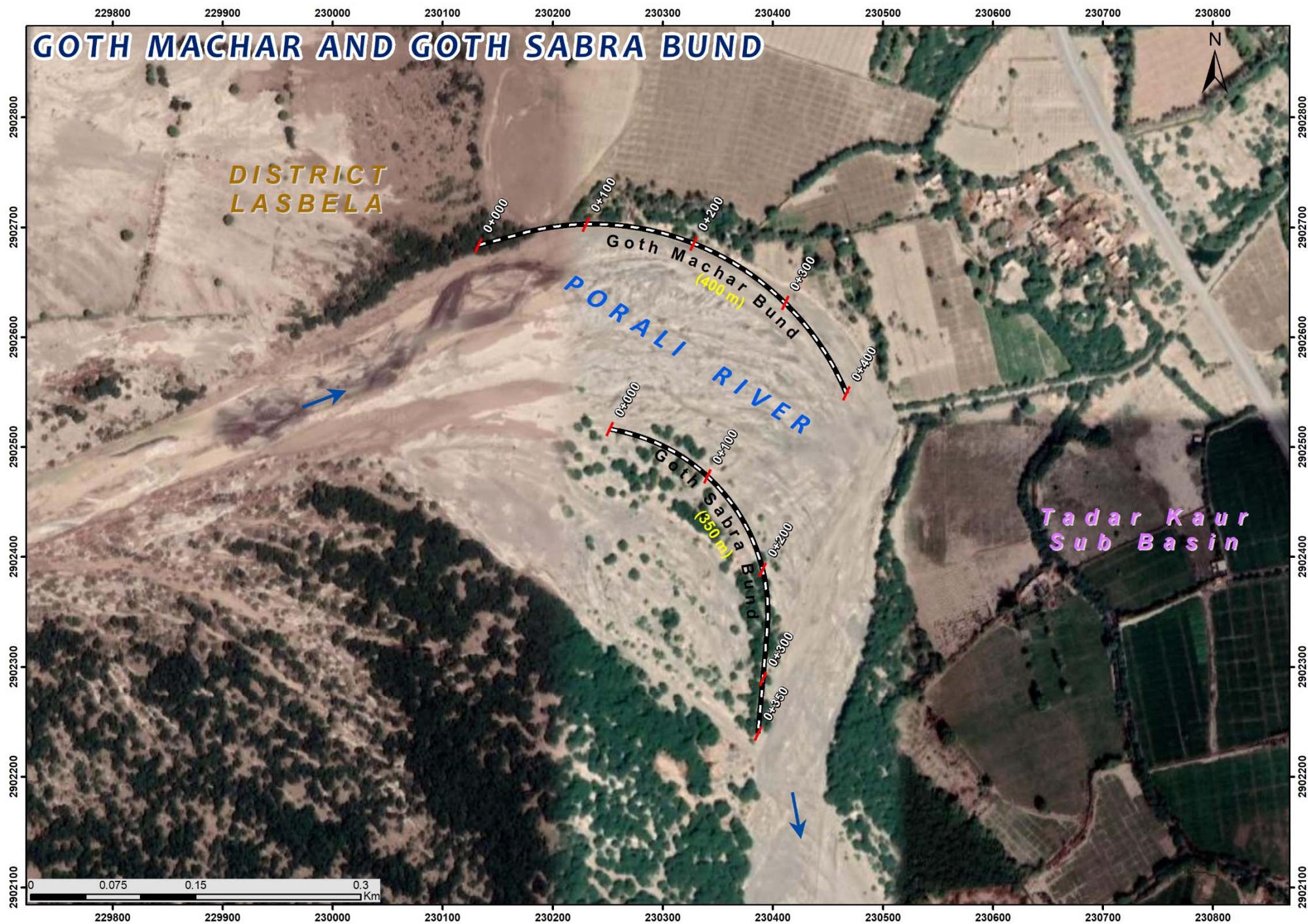


Figure C39 Goth Machar and Goth Sabra Protection Bunds in Porali River Basin, Balochistan Province.

Individual Maps of FP Bunds in Gundacha Irrigation Scheme in Porali River Basin (with image overlay)

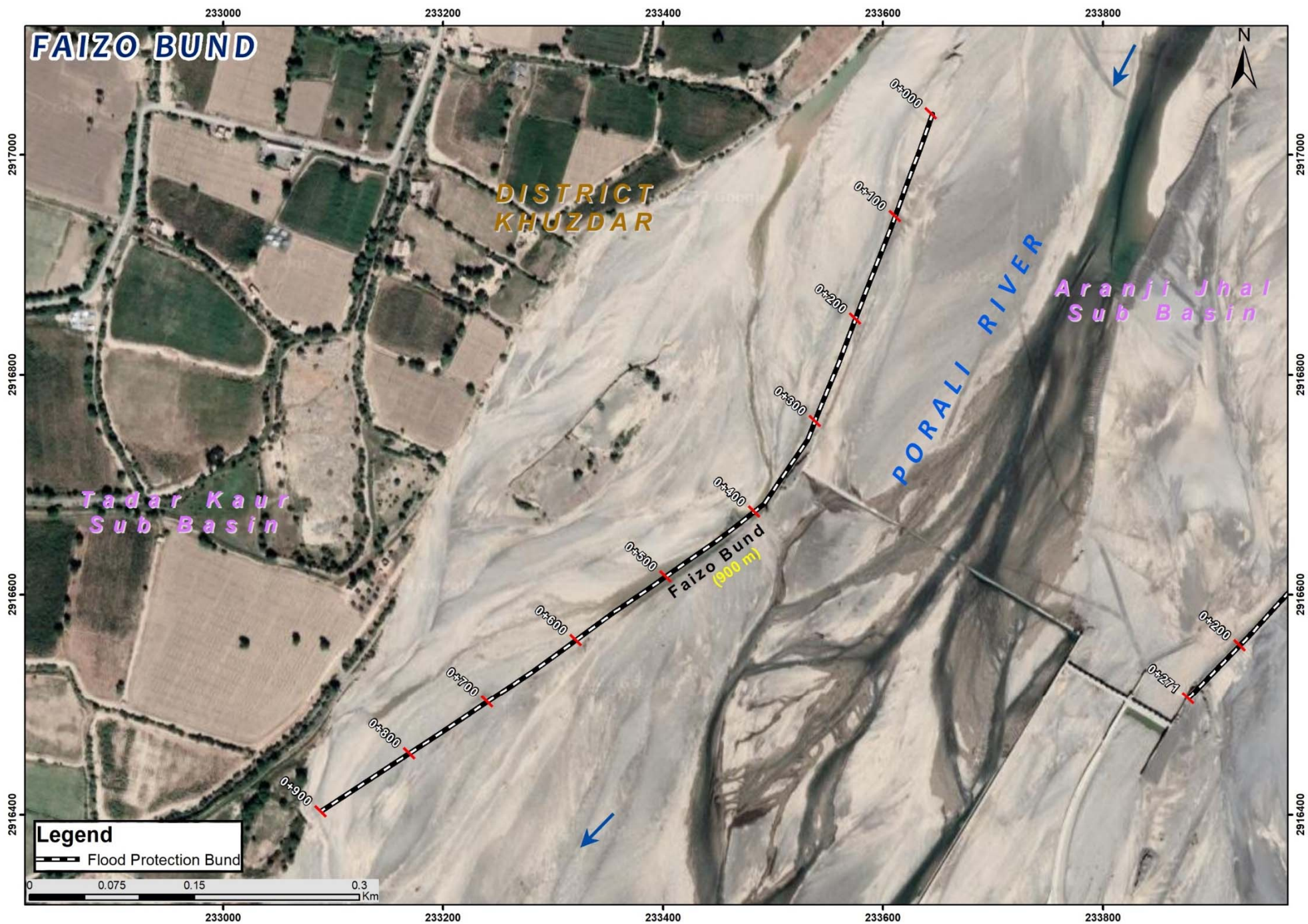


Figure C40 Faizo Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C41 Gagoo Flood Protection Bund in Porali River Basin, Balochistan Province.

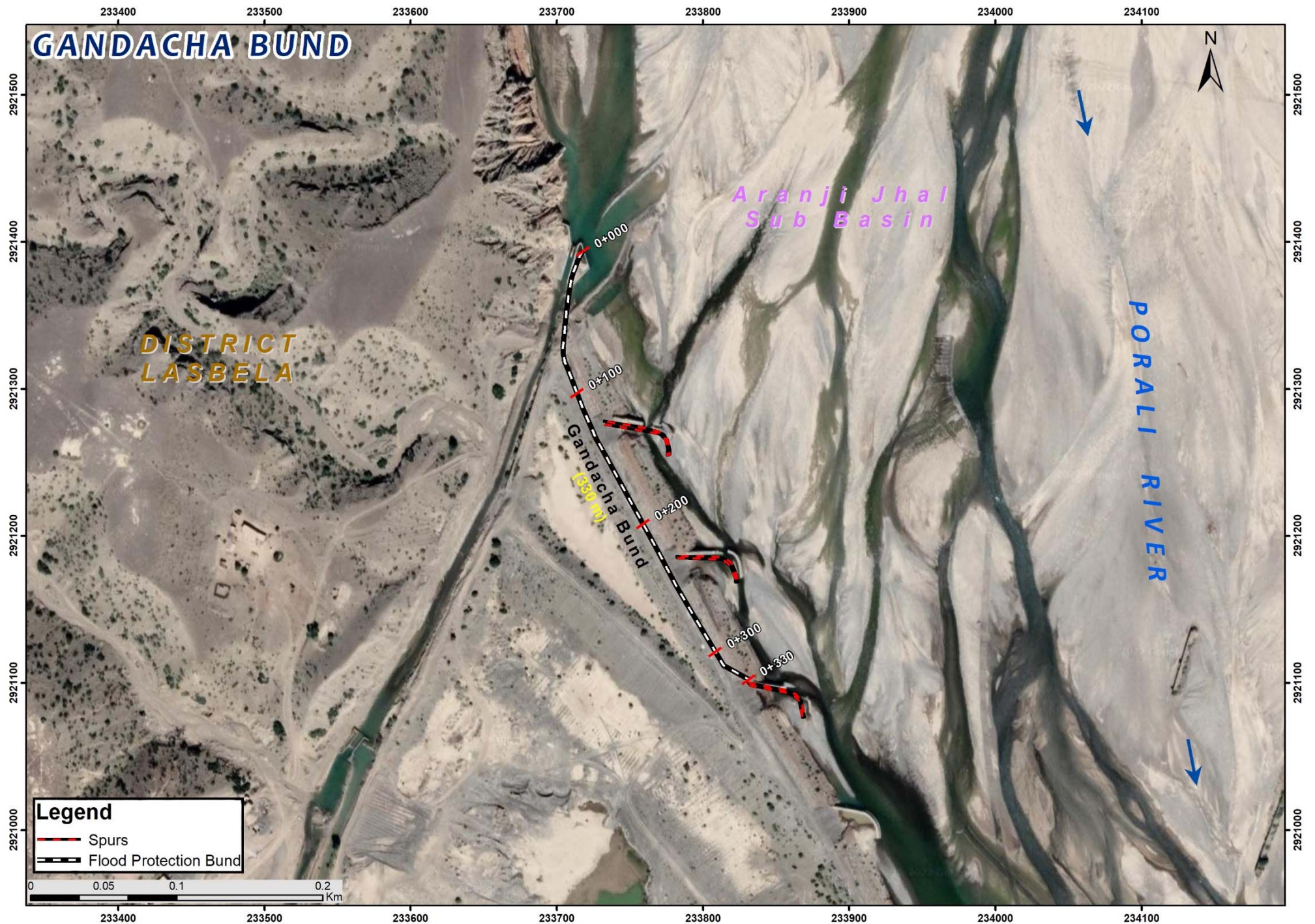


Figure C42

Gandacha Flood Protection Bund in Porali River Basin, Balochistan Province.

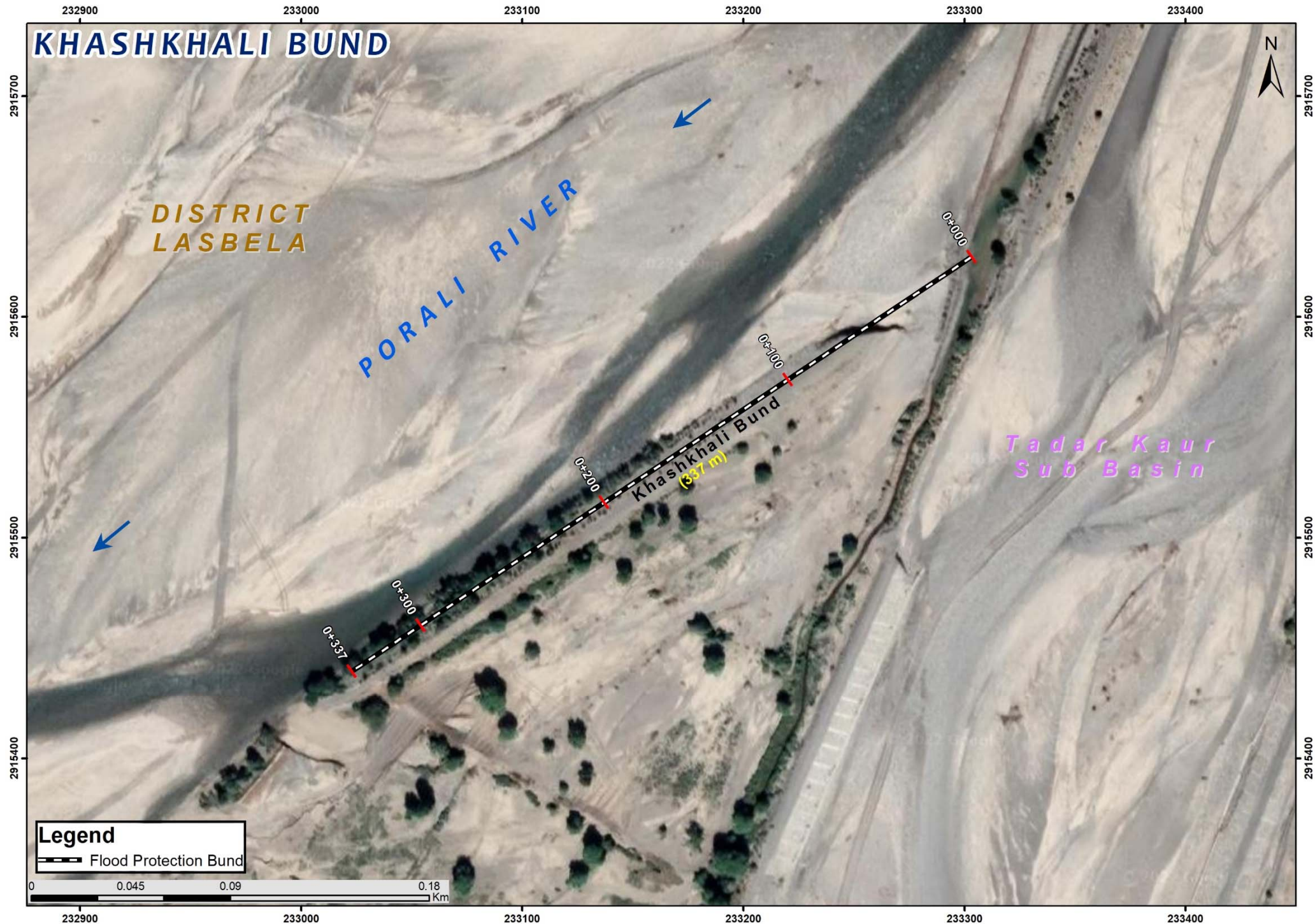


Figure C43

Khashkhali Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C44 Bagari Protection Flood Bund in Porali River Basin, Balochistan Province.

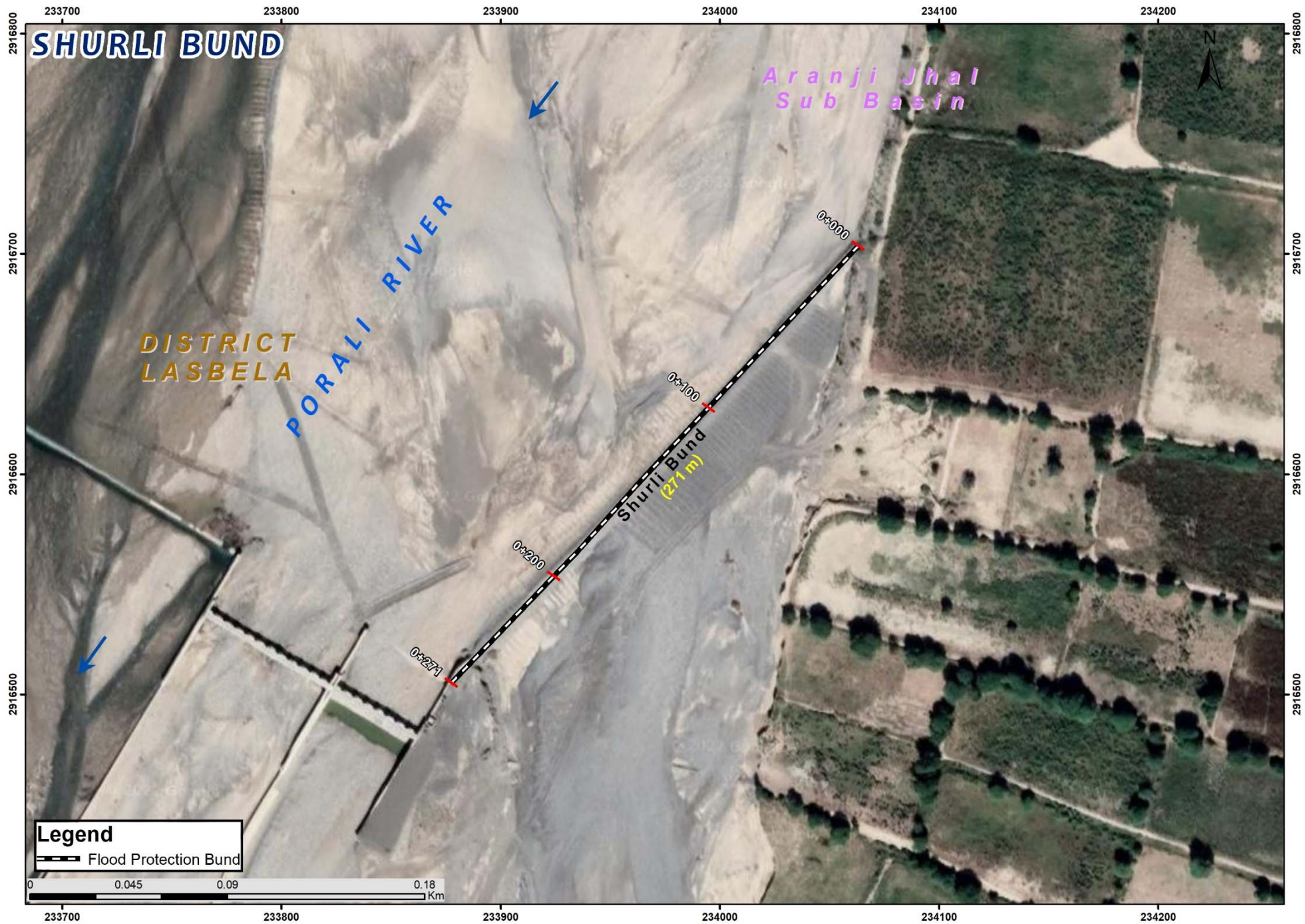


Figure C45 Shurli Flood Protection Bund in Porali River Basin, Balochistan Province.

Individual Maps of FP Bunds in Khuzdar Irrigation Scheme in Porali River Basin (with image overlay)



Figure C46 Bizenjo Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C47 Sailoon Flood Protection Bund in Porali River Basin, Balochistan Province.

Individual Maps of FP Bunds in Nimmi Irrigation Scheme in Porali River Basin

(with image overlay)

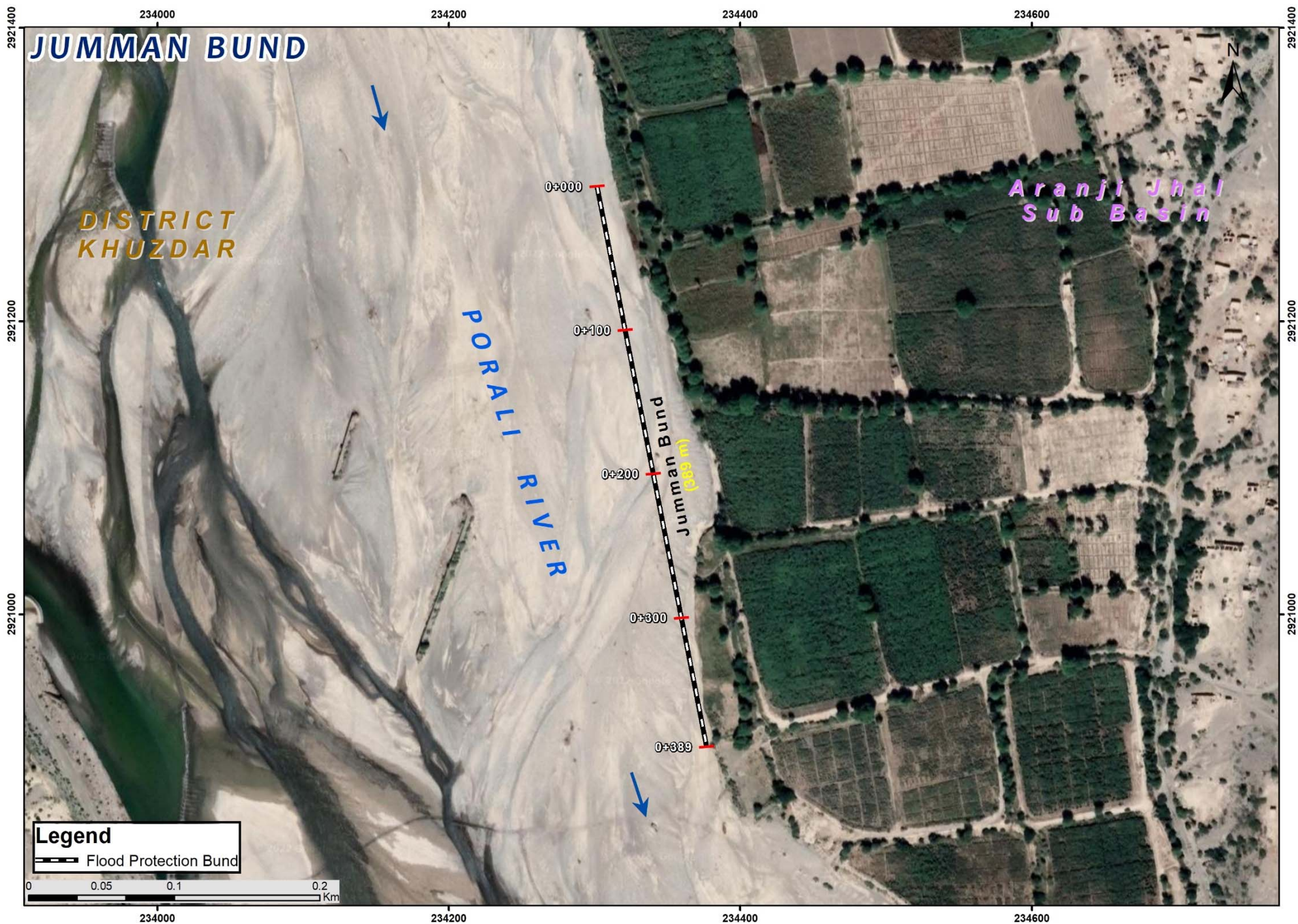


Figure C48

Jumman Flood Protection Bund in Porali River Basin, Balochistan Province.

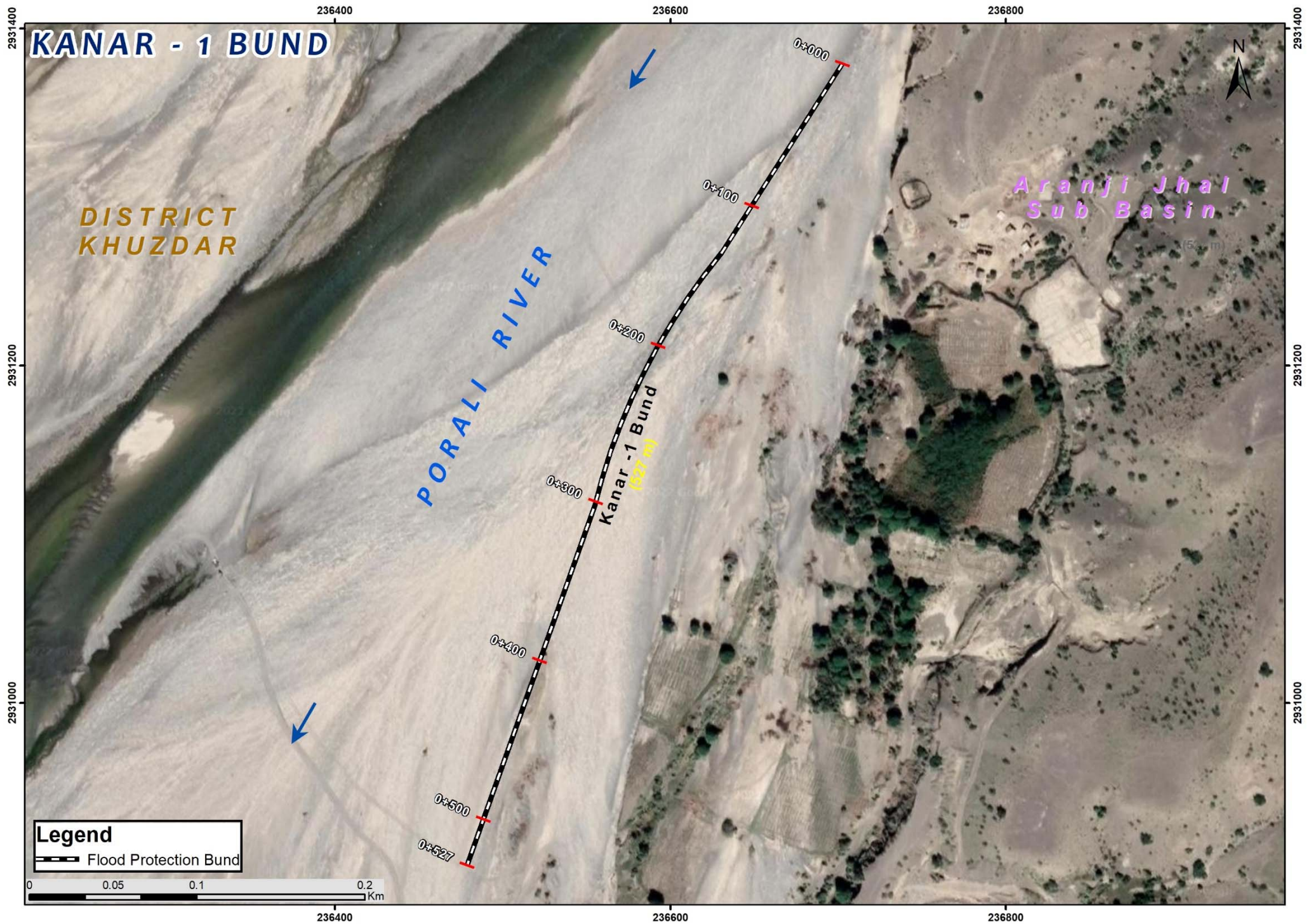


Figure C49 Kanar 1 Flood Protection Bund in Porali River Basin, Balochistan Province.

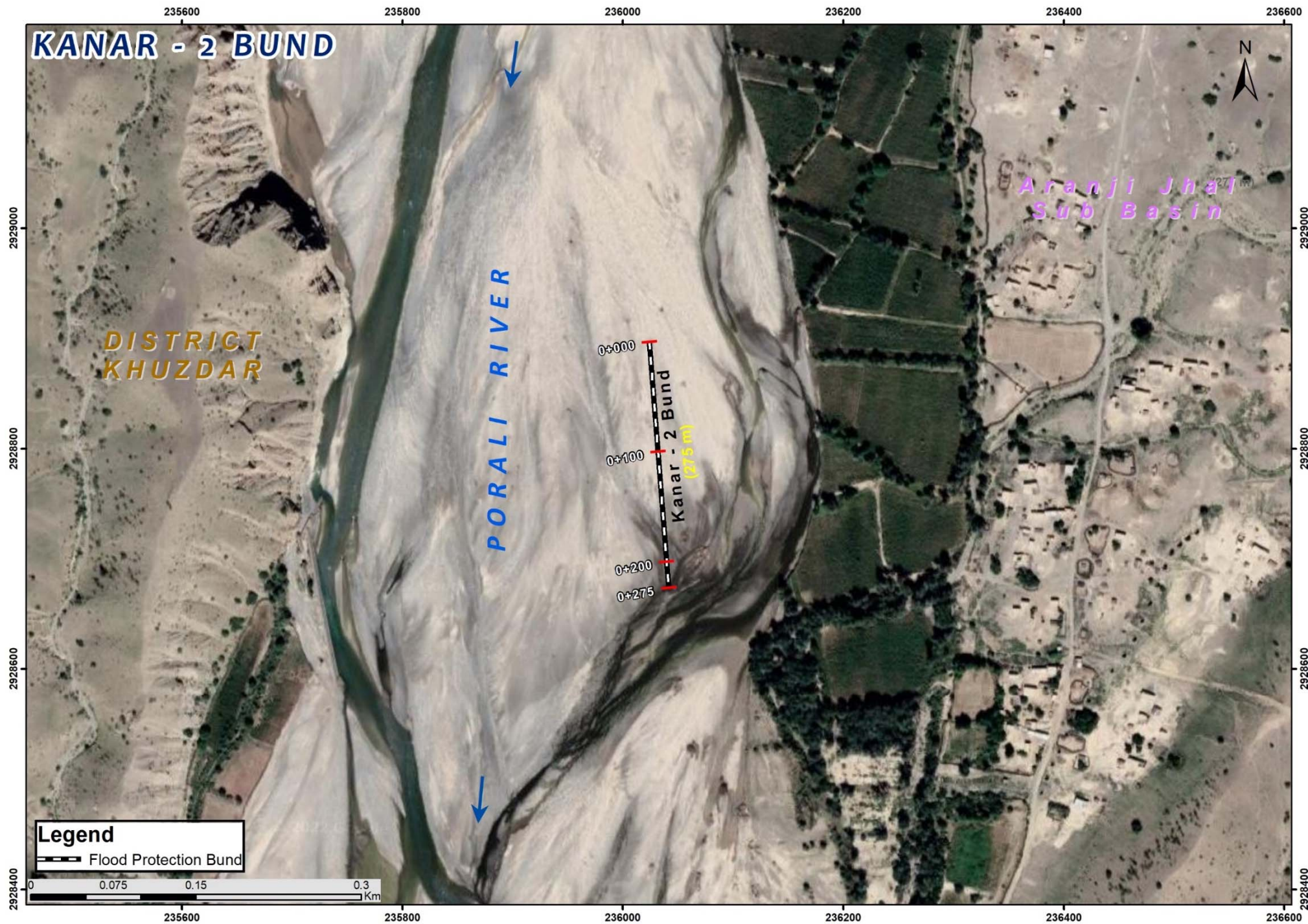


Figure C50

Kanar 2 Flood Protection Bund in Porali River Basin, Balochistan Province.

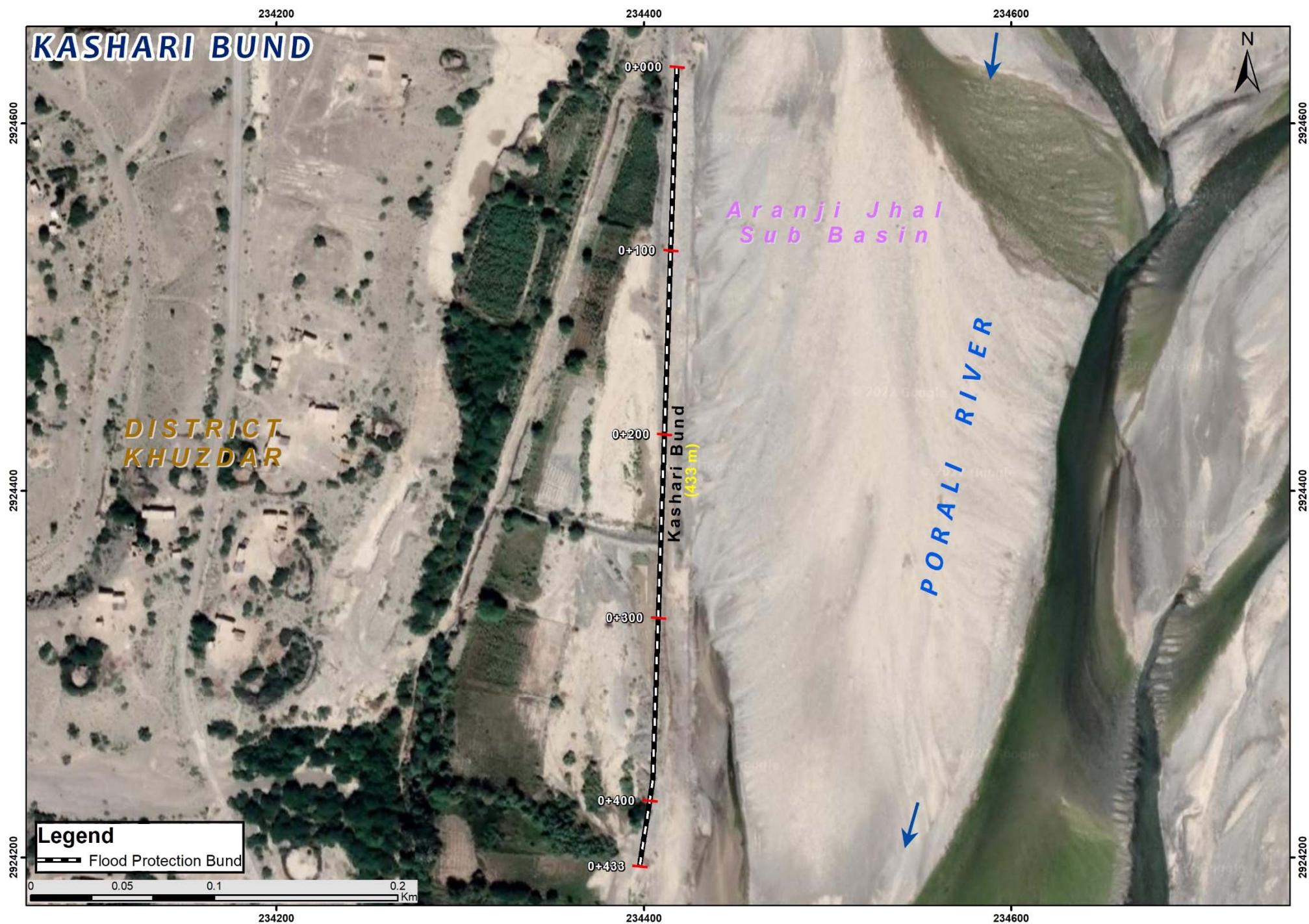


Figure C51 Kashari Flood Protection Bund in Porali River Basin, Balochistan Province.

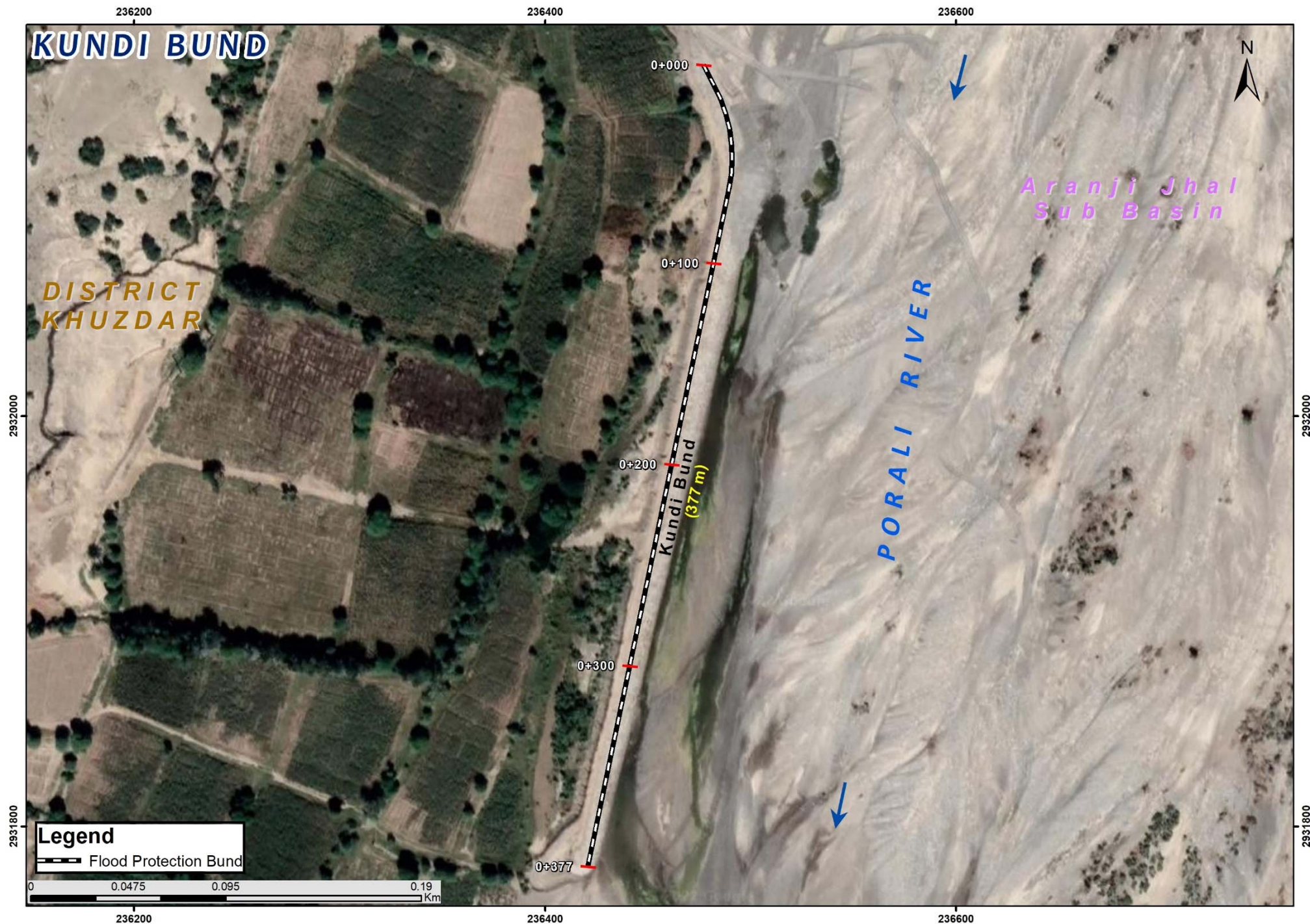


Figure C52 Kundi Flood Protection Bund in Porali River Basin, Balochistan Province.

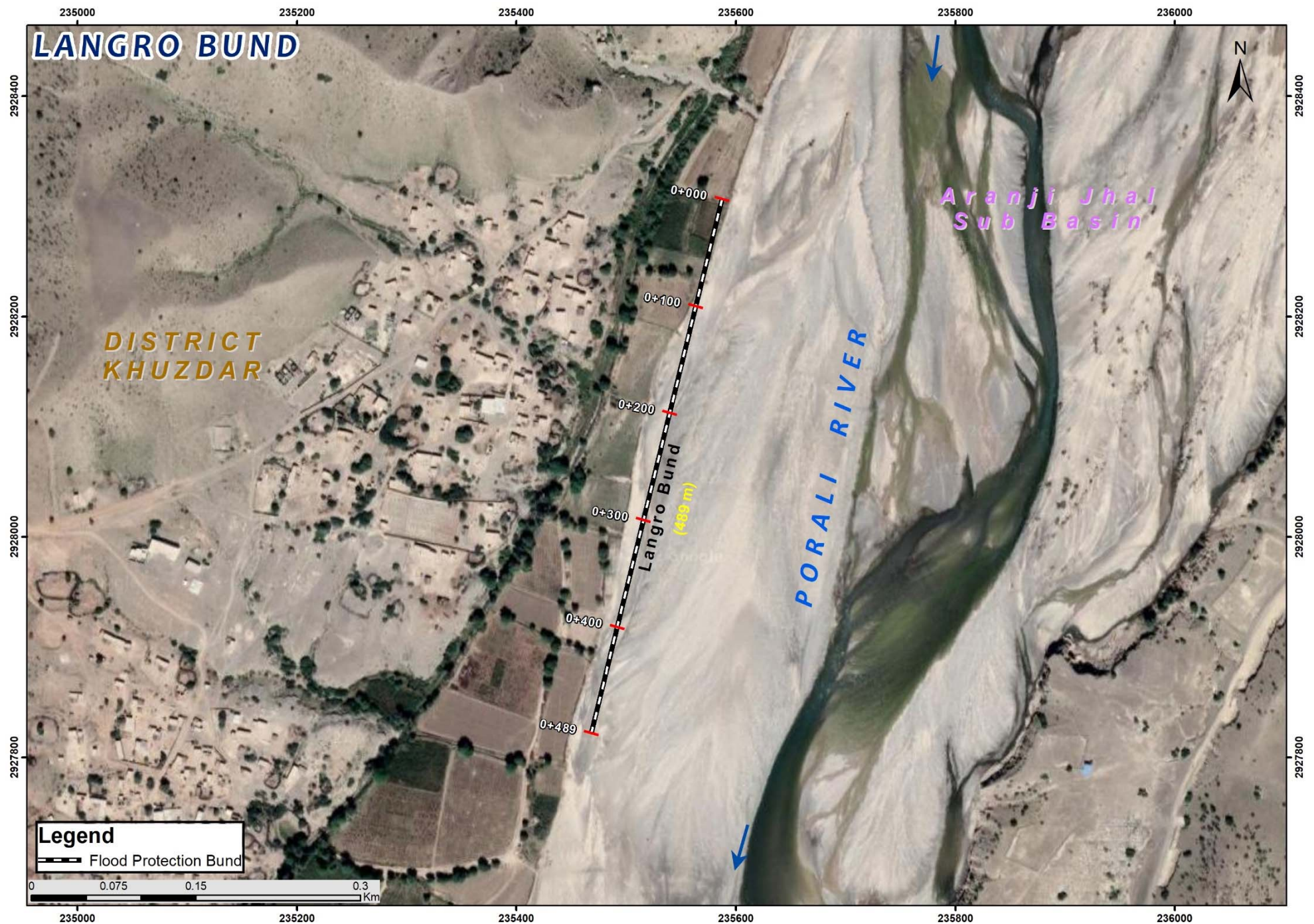


Figure C53 Langro Flood Protection Bund in Porali River Basin, Balochistan Province.

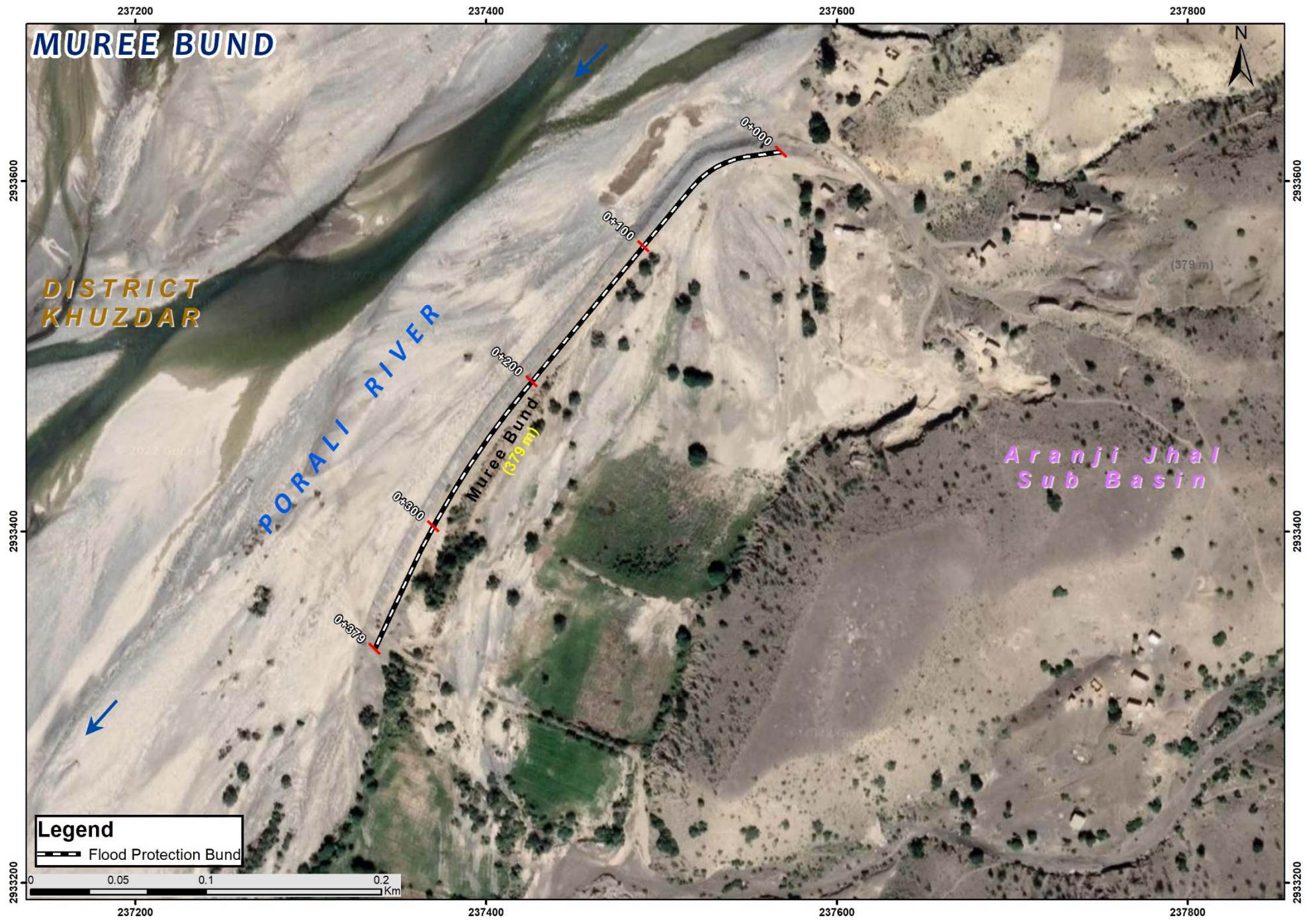


Figure C54 Muree Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C55 Nimmi 1 Flood Protection Bund in Porali River Basin, Balochistan Province.



Figure C56 Nimmi 2 Flood Protection Bund in Porali River Basin, Balochistan Province.

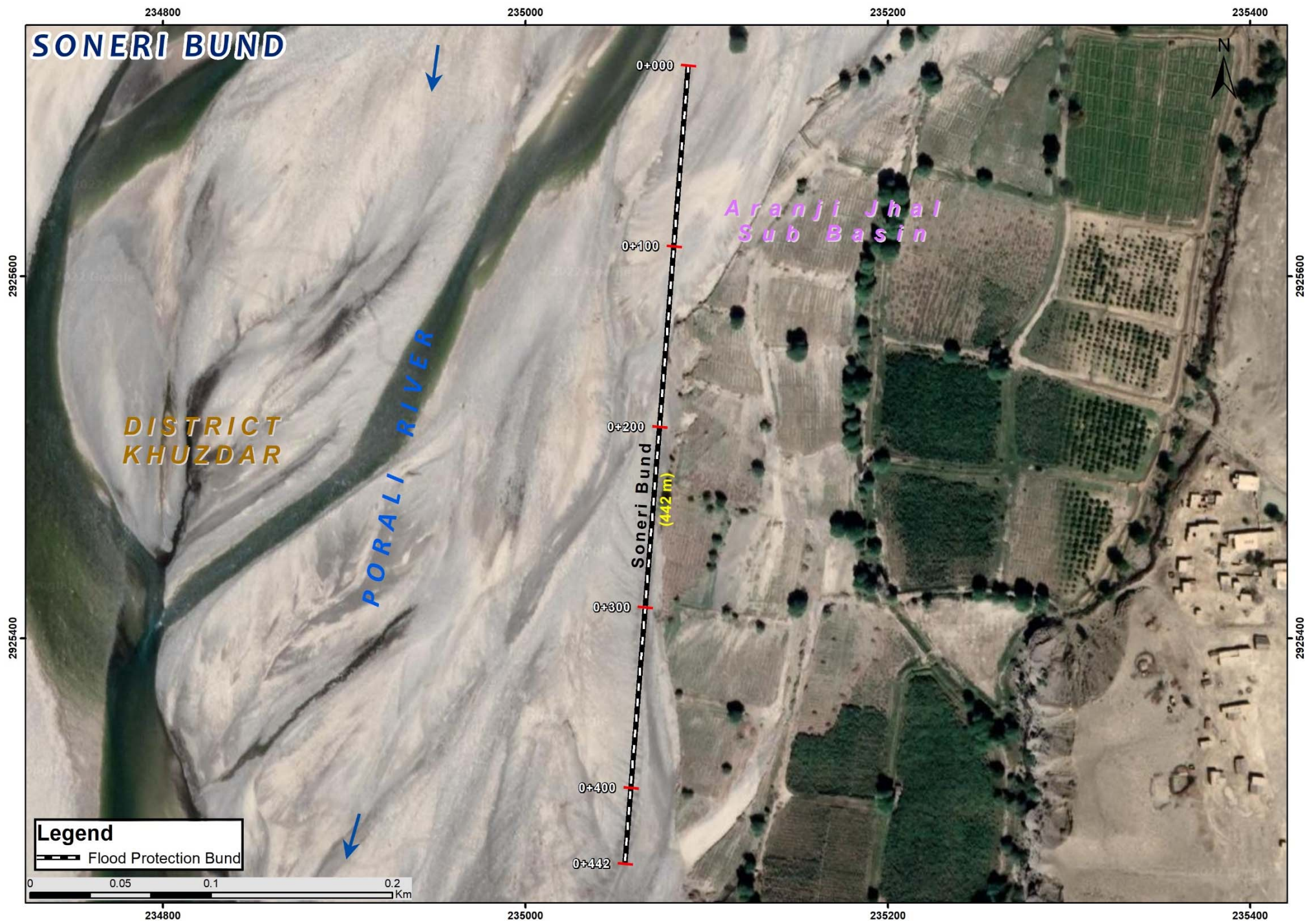


Figure C57

Soneri Flood Protection Bund in Porali River Basin, Balochistan Province.

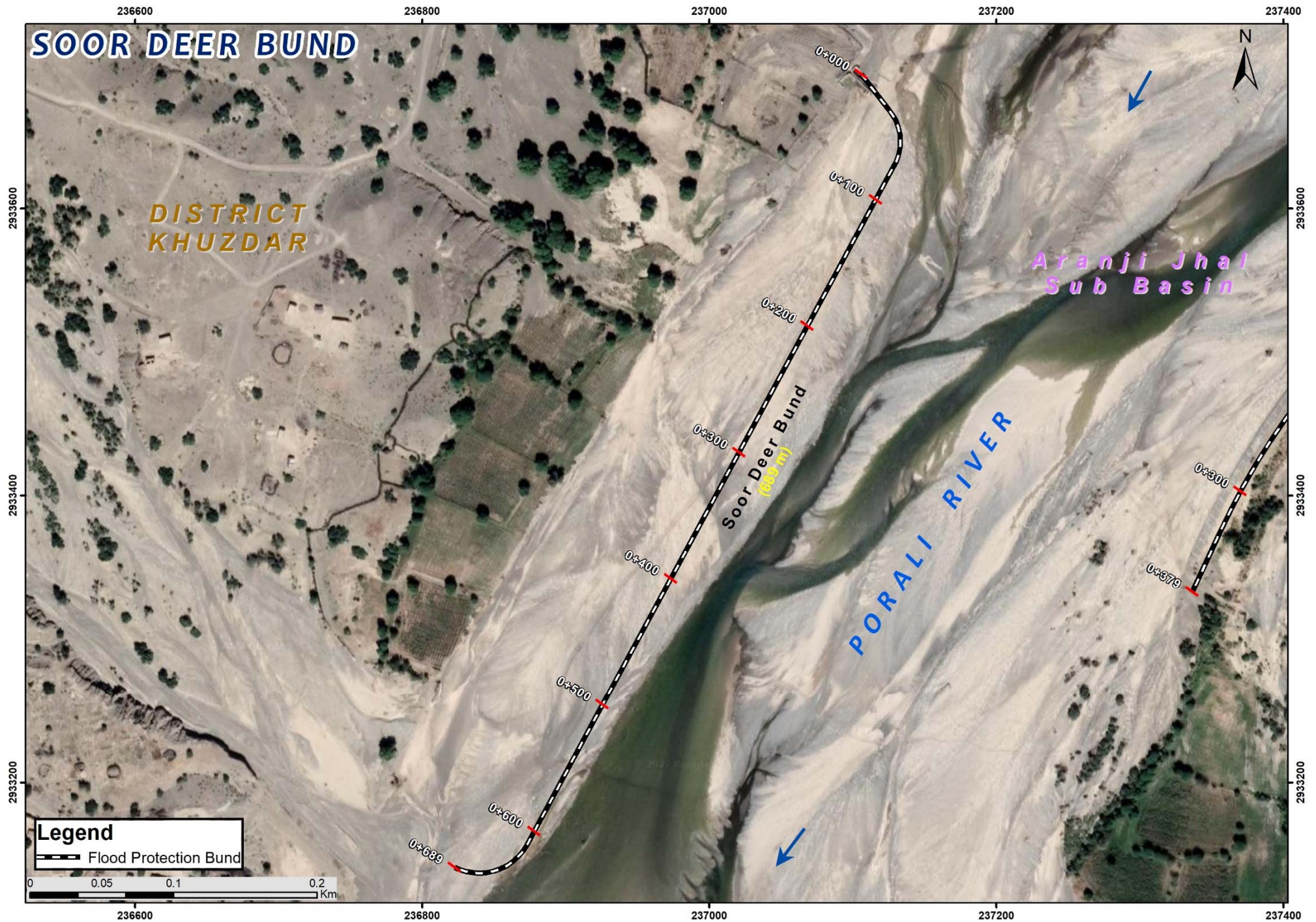


Figure C58 Sordeer Flood Protection Bund in Porali River Basin, Balochistan Province.

Individual Maps of FP Bunds in Nari River Basin

(with image overlay)

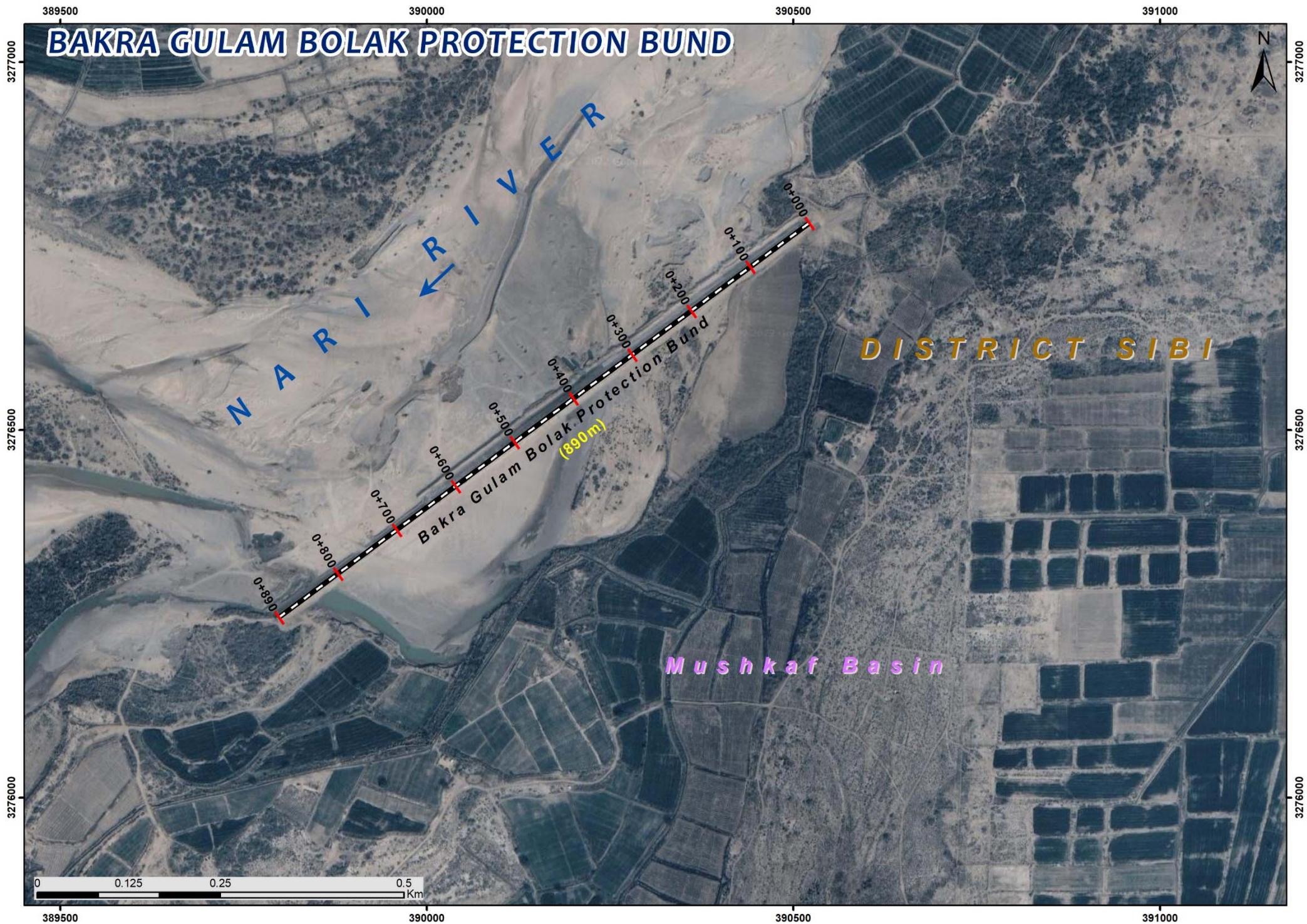


Figure C59 Image Overlay of Bakhra Ghulam Bolak Bund in Nari River Basin, Balochistan Province.

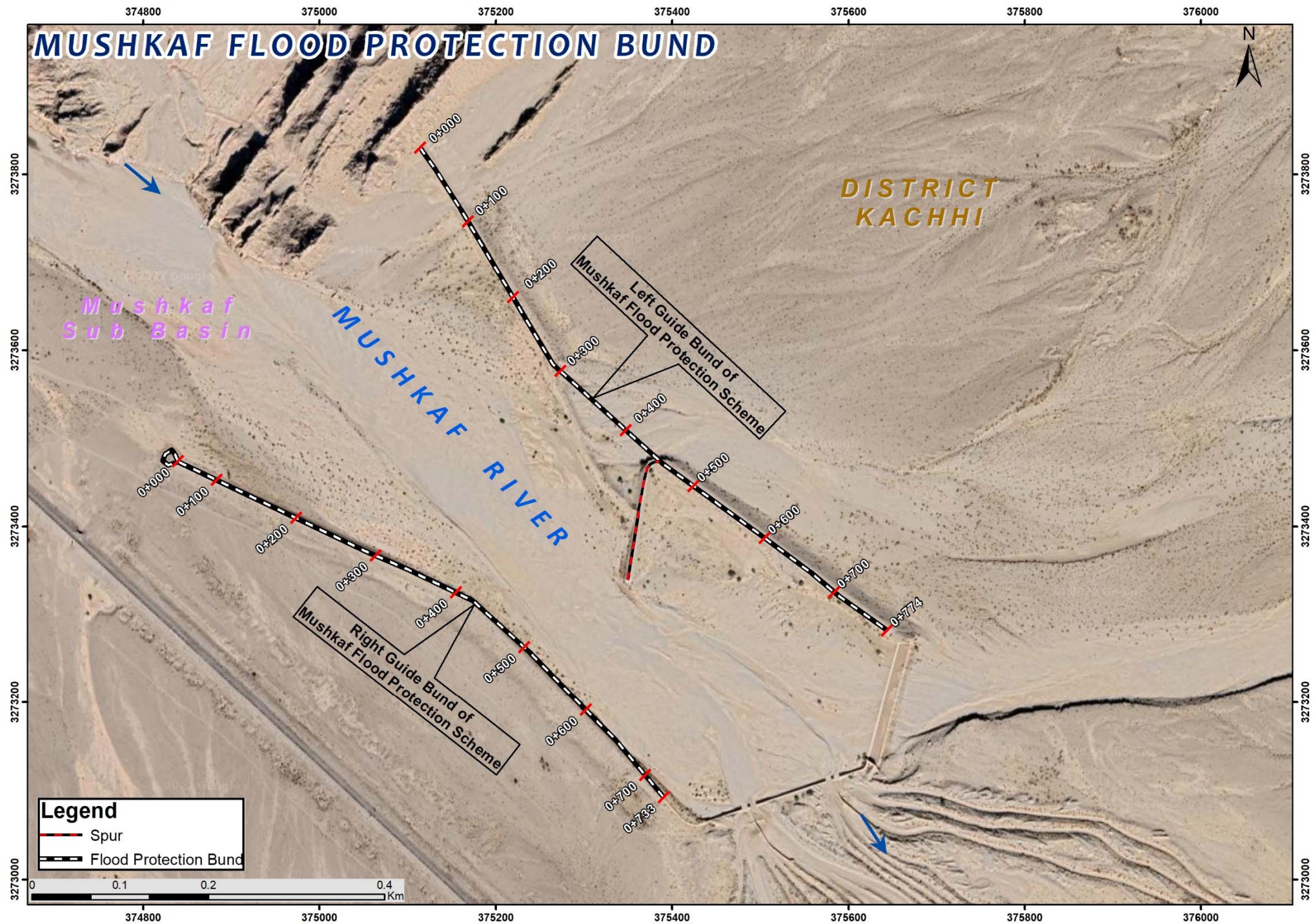


Figure C60

Alignment of Mushkaf FP Bund in Nari River Basin, Balochistan Province.

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